International Labour Organization

ILO/PENSIONS Actuarial Pension Model

User Manual

ILO/PENSIONS

Actuarial Pension Model

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Preface

The ILO Actuarial Pension Model (ILO/PENSIONS) is an online, computer-based projection and simulation tool for pensions developed by the Social Protection Department of the International Labour Office (ILO). The model aims to provide information on the expected financial impact of the introduction of and/or parametric changes to social security schemes for pensions. The model's main aim is to support the costing and design of reforms in social protection systems.

This technical guide explains the methodology and process flow of ILO/PENSIONS and serves as a reference manual for users. ILO/PENSIONS is part of a series of quantitative tools developed by the Social Protection Department to support evidence-based policy reforms. The related technical guides and models can be made available to experts in ILO constituent countries as part of ongoing technical support and capacity-building activities in quantitative techniques in social security. Users of ILO/PENSIONS are expected to be qualified quantitative experts in the actuarial field who have substantial experience in the design and costing of social protection systems. The ILO/PENSIONS model and technical manual can also be used as a teaching aid for specific training in social security quantitative techniques.

The ILO/PENSIONS model and this manual are in line with international actuarial standards and practices, especially the ILO Social Security Minimum Standards Convention, 1952 (No. 102), the ISSA-ILO Guidelines on Actuarial Work for Social Security, 2016, and the *International Standards of Actuarial Practice* (ISAP) recommended by the International Actuarial Association (IAA). The main components of the technical specifications of ILO/PENSIONS were included and developed based on the extensive knowledge produced by the ILO throughout several decades of policy advice and analytical work on social protection, in particular its flagship publications such as *Actuarial Mathematics of Social Security Pensions* (Iyer 1999), *Financing Social Protection: Quantitative Methods in Social Protection Series* (Cichon et al. 2004), and *Actuarial Practice in Social Security* (Plamondon et al. 2002).

ILO quantitative tools are subject to constant development and improvement. New versions of this manual will be published at regular intervals to reflect major technical advances. Requests for further information and user feedback are welcome and can be communicated to us at socpro@ilo.org.

Geneva, July 2021

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How to use this manual: Getting started

This manual was created for actuaries, planners and policymakers working on quantitative aspects of social pension systems using the ILO Actuarial Pension Model. However, the guide is intended to be accessible to all users, so they should feel free to jump between sections to find the relevant parts.

- The Introduction provides an **overview of the model** and its place in the process of actuarial valuation.
- Section 1 discusses the model's **usefulness in policymaking** and the ISSA-ILO *Guidelines on Actuarial Work* that support the **rationale behind it**.
- Section 2 explores the **actuarial valuation process** in depth.
- Section 3 presents the **basic assumptions** regarding the model's architectural framework, its **key functions**, administration and **outputs** (reports and indicators).
- Section 4 gives comprehensive **definitions of key concepts** used in the model and how they are applied.
- Section 5 offers tips on how to **explore the model** and start planning the model.
- Section 6 provides a **practice exercise** to become familiar with the model and its functions, and to learn tricks and techniques to manipulate information within the model.
- Section 7 provides insights into how to conduct a **consistency review** to ensure the accuracy and applicability of the model using projected results from this model.

If users are new to pension systems or would like a more comprehensive discussion of the concepts and definitions behind the model, we recommend reading through the entire manual, taking the time to understand all the definitions and concepts presented in Sections 1-3 before moving on to Sections 4-7.

Even if users have extensive experience with actuarial models or are fluent in the concepts of actuarial planning for social pension systems, they are still advised to read through sections 2-5 to grasp the specifics of this model before using it. Users can then set up the model in section 6, work through some examples in section 7, and review the consistency of the results in section 8. (Tip: Users should take time with this – it may differ from other tools they are familiar with.)

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Introduction

This user manual is designed for use by actuaries, planners and policymakers working in the economic and quantitative field of pension systems, especially those using the ILO Actuarial Pension Model to carry out their analyses.

The manual aims to accompany users throughout the process of diagnosis and quantitative modelling of policies and policy scenarios for pension systems and reforms, under the quantitative methodological framework provided by the ILO Actuarial Pension Model (ILO/PENSIONS). The manual attempts to integrate conceptual aspects of pension systems and pension scheme design with the specific modelling process and methodology followed by ILO Actuarial Pension Model.

The manual and the ILO Actuarial Pension Model are anchored in the core principles embedded in ILO's social security standards, adopted by representatives of the world's governments, employers and workers. These standards are a guarantee for balanced, stable and sustainable approaches to pension design and which are universally applicable to the wide variety of pension schemes. These principles include the responsibility of the State in ensuring the provision of benefits and the proper administration of pension schemes as part of comprehensive national social security systems. States do so by guaranteeing that the necessary actuarial studies and calculations concerning financial equilibrium are made periodically and, in any event, prior to any change in benefits, insurance contribution rates, or taxes allocated to covering the contingency in question. This manual and the ILO/PENSIONS model can be applied to a variety of situations. They include cases at the national or sectoral level where policymakers may want to introduce a new social pension system, social insurance or tax-based pension scheme using alternative financing sources and mechanisms, or to reform existing pension schemes.

ILO/PENSIONS is the result of conceptual, methodological and instrumental development over several decades of experience of the ILO worldwide. It is an actuarial model that combines pension-specific components of economic, demographic and financial modelling. Because of its versatility, the model can also be used to support quantitative work in tax-financed national pension systems.

The formulation of quantitative models for pension systems/schemes comprises a complex and interrelated set of elements, including the macroeconomic framework, labour market, different population groups covered, and rules of financing and access to pension benefits.

This manual is designed to guide the quantitative modelling process in a simple and direct way. Each section combines conceptual design aspects with practical aspects of the modelling methodology and the actuarial tool. Users of the manual will learn how to choose and implement components of the initial configuration and parameterization of ILO/PENSIONS, such as the selection of the projection period, whether to work with a single pension scheme or to simultaneously define different pension schemes according to country-specific circumstances. As different schemes usually operate with different legal conditions and institutional and financing arrangements, a multi-scheme model configuration is needed. Other examples include selecting the specific groups of social security contributors and their dependants (private/public sector employees, rural/urban, among others) that will interact in a specific model formulation; as well as identifying and specifying the pension benefits to be included in the model.

Once a pension model has been specified and parameterized in ILO/PENSIONS, this manual guides users through data entry, initial runs, reviewing and calibrating results for a baseline projection scenario, formulating projection scenarios linked to the policy scenarios to be simulated, conducting analyses and reporting results.

ILO/PENSIONS provides a wide range of options for reporting and displaying results, allowing users to easily follow both intermediate and final quantitative outputs. This feature is beneficial during the calibration and consistency review process. ILO/PENSIONS also provides several output tables and graphing options for most of the intermediate calculations performed, as well as reports that include an extensive set of demographic and financial indicators, and output tables with the consolidated demographic and financial flows.

The ILO is not responsible for projection results produced with the help of its software by users who are not ILO staff. All requests for further information or software updates should be sent to the email address given below.

This user manual was developed by Andrés Acuña-Ulate and Sergio Velasco, Social Security Actuaries of the Public Finance, Actuarial and Statistics Unit, PFACTS, and Fabio Durán-Valverde, Head of the Unit, with assistance from Nanya Sudhir and Zhiming Yu, Technical Officers of the Unit. André Picard, Head of the Actuarial Services Unit of the Social Protection Department of the ILO made contributions to this manual, as did members of the International Social Security Association (ISSA) Technical Commission on Statistical, Actuarial and Financial Studies. The manual also benefited from reviews by the following ILO specialists of the Social Protection Department: Kroum Markov, Legal Officer; Karuna Pal, Head of the Programming, Partnerships and Knowledge-Sharing Unit; Lou Tessier, Health Protection Specialist; Maya Stern-Plaza, Legal Officer; and José Francisco Ortiz, Social Protection Specialist. This manual was prepared under the technical supervision of Fabio Durán-Valverde.

Comments and contributions to improving this user manual are welcome and can be sent to socpropfacts@ilo.org.

1. The ILO intervention model for actuarial work: building a strong technical base for a policy-oriented process

This section is for:
- *Policymakers taking decisions based on actuarial work and reports*
- *Journalists or media and communications specialists who want to report accurately on actuarial valuation processes*
- *General users with an interest in actuarial matters and social protection*

In this section, users will learn:
- *The importance of actuarial modelling for policy design*
- *Why pension schemes need actuarial and financial models*
- *The ILO intervention model for technical assistance in the actuarial field*
- *General features of ILO/PENSIONS*
- *ILO standards and core principles and minimum benchmarks for social pension systems*
- *ISSA-ILO Guidelines on Actuarial Work for Social Security*

The process of intervention for development assistance in actuarial work

The effective administration of a pension scheme based on a sound long-term financial and actuarial perspective is crucial for ensuring its sustainability. The practice of conducting periodic actuarial valuations and assessing the expected impact of proposed pension system reforms is central to operationalizing the State's responsibility under international social security standards. Actuarial valuations provide this long-term financial perspective for managers and planners of social security schemes. Actuarial reviews require the incorporation of long-term demographic and financial projections into the complex financial systems of pension schemes, which can only be done using models. ILO/PENSIONS was developed to support actuarial and financial reviews or studies of statutory pension systems and schemes. It helps to provide a quantitative basis for making policy decisions with respect to pension systems. ILO/PENSIONS enables:

(i) projections of future benefit expenditure and contributions base through year-by-year calculations;

(ii) determination of current and future financing needs, including contribution rates and tax transfers from the government;

(iii) simulation of scheme reserves;

(iv) assessment of the financial impact of changes in design parameters of schemes/programmes; and

(v) identification of factors to be considered when creating the required fiscal space for financing pension systems.

The development of more powerful IT tools has vastly improved the quality of quantitative models in pension systems.

A critical issue for the ILO is that actuarial work and its linkage to policy design should be framed within international social security standards as well as comparative best practices. The ILO Social Security (Minimum Standards) Convention, 1952 (No. 102), which served as the blueprint for the development of social security worldwide, states that the periodic realization of actuarial studies and calculations is the main way the State can assume its general responsibility for the due provision of social security benefits. In particular, Article 71.3 of Convention No. 102 states that: "The Member shall accept general responsibility for the due provision of the benefits provided in compliance with this Convention, and shall take all measures required for this purpose; it shall ensure, where appropriate, that the necessary actuarial studies and calculations concerning financial equilibrium are made periodically and, in any event, prior to any change in benefits, the rate of insurance contributions, or the taxes allocated to covering the contingencies in question."

The International Social Security Association (ISSA), and ILO jointly developed *Guidelines on Actuarial Work for Social Security (*hereafter referred to as the *ISSA-ILO Actuarial Guidelines)* to provide guidance on the application of good practices in the administration of social security systems. The main objectives of the guidelines are to:

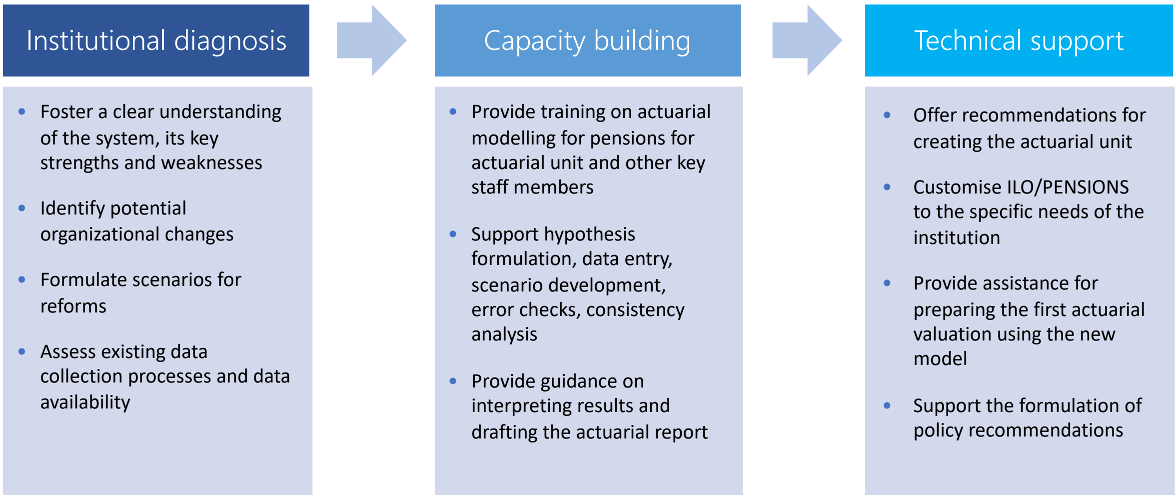
1. promote good practices in relation to actuarial work undertaken by and for social security institutions and support efforts to improve accuracy, consistency and comparability of actuarial work;
2. provide guidance for the procedures carried out by actuaries in their work;
3. facilitate the work of institutions in their governance procedures relating to actuarial work;
4. improve the efficiency of actuarial procedures;
5. provide practical assistance to institutions to facilitate their compliance with actuarial standards; and
6. provide guidance to individuals or bodies responsible for policy issues and regulation on actuarial involvement.

The formulation of ILO/PENSIONS and the methodological approach, as well as the work supported by the model and this manual, are framed within these international standards and good practices.

According to the *ISSA-ILO Actuarial Guidelines*, actuarial work should be adequately linked to national and institutional needs to undertake reforms and improve systems, both in the design of the schemes and managing institutions and in the building of institutional capacities.

Based on its experience of several decades, the ILO developed an intervention model for the actuarial field that covers three main processes: national or institutional diagnostic, capacity building and technical support (Figure 1).

Figure 1 – The ILO intervention model for technical assistance in the actuarial field



This intervention model is important because actuarial work in social security requires reliable diagnoses to better understand social pension insurance schemes and to develop appropriate policy scenarios. ILO/PENSIONS is both an instrument for policy formulation and part of a comprehensive process of intervention for technical assistance. In accordance with the ILO's technical assistance framework in the field of social security, the relevant social security institutions should assume responsibility for the actuarial tools and generate local capacity as autonomously as possible. The ILO intervention model, therefore, considers capacity building crucial for the implementation of the model and subsequent assistance to ensure ownership of the actuarial work by countries and social security institutions.

ILO core principles and minimum benchmarks for pension systems

For the ILO, it is essential that actuarial work on social security and the resulting outcomes, including policy recommendations, are in line with the principles enshrined in the international social security standards developed by its tripartite constituents.

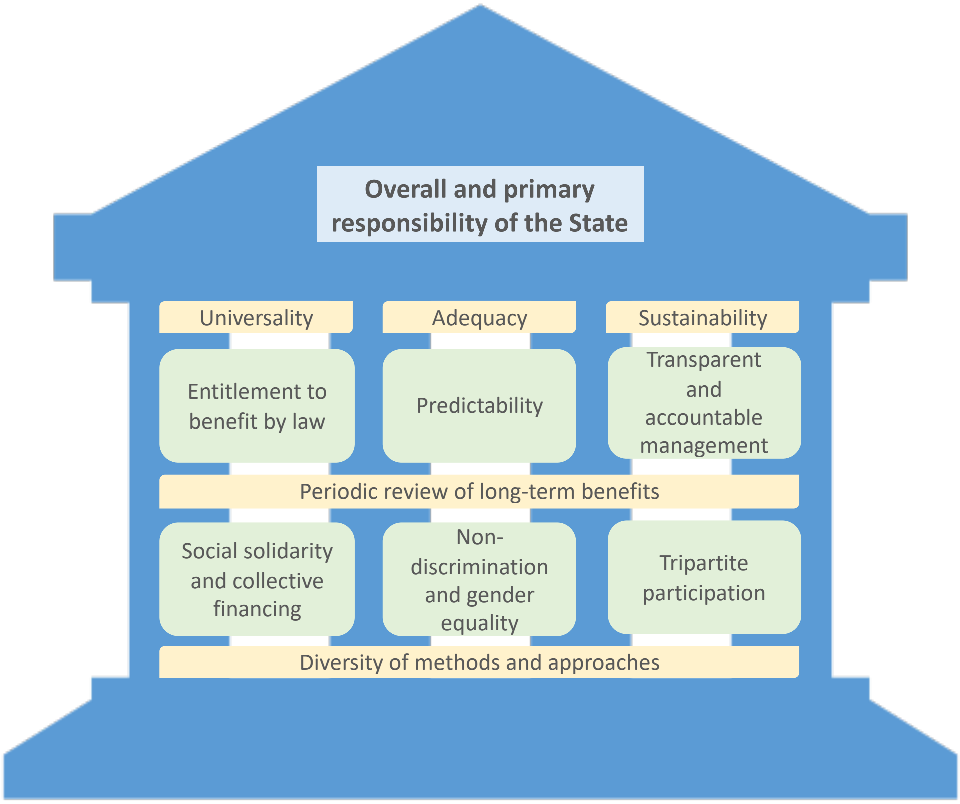
Over its century of existence, the ILO has promoted the core principles and minimum benchmarks enshrined in its standards when providing support to ILO constituents in designing or reforming their national social security systems. Having been adopted by government, employer and worker representatives, these standards constitute an internationally set reference for both policy design and implementation of social security systems.

Notably, these standards establish the principles of collective financing and risk pooling as the expression of social solidarity underpinning social security systems. ILO standards relevant to old-age pensions include the Social Security (Minimum Standards) Convention, 1952 (No. 102); the

Invalidity, Old-Age and Survivors Benefits Convention, 1967 (No. 128) and the Social Protection Floors Recommendation, 2012 (No. 202). These standards have been adopted by governments, employers and workers' representatives, and constitute a key reference for both policy design and implementation of social security systems. Like the other ILO social security standards, these standards are applicable worldwide, considering the different modalities in the design and provision of social security as well as the different levels of development of national social security systems. Consequently, they are designed based on the premise that while there is no one-size-fits-all approach to social protection in general (especially in old age), a set of core principles and minimum parameters (or benchmarks) can be established internationally to serve as a framework for guiding government action, even in the absence of ratification.

The most relevant core principles concerning protection in old age, invalidity and survival set forth in ILO standards can be regrouped into the following main categories:

Figure 2 – Internationally agreed-upon core principles in the ILO standards



The minimum parameters set in the standards include the level of pension benefits, their payment throughout the course of the contingency, eligibility criteria and the minimum coverage in terms of persons to be protected, or the periods of contributions needed to qualify for receiving a pension. By way of example, Convention No. 102 requires that contributory systems guarantee a replacement rate of at least 40 per cent of previous earnings to persons who are at least 65 years old and have 30 years of contributions.

2. The actuarial valuation process in social security schemes

This section is for:

- *Managers or others involved in the development of new actuarial units in social security institutions*
- *Users engaged in actuarial work in social security who want to obtain a perspective of the scale of the entire process*
- *Newcomers to actuarial practice in social security*

In this section, users will learn:

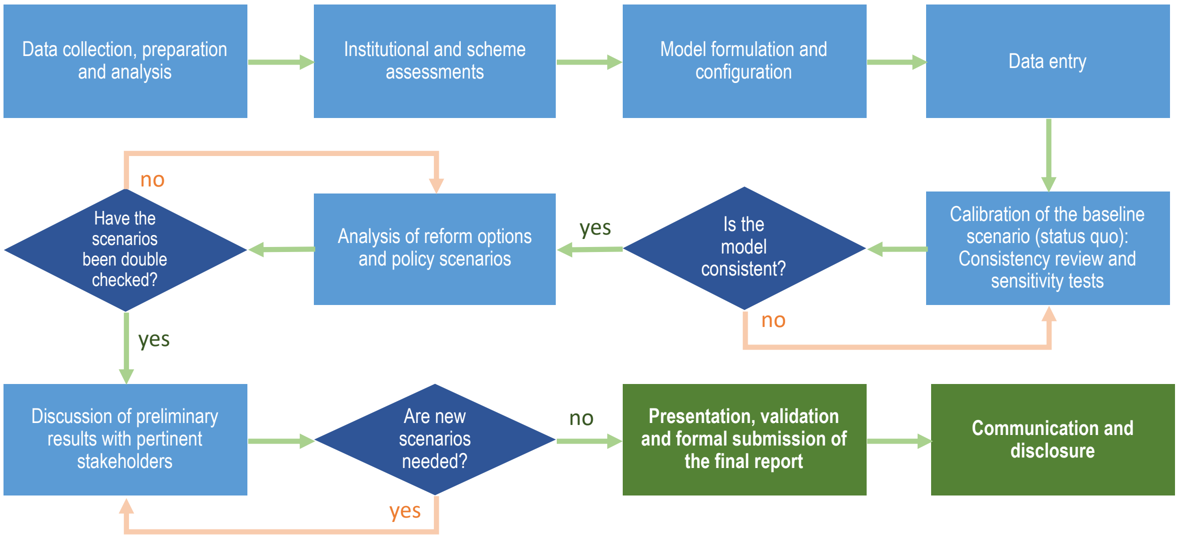
- *The stages of preparing an actuarial evaluation:*
    - *Data collection, preparation and analysis*
    - *Institutional and scheme diagnostics*
    - *Model development and configuration*
    - *Data entry*
    - *Baseline calibration and consistency review*
    - *Analysis of reform options and policy scenarios*
    - *Stakeholder discussions*
    - *Actuarial report*
    - *Communication and disclosure*

It is extremely important that users prepare and review an actuarial valuation of a social security scheme in a systematic, meticulously organized way to ensure high quality results. Although the methodology and processes are standard, it is advisable to agree on their adequate definition to guide the actuarial valuation process developed by both social security institutions and external actuarial service providers.

Specifically, the process must comply with the international standards and guidelines of the International Association of Actuaries (IAA), and the *ISSA-ILO Actuarial Guidelines*, especially Guidelines 1-12, 25-28, and 40-46.

This section describes the different stages of preparing the actuarial valuation and walks users through the steps to ensure that the actuarial valuation complies with international best practices, especially the *ISSA-ILO Actuarial Guidelines*. The section is not intended to replace the contents of the *ISSA-ILO Actuarial Guidelines*, nor does it attempt to cover all aspects of developing an actuarial valuation. Users who want more detailed information should consult Guidelines 1 to 12 of the *ISSA-ILO Actuarial Guidelines*.

Figure 3 – General workflow of actuarial valuations



As required by the *ISSA-ILO Actuarial Guidelines*, each stage of the actuarial valuation should include a clearly documented peer review, specifying who is responsible for carrying it out, what the findings of this process were and what measures were taken, if any.

2.1. Data collection, preparation and analysis

The proper organization and implementation of data collection, preparation and analysis are critical to ensuring high quality results throughout the process.

The data required for the operation of the actuarial model include the demographic and financial information of current active and inactive contributors, current and potential beneficiaries, as well as the current rules under which the system operates and any expected future changes to them. The social security institution is responsible for ensuring that this information is updated, available and reliable.

Box. ISSA-ILO Guidelines on Actuarial Work for Social Security

Guideline 2. Data

In preparing a report, the social security institution ensures the availability of sufficient and reliable data necessary to perform actuarial work. The social security institution is responsible for the management of the data pertaining to the social security scheme participants and provisions, and compliance with data privacy legislation and national standards. The actuary provides an opinion on sufficiency and reliability of data, describes any modification made to data and the impacts of imperfect data on the social security scheme and its participants, and makes recommendations for improving the quality of data.
(…)

Principles:

- The social security institution should define responsibilities for data management within the organization including who is responsible for the management of the process and peer review processes.
- The data management process should ensure security of data (including detailing back-up procedures) and that any legal requirements regarding data privacy are respected.
- Data requirements should be documented and justified. These should take into account specific needs of the programmes that require actuarial work and the actuarial method and models adopted for the valuations. The documentation should: identify data elements; describe the use of data; provide sources of data.
- Social security institutions should have a well-documented and structured procedure on preparing data requests for external and internal data providers.
- Social security institutions should establish a well-documented and structured data validation process which will test internal data consistency as well as consistency with external sources (e.g. audited financial statements).
- Data collection should be undertaken using the seriatim approach. In a case where grouped data is used for the actuarial valuation, it is the responsibility of the actuary to determine the appropriate approach to group the data. The impact on the results of using grouped data as opposed to individual data should be assessed and communicated appropriately to relevant stakeholders.
- Lack of data, for example for a newly established social security scheme, presents a major challenge for social security professionals. In such situations, actuaries may need to rely on data from other sources and programmes. The actuary should coordinate with other agencies and stakeholders to ensure that the most appropriate data is used.

Entering data into the actuarial model requires information from different sources, not only from the social security institution, but also from other institutions, including household surveys, macroeconomic and social sector surveys, reports and databases. Coherence and consistency of information from the different sources must be ensured through a data review, analysis and cleaning process. Modern data science tools such as data integration and data visualization are instrumental to this process. The main sources of data required for the model include:

- **Official statistical information.** Consistency should be maintained between publications by the national institutions, including statistical yearbooks or other statistical or official database sources (economic, demographic, financial, etc.). Any discrepancies with the official information may later be questioned, also calling into question the results of the process.

- **Previous actuarial valuations**. The actuarial study should follow up on and analyse trends, conclusions and recommendations in previous studies. This also applies to events and decisions (actions) taken between the previous and most recent valuations. Any significant differences should be explained. According to Guideline 7 of the *ISSA-ILO Actuarial Guidelines*, "The valuation of a social security scheme includes the reconciliation of the value of the sustainability measures, financial indicators and other relevant results between the previous and current valuations. As part of the risk management of the social security scheme, the social security institution examines the main drivers of the changes in results between successive valuations." Sustainability measures, financial indicators and other results that can be reconciled may include, but are not limited to, the following:
    - The difference between assets and actuarial liabilities (determined using the closed or open group methodology for fully funded schemes, or open group methodology for PAYG and partially funded schemes);
    - PAYG rates;
    - General average premium (GAP);
    - Relevant contribution rates;
    - Actuarial balance;
    - Total expenditures as a percentage of GDP; and
    - Ratio of assets to expenditures.

- **Financial statements.** Revenues, expenditures, reserve funds and interest revenues, etc., disclosed in the financial statements should be consistent with the actuarial valuation, especially in the early years of the projection.

- **Plans and programmes for the extension of coverage.** These plans and programmes should be consistent with the demographic and financial assumptions adopted during model formulation and should therefore be reflected in projection results. If the results of the actuarial valuation are inconsistent with any of these documents, the reasons for this should be clearly explained in the technical report.

- **Actuary's opinion on the data.** The actuary must issue their technical opinion regarding the sufficiency and reliability of the available data and clarify the adjustments made to the original data.

2.2. Institutional and scheme assessments

The formulation of actuarial work, in particular the design of policy scenarios, must be supported by a rigorous analysis of the institutional situation and the social insurance scheme parameters to be evaluated. This process includes the analysis of the:

(1) social, demographic, macroeconomic and labour market environment, which affects sources of financing (productivity and wages, social contributions, interest income from the reserve, inflation rates) and expenditure trends;
(2) legal and regulatory framework against the principles and minimum benchmarks established by ILO standards on social security (including comments by ILO supervisory bodies in the event of ratification of a relevant Convention);
(3) governance in general, including the organization of political and administrative structures (see *ISSA Guidelines on Good Governance*);
(4) administrative and operational processes to identify areas of potential improvement that affect efficiency and results in terms of contribution collection, administrative cost, adequacy of benefits, and coverage and access to benefits;
(5) the scheme's investment regime and functioning;
(6) other areas of interest based on specific requirements of the analysis.

Experts with relevant experience and expertise in social protection may participate in institutional and scheme assessments. The information needs to be detailed enough to inform the actuary who will lead the actuarial work, including configuration of the model and the operationalization of the policy scenarios to be simulated.

2.3. Model formulation and configuration

The formulation and configuration of a specific actuarial model must comply with a set of technical, actuarial and policy analysis requirements. This process should be guided by practical criteria that consider existing evidence of problems already identified, resulting from studies and analyses conducted before this stage. It should avoid abstract exercises and prioritize applicability.

Some aspects to consider while formulating a scenario:

Level of disaggregation of inputs and outputs required. The definition of this level is related to the final objectives of the model formulation in terms of the policy scenarios to be modelled. The availability of information or input data is also a determining factor in the level of disaggregation of the model inputs. As a rule, the model aims for a level of disaggregation that best allows it to answer the relevant policy questions, as long as data availability allows it.

Assumptions. The definition of demographic and financial assumptions is one of the most sensitive issues related to an actuarial study. The *International Standards of Actuarial Practice 2* (ISAP2) provides a simple, practical criterion for their definition. "If the actuary sets the assumptions, the actuary should use neutral assumptions in a financial analysis of a social security programme. Neutral assumptions are such that the actuary expects that the resulting projection of the scheme experience is not a material underestimate or overestimate." Additionally, all assumptions must meet certain conditions. For instance, short-term assumptions cannot deviate significantly from recent experience.

Sufficiency and role of the actuary and stakeholders. According to the Guideline 3 of the *ISSA-ILO Actuarial Guidelines*, assumptions used for the valuation of a social security scheme are sufficient to value the scheme in accordance with its financing objectives and consistent with the overall socio-economic environment of the country. The development of assumptions combines the analysis of historical trends with a forward-looking approach. Social security institutions assign major responsibilities to an actuary in the assumption-setting process. An actuary provides an opinion on the extent to which the assumptions used for actuarial work are reasonable and appropriate both individually and on an aggregate basis. By their nature, social security programmes cover wide segments of the population. Thus, economy-wide and nation-wide economic and demographic assumptions are often needed for the purpose of performing actuarial valuations. The development of assumptions is often a joint exercise that involves inputs from many parties: experts from the responsible institution, relevant ministries, various governmental organizations and independent bodies of experts. Moreover, some of the assumptions may be prescribed by legislation or provided by various governmental organizations.

Cross-validation. Whenever possible, and to avoid misunderstandings, responsible institutions and other national counterparts should participate in the definition and validation of these assumptions, emphasizing the criteria they must meet for the results to be valid.

Consistency with current data available. The assumptions adopted should be consistent with both the information observed in the base year of the projection and with recent trends. If there are significant deviations, they must be adequately explained. The actuary's technical criteria play a pivotal role when analysing the evolution of the results of the actuarial and financial projections. For instance, the actuary needs to determine the extent to which existing commitments and obligations, such as investments made in the short and medium term with already established rates of return, can and should affect short- and medium-term assumptions.

Mutually consistent assumptions. The assumptions must be mutually consistent throughout the projection. For example, the average growth rate of certain pensions must be aligned with the average growth rate of insurable earnings and the economy as a whole. Although there are situations in which these relationships seem to be affected by external factors, there should be consistency when considering sufficiently long periods.

Existing plans and programmes. Existing plans that provide for future changes or adjustments, such as: extension of coverage to excluded groups, expansion of existing infrastructure, adjustment of benefit calculation rules, and modification of the investment portfolio, among others, should also be considered when defining demographic and financial assumptions and should therefore be reflected in projection results.

Nominal versus real values. The actuary should determine whether the model is formulated in nominal terms or in real terms. Both options are valid, but whatever the decision, the actuary must clearly state it when documenting the model and ensure that all calculations and results of the actuarial report are clear and consistent.

Opinion of the actuary regarding the assumptions. The actuary should issue a technical opinion on whether the assumptions adopted are reasonable and appropriate, referring to the assumptions both individually and collectively.

Definition of scenarios. As the additional scenarios respond to solutions to identified problems or to policies to improve management, coverage, adequacy, or compliance with international social security standards, among others, their definition should be made taking into account the opinion of the organizations of the stakeholders involved in the administration of the social security scheme, which are usually workers, employers and government. This topic is discussed in more detail later in this section.

2.4. Data entry

Entering data into the model (variables, parameters, assumptions, and others) is often a laborious and tedious activity. Users should only begin this phase when they are fully confident of the specific objectives to be achieved by the formulation of a specific model. Monitoring and double-checking this process are critical.

Preparing the model inputs is a meticulous process that in some institutions may demand a significant effort, particularly the first time the necessary data set is produced. Social security institutions must make an effort to produce accurate data for model inputs.

Generally, users reviewing the model should be different from users entering data. Alternatively, if more than one user is assigned responsibility for entering data into the different blocks of a model (context, internal demographics, rules and regulations, etc.), the technical team involved in the actuarial work can supervise and cross-check this process.

The data entry process for ILO/PENSIONS is explained in section 6 of this manual.

2.5. Calibration of the baseline (status quo) scenario: consistency review, sensitivity tests and reconciliation

Model calibration is the process of adjusting a model's inputs and parameters and putting in place constraints on the margins of certainties to obtain results that meet certain criteria. By adjusting the model's parameters, the calibration process allows users to correct significant deviations from the observable values of the projection variables. Consequently, the calibration process requires sufficiently observed and credible historical data.

To address calibration, the actuary needs to have a clear idea about the purpose of formulating a given model. The degree of complexity of the calibration process is directly related to the degree of complexity of the model. Accordingly, the calibration process requires the judgement of a professional actuary, which is usually developed through professional training and years of experience.

Usually, the model should be able to reproduce, to a certain degree of accuracy, results observed in a recent period. There are no specific rules on how to calibrate an actuarial model, and this is where the professional experience of the actuary becomes critical. But as a first step, the model, along with its parameters and assumptions, should reproduce with some accuracy the demographic and financial results observed for the first year of the projection, the fraction of the year with available results, or the observed results of several previous annual periods if the projection period begins in a period prior to the current year. An alternative method, not included in ILO/PENSIONS, is to run a back projection, i.e. go back in time to reproduce the values observed in the years covered by the back-projection exercise.

2.5.1. Consistency review

The calibration process discussed in the previous section must be accompanied by a rigorous consistency review of the results for the whole projection period to identify explanations or unexpected deviations. This part of the process is critical to ensure the success of the actuarial valuation. Section 7 offers a detailed discussion of the consistency tests supported by the projection indicators generated by ILO/PENSIONS.

The review process should address consistency of results in two areas. First, the trends in the main demographic results, such as the projection of active and inactive contributors (members) according to labour force size; scheme beneficiaries; coverage rate; age structure, which should be consistent with the assumptions by population group, sex and year of projection; and others. Second, the trends in the main financial results, such as the pay-as-you-go (PAYG) rate, expenditure growth rate, expenditure distribution and proportion of administrative expenditure, among others, in accordance with the set of hypotheses adopted.

2.5.2. Sensitivity tests

The objective of sensitivity tests is to study the impact of the various sources of uncertainty in a quantitative model. Unlike the consistency review, which aims to verify the internal consistency of the results and detect possible modelling problems, sensitivity tests determine how the different values of an independent variable affect dependent variables under a given set of assumptions. The analysis can include one or more input variables.

In the case of actuarial valuations for pension schemes, the following sensitivity tests are recommended to measure the impact on the main financial indicators (balance sheet, PAYG rate and others):

- changes in inflation rate
- changes in wage growth rate
- changes in GDP growth rate
- changes in the rate of return on investments
- any other variable considered important in a particular scenario.

The results of sensitivity tests should be analysed with extreme caution and preferably discussed with the technical team assisting in the actuarial valuation. If it is determined that there are variables that may have a significant impact on the level of certainty of the results, these tests and results should be mentioned in the actuarial report.

2.5.3. Reconciliation

When previous actuarial valuations are available, it is useful to reconcile results obtained in the current valuation with those of previous valuations, especially the most recent one. This exercise not only helps to identify risks not foreseen in previous valuations, but also contributes to the accuracy of the results.

Guideline 7 of the *ISSA-ILO Actuarial Guidelines* contains some results that can be reconciled between these valuations.

2.6. Analysis of the baseline scenario and discussion of reform options and policy scenarios

The baseline scenario analysis is important for identifying unwanted situations that may arise in the future. To this end, it is essential to consider not only the results of the baseline scenario projections, but also the institutional and pension system assessment (discussed in section 2.2). While the list of potential problems to be identified may be broad, it should not be limited to items directly related to income and expenses. The adequacy of benefits (sufficiency, timeliness, duration and revision of benefits) and coverage should also be analysed, as well as possible management problems associated with the collection of contributions, administration and investments.

This analysis should consider compliance with the principles of social security, especially with the ILO conventions ratified by the country, specifically Convention No. 102 concerning social security minimum standards.

Once the potential problems and situations to be corrected have been identified, solutions must be found. These solutions should be discussed with social partners and translated into policy scenarios to evaluate their impact. This scenario evaluation exercise will provide important information for decision-makers.

The analysis of reform options and policy scenarios is a key objective of quantitative modelling in actuarial science applied to social security. This stage is therefore critical and usually constitutes the point of greatest interest to users of actuarial reports, namely strategic decision-makers.

Policy scenarios respond to a need for solutions to existing problems or policies to improve management or administration (efficiency issues, i.e., return on reserve fund investments), coverage, adequacy and compliance with international social security standards, among others. In the context of actuarial valuations designed to contribute to the analysis of pension reforms, ideally, strategic decision-makers should be involved, or at least consulted, with respect to the development of policy scenarios.

The development of policy scenarios has two stages: formulation and analysis. Formulation relates to deciding on which policy options will be used to make projections (scenarios) while the analysis stage seeks to explain results, deviations and their causes. Both stages interact to provide mutual feedback. This means that the results of the analysis of some policy scenarios may lead to the decision to explore, formulate and analyse new scenarios.

Scenario formulation and analysis should be done considering the opinion of both (a) the organizations of the stakeholders involved in the administration of the social security scheme, usually worker, employer and government representatives, and (b) the technical staff working on the actuarial valuation. Transparency at this stage is essential to achieve the expected results. This is especially true with respect to actuarial valuations, which are part of social dialogue processes to introduce social security reforms. It is important to involved social partners in this process to gain their inputs and confidence in decisions made.

The following is a list of typical examples of policy scenarios:

- variations (increase or decrease) in contribution rates, in contributions from a particular sector, or in government transfers;
- variations in the amounts of salaries or income subject to contribution: minimum and maximum contributory earnings;
- extension of a scheme's coverage, usually to include new populations, such as workers in the informal economy, rural workers or migrant populations;
- modifications in the level of benefits or in the conditions for adjusting benefits: replacement rate, calculation formula, rules for adjustment of benefit amounts (periodicity, criteria), minimum and maximum levels of benefits; and
- variations in the requirements to access scheme benefits, such as waiting periods, minimum number of contributions and retirement age, among others.

2.7. Discussion of preliminary results with relevant social partners

The results of actuarial valuations are often key inputs for decision-making at the level of both the institution responsible for the scheme and at the level of the policy on overall social protection systems. To this end, the preliminary results of the work, including the successive rounds of scenarios evaluated, should be discussed with relevant social partners. This includes representatives of the protected persons and those involved in financing the scheme under evaluation.

An actuarial valuation is merely a tool; final policy decisions are in the hands of others. For this reason, there must be transparency in the understanding of the intermediate results of the actuarial exercise by those who will ultimately make the decisions. It is the actuary's responsibility to guarantee the transparency of the process, which includes maintaining an adequate level of communication with the social partners responsible for decision-making.

Throughout the process, the intermediate and final results of the actuarial study must be shared with those *not* using all the technical instruments required for this type of exercise. That is why it is crucial to communicate information on results in simple, clear language, although without ignoring the technical perspective or objectivity.

2.8. Presentation, validation and formal submission of the final report

Actuarial reports are a fundamental part of the actuarial valuation work, as they are the main means by which the results of the process are communicated to decision-makers and pension insurance authorities, in the form of conclusions and recommendations. The actuarial report should be prepared in line with Guideline 9 of the *Actuarial ISSA-ILO Guidelines* (see box).

Actuarial reports for pension schemes are much more than descriptions of model results. The key message of an actuarial report is whether a scheme will be financially sound in the short, medium and long term. Although the ILO actuarial models provide a solid base on which to formulate perspectives regarding the financial soundness of schemes, models can only serve as a support and should not be expected to replace sound judgement and experience. This assessment of soundness, as well as the choice of methods and assumptions used for modelling, depend largely on the personal judgement of an informed and experienced technical staff.

Actuarial studies of pension systems must show the short-, medium- and long-term results. In this context, the long term is understood as a sufficient period to observe the demographic and economic maturity of a pension scheme, normally a period covering more than 50 years. The presentation of the results should show the calculations and projections for the baseline scenario (status quo), as well as for the other scenarios, and explain the rationale behind their formulation. Actuarial reports should be clear and accessible to facilitate their understanding and use by other professionals who are unfamiliar with actuarial issues.

Box. ISSA-ILO Guidelines on Actuarial Work for Social Security

Guideline 9. Reporting

In preparing a report on the actuarial valuation of a social security scheme, an actuary considers legislative requirements and relevant professional standards and guidance, as well as the intended audience.

A report on the actuarial valuation of a social security programme could be considered as a final product of the actuarial valuation process. It is a tool that provides stakeholders with information necessary to make responsible decisions with respect to a social security scheme. As such, a social security institution as well as the actuary should make every effort to prepare a comprehensive, transparent and explicit report on the actuarial valuation. This guideline should be read in conjunction with Guidelines 11, 25, 26, 27 and 28.

Principles:

- The report on the actuarial valuation should contain sufficient information to permit the conduct of the independent expert review (see Guideline 11) and to allow stakeholders to make sound decisions based on the results set out. It should be written in such language as to be understandable and unambiguous for all stakeholders, including those without an actuarial background.
- The report on the actuarial valuation should contain an opinion describing the actuary's views on the appropriateness of data, assumptions and methodology as well as other material elements of the performed work. This opinion should be signed by an actuary who fully meets the professional requirements for making such an opinion as set down by the national actuarial organization and recognized by the International Actuarial Association.
- The social security institution should ensure that reports on the actuarial valuation as well as any supplemental information with respect to the actuarial valuation are available in all relevant languages.
- Additional communication may be required in order to address needs of a more technical nature as well as to facilitate the understanding of the report by stakeholders.

Actuarial reports usually include the following:

- The reason for the actuarial valuation and a description of recent scheme developments.
- The social, demographic, economic and political context underlying the social security scheme.
- A description of the provisions of the scheme or schemes to be evaluated in terms of legislation, rules and regulations, and the ILO social security conventions ratified by the country (especially Convention No. 102 of Minimum Standards) and the analysis of their compliance. This description includes coverage, nature of the scheme (e.g., defined benefit or defined contribution), financing approach (e.g., PAYG, partially funded, or fully funded), source of funding, and benefit provisions (e.g., contingencies covered, formulae, amounts, restrictions and eligibility conditions).
- Methodology, data, and assumptions. Overview of the actuarial valuation model (ILO/PENSIONS). The methodology used, technical bases, the demographic, economic and financial hypotheses adopted, and the scenarios, including data annexes and methodological annexes, where necessary.

- Results and findings. Projected demographic values at selected future points in time. Financial projections showing cash flows and balance sheet values for the recent past and for the future. Cost rates as appropriate (PAYG cost rate; general average premium or partially funded cost rate; fully funded cost rate).
- Analysis of results, including demographic and financial projections based on status quo conditions that yield a financial analysis of the scheme. Reconciliation with the previous actuarial report, along with explanations of significant changes in results. Discussion of the pattern of financial projections and its implications. Sensitivity of results to variations in one or more assumptions. Findings with respect to the short-, medium-, and long-term financial sustainability of the scheme, with due regard for any funding rules.
- Financial analysis of reform options and scenarios.
- Discussion of the impact of reform options and scenarios and the formulation of final reform strategies.
- Conclusions and recommendations on the adequacy of the legal framework, compliance with international standards, administration, reform options and political scenarios, including:
    - suitability of the financial system;
    - adequacy of actual or proposed contribution rates;
    - efficiency of benefit provisions;
    - adequacy of the adjustment of pensions in payment;
    - performance of the administration and level of administrative cost (collection of contributions, benefit payment process and others); and
    - investment policy and performance (safety, return, liquidity).
- An appendix containing baseline data, detailed results and the methodological basis of the estimates.

The report's structure and content must comply with both the IAA's *International Standards of Actuarial Practice 2* (ISAP2) (section 3.1 and appendix) and the *ISSA-ILO Actuarial Guidelines* (section D on Reporting, Communication and Disclosure and other related guidelines). The appendix to ISAP2 describes the possible contents of the actuarial report, considering the financial system and valuation method used.

In addition to the specific content of the actuarial reports, these standards address critical issues such as:

- The frequency with which actuarial studies should be carried out and the relationship that this frequency has with the nature of the pension scheme to be evaluated.

- The circumstances under which the frequency of these studies should be increased.

- Since it is necessary to share the information on the actuarial valuation with the interested parties in the scheme (workers, employers, pensioners, etc.), the social security institution should adopt a policy for communicating actuarial reports.

- Actuarial information should be communicated at a technical level tailored to the target audience to ensure that it is easily understood and used.

2.9. Communication and disclosure

Communication is an important component of actuarial work. Social security institutions and actuaries must provide accurate, relevant and timely information to ensure sound reporting and communication processes.

The *ISSA-ILO Actuarial Guidelines* (Guidelines 25-28) address communication and disclosure aspects of actuarial reports, such as communication between board members, management and the actuary, the reporting process, responsibilities of the social security institution with respect to reporting and communication, including the correct form of technical and non-technical communication depending on the audience.

Ideally, there should be legislative deadlines with respect to the production of the results of the actuarial valuation, and their transparent communication to social partners. Social security institutions, with the support of the actuary, should meet these deadlines.

Social security institutions are responsible for reporting and communicating changes in the provisions of the scheme, which usually form part of actuarial analysis and reports. The actuarial situation of social security programmes should therefore be reported regularly, in a timely and comprehensive manner, particularly where the sustainability and adequacy of benefits may be compromised.

Due to the technical complexity of actuarial work, communication of the results of actuarial valuations should be tailored to the specific needs of each audience, such as congressional representatives, members of the institutions' boards of directors and senior technicians of the institutions, among others. The publication of the results of actuarial valuations may be accompanied by a communication (e.g., a press release or an executive summary) that summarizes in simple language the main conclusions, policy options and recommendations of the actuarial valuation.

3. Main features of ILO/PENSIONS: A methodological overview

This section is for:

- *Managers who want to use the outputs generated by this model to substantiate policy recommendations with evidence to decision-makers*
- *Individuals conducting actuarial work in social protection who want to learn more about the inputs and outputs of this model*
- *Actuarial experts who want to be informed of the data requirements of this model*
- *General users and newcomers to actuarial practice who want to learn the specifics of ILO/PENSIONS*

In this section, users will learn:

- *The technical specifications of ILO/PENSIONS*
- *The structure of ILO/PENSIONS' modelling framework: phases, inputs, outputs*
- *Definitions of basic concepts used in the model*
- *The main functional processes in the model: users, models, scenarios and reporting*

3.1. General overview

ILO/PENSIONS is part of the ILO Quantitative Platform on Social Security (QPSS). This platform contains a set of calculation, simulation and analysis tools, both actuarial and non-actuarial.

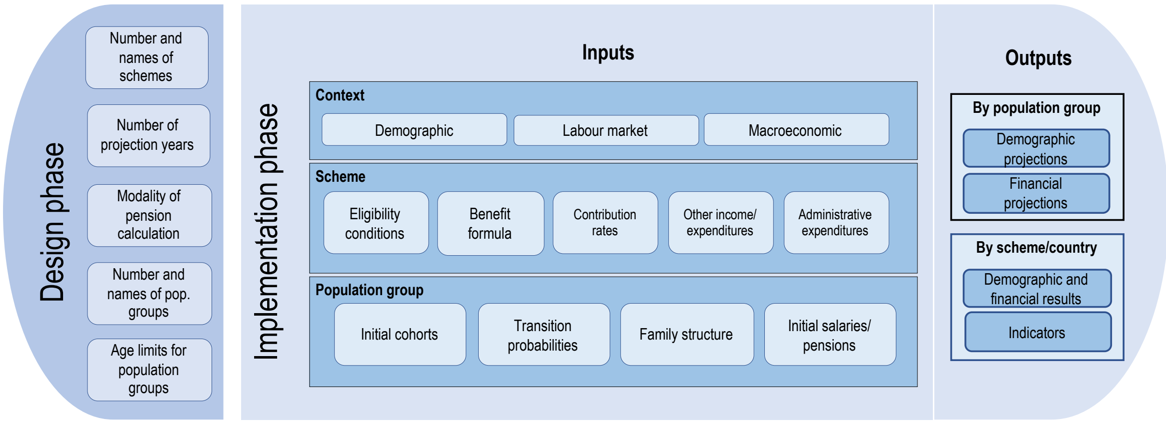
The QPSS is equipped with a central administration tool (the CAT tool), which allows varying levels of control over operations related to the use of the different quantitative tools. These operations include registration of social security institutions, users, process control, data control and IT security in general. Individual and institutional users have private workspaces to ensure the confidentiality of the information managed in the different tools. The ILO is committed to guaranteeing the security and confidentiality of the data stored on the platform.

The QPSS is a service whose IT security and consistency comply with ILO standards. The QPSS is an MS Azure cloud-based service that provides users with an actuarial-as-a-service model (SaaS infrastructure model) within a multi-layered and responsive tool to be consumed in a secure web-based environment.

3.2. The building blocks of the modelling framework

ILO/PENSIONS is built on a basic set of working blocks. Understanding these working blocks is crucial to modelling and obtaining the desired results (Figure 4). Work in the model is done in two phases:

Figure 4 – ILO/PENSIONS: Overview of the modelling framework (building blocks)



Work in the model is done in **two phases**:

The first phase is the **design phase**, where users establish parameters in the tool to set up their definitions of different models. Users need to first discuss and analyse the critical aspects of setting up a particular actuarial model. To this end, users should define the *schemes* they are going to model, the *population groups* belonging to each scheme and the *age limits* of each population group within the scheme. For each scheme, users need to create at least one group of *active contributors*. Every scheme also automatically creates a group of *inactive contributors* and four *beneficiary groups*: old age, disability, widow(er)s and orphans. Users set the *projection period* and the *modality of calculation* of reference salaries for pensions in real or nominal terms. Sections 5.3.2 and 6.1.2 provide more details on these decisions and how to operationalize them.

ILO/PENSIONS creates an initial definition of the pension schemes that make up a national pension system. A national pension system may include one or more schemes functioning at the national or sectoral level. Thus, there can be national single-scheme models and multi-scheme models. Each scheme has its own rules and population groups.

The second phase is the **implementation phase** of the modelling process. Once a model's parameters are set, users can create baseline and policy scenarios and scenario matrices with relevant information for the projection exercise.

INPUTS: Inputs help to simulate the demographic and financial dynamics of the population groups. Inputs relate to 1) context: mainly related to the national demographic, labour market and macroeconomic situation in which the schemes function; 2) the scheme's characteristics: eligibility conditions, benefit formula, contribution rates, income and administrative expenditures; and 3) population group characteristics: initial contributions, structure and transition probabilities (including those of inactive and all beneficiary groups).

- The **context** is a set of national-level variables and parameters. These include projections of the national population by sex, rates of participation in economic activity by sex, and a set of basic parameters for the macroeconomic framework, including GDP growth rate, inflation rate, salary growth rate and interest rate.
- **Scheme inputs** are characterized by a set of rules that determine who pays contributions, the period during which they do so, and the proportion of earnings paid as contributions. On the beneficiary end, the scheme rules also determine who has access to the scheme's benefits, how much they cost and how they are calculated.
- In terms of **population groups**, inputs are the initial composition of the different groups, their different transition probabilities (probabilities of moving between populations groups within the scheme or from the external world), their dependency situation and relevant cash flows from the scheme's perspective (salaries or pensions).

OUTPUTS: ILO/PENSIONS allows users to generate an extensive set of reports for different uses and needs in terms of analysis and policy design. Relationships between inputs allow the model to project outputs. There are two main groups of outputs: outputs at population group level (demographic and financial projections), and scheme- or country-level outputs.

Output matrices have several levels of detail, as will be discussed later. The first kind of output corresponds to **demographic projections** at population group level. Demographic projections interact with other inputs to estimate financial projections at the population group level. These contain average values of salaries, new benefits, total benefits and estimations of the main cash flows associated with each demographic group. In time, **financial projections** at each demographic group level are combined with other inputs to enable the model to prepare financial reports and demographic and financial indicators at the scheme and country levels.

All intermediate and final calculation outputs can be displayed, copied and transferred outside the model (csv or xls), including year-by-year and age/sex breakdowns. The final outputs include demographic and financial flows projected in absolute values, such as directly contributing populations, eligible populations, scheme revenues and expenses, and actuarial technical reserve levels, among others.

These indicators can be used both to support model calibration and consistency testing and to aid in results analysis and reporting. These outputs include a set of indicators useful for performing a step-by-step consistency test.

3.3. Basic concepts used by ILO/PENSIONS: An introduction

Before starting to use ILO/PENSIONS, users should have a firm grasp of some basic concepts, such as model, scenario, scheme and population group. The definitions of these concepts may vary from one country to another, therefore the definitions of each concept as per ILO/PENSIONS are provided below.

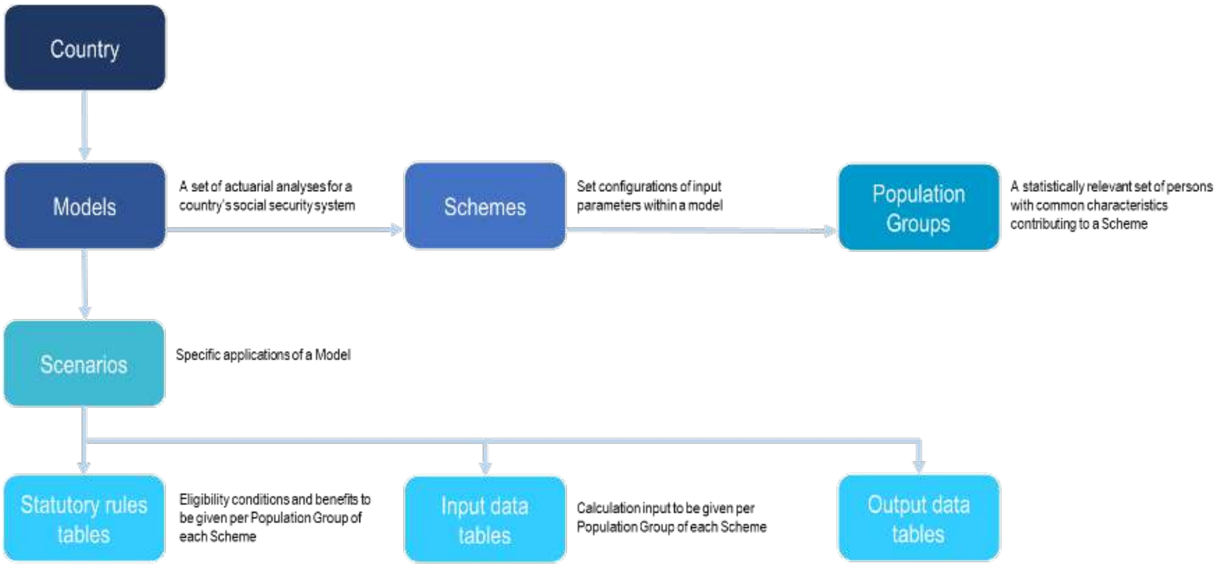
Model. A model is a quantitative formulation specific to a country's pension system. It includes general definitions (i.e., model description, which users are authorized to use in the specific model application, projection period and others) and specific definitions for each pension scheme included in the model (i.e., scheme rules, populations covered and others). Therefore, a model configuration can include general definitions and parameters common to many different pension schemes operating in the country, as well as the specific features of each pension scheme comprising the model at the country level.

Scenario. A scenario is a specific formulation of a model under a certain set of parameters. Each scenario differs from all others in terms of parameters that define statutory rules, population biometrics, past credit and others. A single model may contain several scenarios to reflect a variety of conditions in which the model plays out. A user with editing rights can create scenarios to simulate the financial impact of parametric changes to the scheme or programme.

Baseline scenario (status quo scenario). It is a good practice to formulate a "baseline scenario", i.e., the pension scheme(s) scenario included in the specific model formulation, assuming current conditions with no changes or reforms to legal terms and the most plausible developments in demographic and financial terms. A baseline scenario is essentially a scenario reflecting the status quo, with no changes to legislation (statutory rules), coverage, level of benefits, salaries or other variables. Once the baseline scenario has been formulated and calibrated, any alternative scenarios serve to compare the results of certain simulations, typically policy scenarios, with those reflected in the baseline scenario.

Population group. Each pension scheme may cover one or more populations. One aim of the model is to analyse the impact of policies on specific populations, such as civil servants, private sector employees, the self-employed and others covered by the same pension scheme. The decision to define more than one population group in a specific model is limited by the availability of specific data to feed the model for each of these population groups separately. Therefore, before defining the population groups, users must determine whether the management information system supporting the social security system’s administrative operations can generate the separate datasets for each population group.

Figure 5 – Overview of the relationships between models, scenarios, schemes and population groups



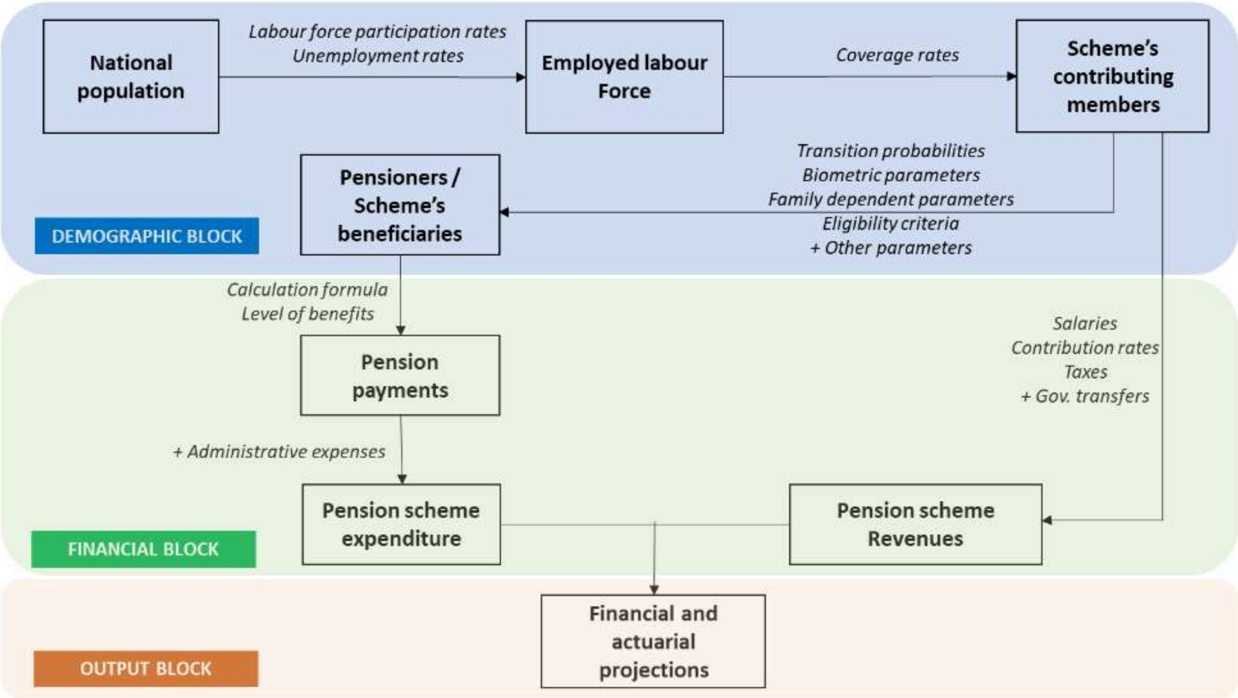
As shown in Figure 5, the definition of the different schemes, their associated populations and conditions for entitlement to certain benefits, are critical elements when designing a new actuarial model for country application using ILO/PENSIONS. Ideally, this work should be carried out with the support of a multidisciplinary team with an emphasis on the final policy analysis objectives. Design features and parameters of each scheme must be known and described accurately for the actuary to carry out the analytical work. The same is true for the formulation of scenarios to simulate parametric changes.

Although users can redefine a model practically in its entirety, the work of formulating a new actuarial model can be quite laborious and time-consuming. Before starting to work with ILO/PENSIONS, users should carefully discuss and design the parameters and configuration of the model. The simplest way to do this is to begin with a step-by-step approach, starting with a model that includes only one pension scheme. When this model is calibrated in its baseline scenario, users can then decide to move on to the next stage of adding new schemes and scenarios. A stepwise approach to modelling population groups is also recommended, starting with a model of a single pension scheme and a single population group (e.g., the "general pension scheme" of the country) until the baseline scenario is calibrated. Users can then continue adding elements, including more populations (if required and if specific data are available for each population) and more schemes.

3.4. General flow of the calculation algorithm

Although ILO/PENSIONS may be mathematically complex internally, the general logic of the calculation algorithms is relatively straightforward. Figure 6 presents an overview of the steps involved in preparing annual projections.

Figure 6 – Overview of the calculation flow (a simplified flow)



In general terms, the logic of the projections flow can be described as part of three blocks: demographic block (inputs), financial block (inputs) and projections (outputs).

3.4.1. Block 1: Demographic block

The demographic block is composed of the estimation of the general populations and scheme-specific populations:

1. **National population.** To ensure the overall consistency of the population projections, a safe starting point is to input a national population projection distributed by sex into the model. This projection can be obtained from official national sources. In the absence of official national projections, the UN World Population Prospects database is a reliable source of these projections.
2. **Employed labour force.** The hypothetical and projected labour force participation rates, as well as unemployment rates, are applied to the population to project the employed labour force. Most national statistical offices prepare these types of projections, which can be used as inputs for the model. Hypotheses on the future behaviour of these parameters should consider the main factors affecting their evolution: change in female labour force participation rates; urbanization trends; size of the agricultural, services and manufacturing

sectors; coverage of the education system; coverage of pension insurance systems; and current and expected trends in levels of labour informality, among others.

3. **Scheme's contributing members.** Based on the coverage level of the employed population, the initial age and sex distribution of active and inactive contributing groups of the scheme are used to simulate how new generations of the pension scheme's contributing members will be distributed by age, sex and number of contributions. This is calculated using the scheme's administrative data and the transition probabilities previously discussed.
4. **Pensioners / scheme beneficiaries.** Contributing populations transition towards claiming benefits once eligibility conditions are met and contingencies materialize. Initial generations of beneficiaries survive according to statistical expectations and are joined by new beneficiaries from contributors or their families.

3.4.2. Block 2: Financial block

The financial block requires the calculations performed in the demographic block. Using certain assumptions, this block estimates:

5. **Pension scheme revenues.** Contribution revenues are derived from salary information and the demographic projection of contributors (i.e., average amount of contributions of demographic groups). Salaries are estimated based on the interaction of previous surviving contributing groups and new entries. The salary structure is a weighted average of theoretical salary structures and observations from the most recent available records.
6. **Pension scheme payments.** The average value of benefits (and total benefit expenditure) is derived by weighting surviving and beneficiaries. The average value of benefits is the weighted average of new and past benefits. The weighting factor used for past benefits considers the probability of survival of past generations of beneficiaries. The average value of new benefits by age and sex results from the application of the pension formula on the calculated reference salary.
7. **Pension scheme expenditure.** Total expenditure, which is composed of total benefit expenditure and derived from information on average benefits and demographic projections of beneficiaries (i.e., average benefits of the demographic groups). Administrative expenditures are assumed to be a set percentage of benefit expenditures.

3.4.3. Block 3: Projections

By combining the steps above, this block enables users to:

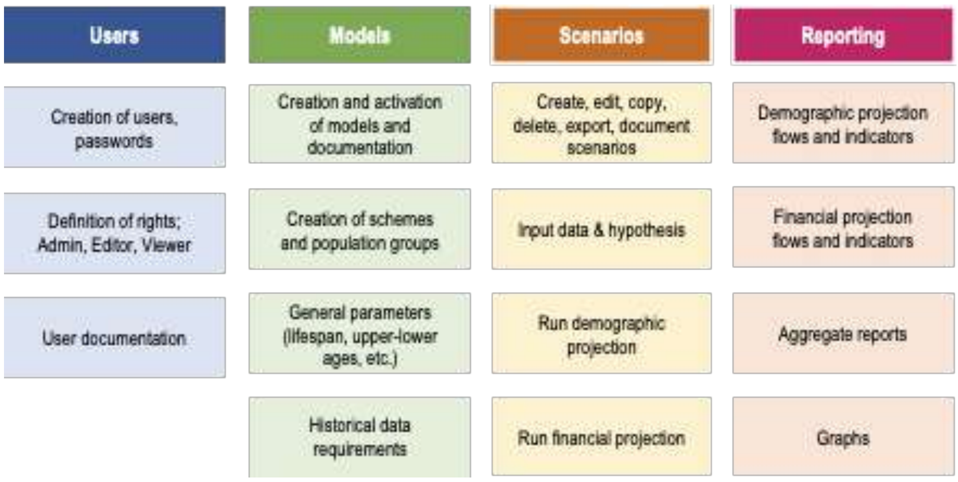
8. Project **financial and actuarial results and indicators.** ILO/PENSIONS can generate and display a wide range of demographic, financial and actuarial output variables and indicators. This calculation includes projections of the populations covered by population group, sex and age; scheme expenditures by sex and age; revenues from member contributions by sex and age; financial flows of income and expenditure and financial results of annual operation; and actuarial, coverage, revenue and expenditure indicators.

> **TIP:** To safely proceed in these three steps, users should consult with economists, statisticians, demographers, social protection specialists and labour market experts, among others.

3.5. Functional processes: Configuration / Models / Scenarios / Reporting

An operational approach to using ILO/PENSIONS refers to the major functional processes supported by the tool (Figure 7).

Figure 7 – Overview of the main functional processes



3.5.1. Administration of users

To use a specific model, it must first be created on the IT platform. This work requires prior administrative authorization from the ILO, as well as the intervention of the technical staff managing the ILO Quantitative Platform on Social Security. The result is the creation of a workspace, generally assigned to a group of users of a model in a social security institution or country.

Three types of users can be defined, depending on the rights of use assigned to them:

- **Administrators** have rights assigned in a specific ILO/PENSIONS application to configure and modify all elements of the model, including the creation of new models and scenarios, and the backup of data outside the online platform.

- **Editors** have the right to edit all model data, including parameters, variables and other specific configurations at the scheme level, as well as to run the model and view and extract all results. Users with editing rights usually work on the actuarial platform daily.

- **Viewers** have limited rights to view all information associated with the workspace where a specific application of the model exists. They are unable to modify contents.

The basic idea of distinguishing between three different types of users is to guarantee a secure working environment, in terms of confidentiality, protection of information (including the models and data developed and entered by users), and quality control of the process and results.

When a model is run, ILO/PENSIONS automatically generates an extensive set of reports. The model runs are made in two blocks: the demographic block and financial block. Output users are also classified by the types listed above.

3.5.2. Output reports for financial and actuarial projections

This category of outputs includes a wide set of reports that provide details on the intermediate and final calculations performed by the calculation tool. Users can move through the different output matrices to display the outputs of the calculation. To protect the integrity of output data, output reports are not editable within the tool; however, they can be exported to csv or xlsx format to be edited using MS Excel or other spreadsheet programmes. With each run of a new model scenario, the output matrices are reset and automatically replaced by new outputs.

The annex on data requests (annex 2) provides a detailed list of the output reports. Some are reviewed in detail in section 6.4. In general, they contain the following:

- **Demographic projections** by sex, age, population group and pension scheme. Includes details for active and inactive contributors and beneficiary populations.
- **Detailed financial projections**. These include projected flows of salary mass, income and expenditures, and projected scheme expenditures (by type of expenditure). Where applicable, these projections are disaggregated by sex, age, population group and pension scheme.
- **Financial and demographic indicators**. The reports on indicators allow users to revise the resulting values to assess whether a specific model formulation is performing well according to expected logical results for the specific scheme under evaluation. It also enables them to provide a more detailed overview of the future development of

different coverage schemes, the calculation of average ages of different subsets of beneficiaries and the average pensions of current and new pensioners, among others. Some calibration and consistency tests require the set of indicators generated by ILO/PENSIONS.

ILO/PENSIONS calculates a set of indicators classifiable into two groups, demographic and financial:

Demographic Indicators	Financial Indicators
• Labour force coverage rate, total and by sex: active contributors / labour force • Coverage rate of the working age population, by sex: active contributors / working age population • Coverage rate of affiliates, by sex: total affiliates / working age population • Effective coverage rate of beneficiaries 65 and over: pensioners aged 65 and over as % of population aged 65 and over, total and by sex • Effective coverage rate of beneficiaries 60 and over: pensioners aged 60 and over as % of population aged 60 and over, total and by sex • Average age, total active contributors, by sex • Average age of total old-age pensioners, by sex • Average age of new contributors, by sex • Average age of new old-age pensioners, by sex • Average age of new disability pensioners, by sex • Average age of new widow(er) pensioners, by sex • Average age of new orphans' pensions, by sex	• Average insurable earnings, total and by sex • Annual growth rate of the average insurable earnings, total and by sex • Average old-age pension amount by sex • Average disability pension amount by sex • Average widow(er)s pension amount by sex • Average orphan pension amount by sex • Average old-age pension growth rate by sex • Average disability pension growth rate by sex • Average widow(er) pension growth rate by sex • Average orphan pension growth rate by sex • Administrative expenditure as % of expenditure of pension benefits • Expenditure on pension benefits as % of GDP • Total expenditure as % of GDP • Reserve ratio • General average premium • Total pension benefit expenditure by sex • Total lump sum expenditure by sex • Total expenditure on benefits by sex
See section 6.4.4 for instructions on how to use worksheets relating to each of these indicators.	See section 6.4.3 for instructions on how to use worksheets relating to each of these indicators.

Main demographic aggregates table

This table displays a set of year-by-year aggregated variables by sex and total, comprising the following: projection year, employed labour force, active contributors and beneficiaries: retired, disabled, widowed, orphaned; and lump-sum beneficiaries: retirement, disability, death. It also includes the coverage rate of contributors as a percentage of the labour force and coverage rate of the total insured population as a percentage of the total population. Section 6.4.2 provides more details and instructions on these indicators.

Main financial aggregates table

This table contains a set of year-by-year aggregated variables by sex, as follows: projection year, salary mass, revenues (contributions, interest and others), expenditure on benefits (old-age, disability, widow(er)s, orphan, and lump sum). A similar table is produced with values as a percentage of GDP. Section 6.4.1 provides more details and instructions on these indicators.

The ILO/PENSIONS Grapher:

The ILO/PENSIONS Grapher is a separate tool developed in MS Excel that enables users to capture a given set of ILO/PENSIONS output files and automatically display the main results in user-friendly graphs according to the requirements of different types of users. These graphs have several objectives. On the one hand, they clearly and simply demonstrate changes in several key variables of the projection and, on the other, they serve to detect calibration or information errors that could be affecting the performance of the projections.

To generate a results file in MS Excel using ILO/PENSIONS Grapher, users should first export the respective set of files from the ILO/PENSIONS platform. Once the output files are generated in MS Excel, users should open the ILO/PENSIONS Grapher and follow the instructions on how to update the set of graphs.

TIP: ILO/PENSIONS has its own basic graphic display, which allows basic visualizations during the phase when data inputs are being fed into the model. Therefore, apart from the external Grapher tool, the set of matrix distributions by sex and age can be displayed using the platform’s own graphing tool.

4. Rationale behind the model

This section is for:

- *Actuaries interested in understanding the dynamics of the model and the background to the simulation exercise*
- *Any user who will interact with ILO/PENSIONS, including those entering data, viewing results and reports*

In this section, users will learn:

- *Definitions of coverage, population groups and financial flows*
- *Processes simulated in the actuarial platform*
- *Factors that affect demographic and financial flows*

4.1. Coverage and population groups

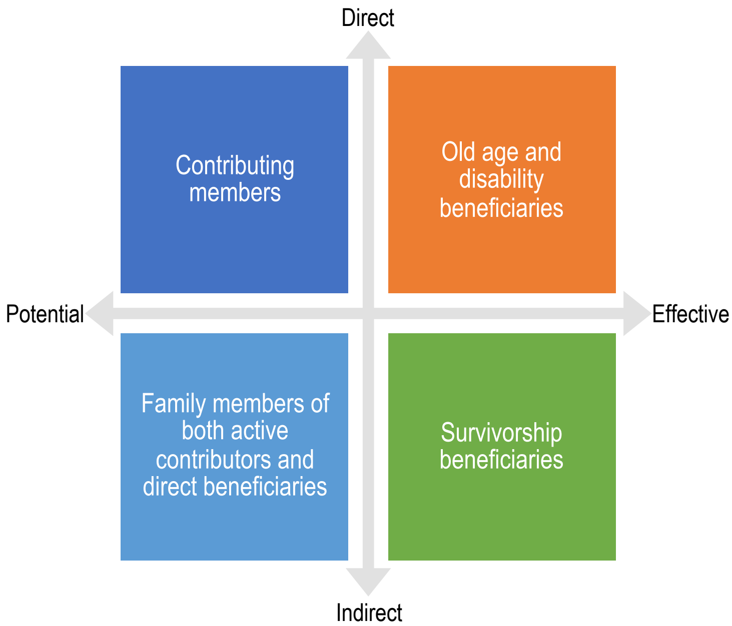
To understand the demographic dynamics of a pension scheme, it helps to understand the concept of coverage.

Coverage means belonging to a pension scheme by accruing the right to enjoy its benefits over time or currently.

One way to understand coverage is through the categories listed in Figure 8 – Beneficiary types (Direct, Indirect, Potential and Effective) :

- **Direct protection.** A type of coverage obtained through own contributions
- **Indirect protection.** A type of coverage obtained through somebody else´s contributions (a sponsor or custodian) for the contingency of death of the contributor
- **Effective benefit.** A cash benefit in the form of a lump sum or a regular pension payment
- **Potential benefit.** The legally backed warranty of receiving a cash benefit in the event of death, old age or disability

Figure 8 – Beneficiary types (Direct, Indirect, Potential and Effective)



4.1.1. Coverage levels

Persons covered by a pension scheme fall under the following four categories:

1. **Directly protected, effectively benefited:** Direct beneficiaries, consisting of recipients of disability and old-age pension payments, or lump sum recipients in the current period. They enjoy the economic protection they themselves contributed towards in the past. In the event of their death, they provide benefits for their respective families.
2. **Directly protected, potentially benefited:** The contributing members of the scheme contributing towards an old-age or disability benefit. Many of them are already covered in the event of a disability (they have already met requirements for number of contributions or length of employment) and continue to contribute to be covered when old-age requirements are met.
3. **Indirectly protected, effectively benefited:** Indirect beneficiaries or survivor pensioners. People who receive cash benefits generated by contributions made by a deceased contributor family member (sponsor) in the past.
4. **Indirectly protected, potentially benefited:** People who will potentially receive a cash benefit in the event of the death of a contributing member or a direct beneficiary.

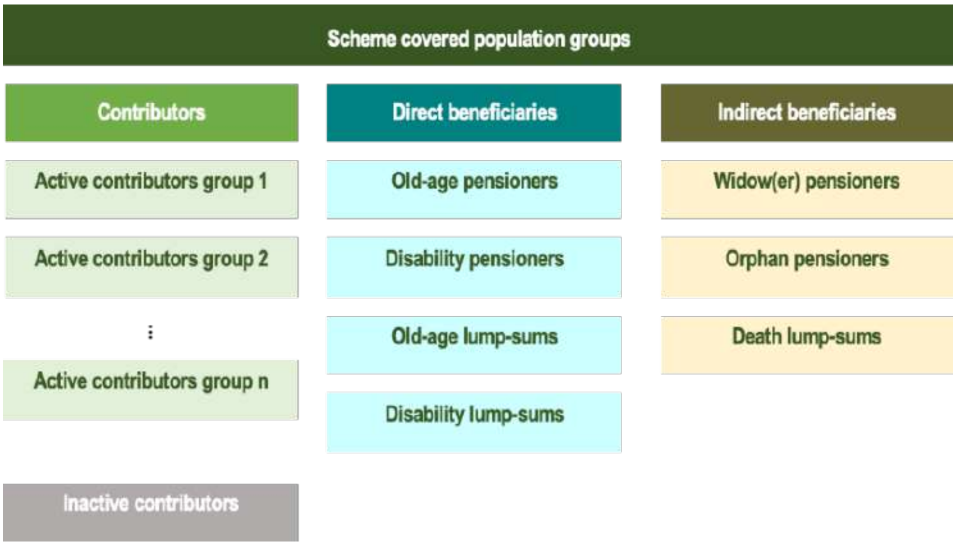
The first group is the main source of income through contributions; the second is the main cause of expenditure for a mature scheme; and the third is a major cause of expenditure for a maturing pension scheme and still relevant in mature schemes. The fourth group does not usually affect the cash flow of the pension scheme.

4.2. Population groups in a scheme

The main task of ILO/PENSIONS is to estimate the size and exposure to risk of the first three groups over a projection period. Exposure to risks affects the potential for generation of cash flows in the future, as well as the potential size of those flows. Exposure to risks refers to additional factors that affect the likelihood of certain contingencies and/or the magnitude of their consequences if they materialize. The main factors for assessing exposure to risks are age, sex, accumulated contributions and salary or pension amount. Factors such as age and sex affect the frequency of certain risks while past credits and salaries affect the magnitude of their potential cash flows.

The population stocks for a scheme in ILO/PENSIONS are as follows:

Figure 9 – Population groups modelled in a scheme



Contributors can be divided into as many active contributor groups as desired. They share the contributors' group with a group of inactive contributors. Active contributors are those who have contributed during at least one contributory period (month) to their individual record over the past 12 months. Inactive contributors are contributors who have contributed in the past but have failed to make a contribution over the past 12 months. Together, they are the affiliated contributors: they have potential rights to benefits supported by previous contributions; this is what sets them apart from non-contributors (i.e. those who have never contributed to the scheme).

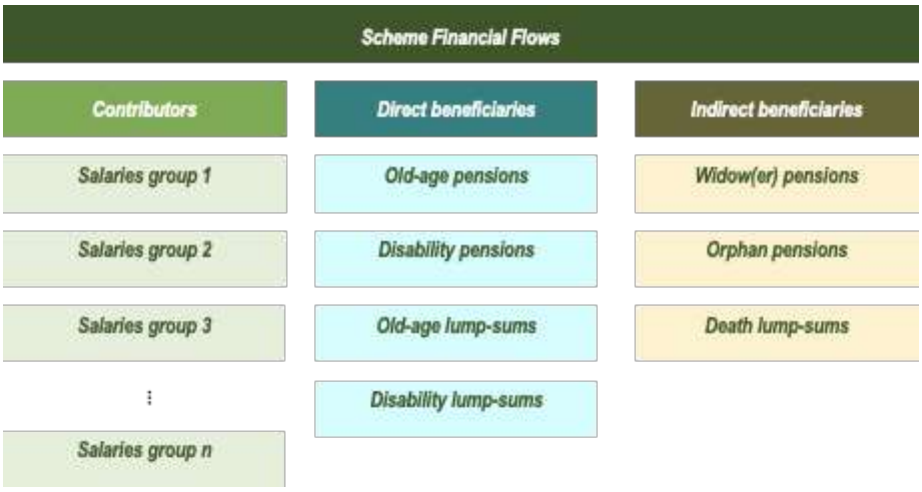
Direct beneficiaries are divided by the type of benefit and the contingency that results in the benefit. The two kinds of benefit are: lump sums and pensions. A lump sum is a single cash payment. Pensions are periodic cash payments of predictable size that last as long as the beneficiary is alive in the case of direct beneficiaries. The contingencies considered for direct beneficiaries are old age (retirement) and disability.

Indirect beneficiaries are of three kinds: death lump sum beneficiaries, widow(er) pension beneficiaries and orphan pension beneficiaries. As the only contingency causing indirect beneficiaries is death, pensions of this type can sometimes be discontinued for reasons other than death of the beneficiary, i.e., marriage, remarriage, finalization of studies, entry into the job market, or reaching adulthood (usually 18 years of age).

4.3. Financial flows related to population groups

As previously mentioned, the three population groups highlighted are especially important because they relate to specific financial flows for the scheme. Their exposure to risk affects expectations and therefore projections of those financial flows.

Figure 10 – Financial flows modelled in a scheme



Active members contribute through their salaries. These salaries are the main source of income for most pension schemes. Inactive members do not pay contributions. Their salaries, either unknown to the scheme or non-existent, are not part of the salary mass of the scheme.

Direct beneficiaries have four financial flows. Two are one-time payments without any further commitment for payment: lump sums for old age and disability. The other two are life annuities whose payment will continue as long as the beneficiaries are alive.

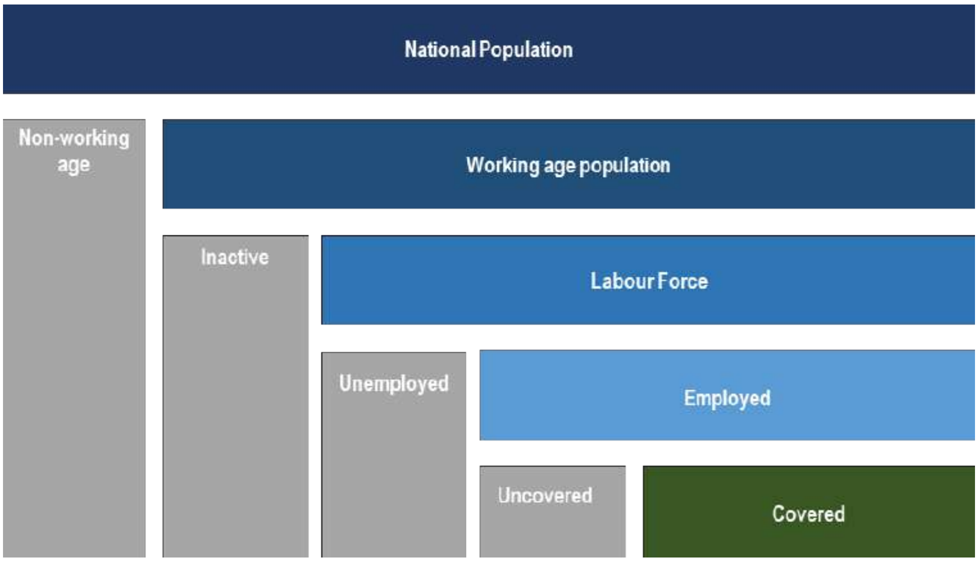
The indirect beneficiaries have a unique one-time payment for death lump sums and for widow(er) and orphan pensions that are life annuities in the first case – excluding some cases of remarriage that can terminate the benefit payment, and payments made until a certain age in the case of orphans.

Life annuities (pensions) are the major source of expenditure for most pension schemes. They are also the main source of financial security for their direct beneficiaries.

4.4. Active coverage

Active coverage corresponds to the proportion of the active contributors (for one group or for the sum of all groups) in relation to the employed population. The application processes this relationship as follows:

Figure 11 – Covered population of a group as a subset of total population



From a total population by sex, the labour force is extracted by applying the labour force participation rate.[1] As the figure shows, the labour force is a subset of the total population. The segment of the total population that does not belong to the labour force is the inactive population, i.e. those who are not actively looking for a job and not currently working. The labour force comprises two groups: the employed and the unemployed. The percentage of the unemployed population in the labour force is the unemployment rate. Multiplying the labour force by the employment rate gives the employed population. The proportion of the employed population covered by a given scheme is the coverage rate. The remainder of the covered population is employed workers covered by other schemes or not covered at all.

Using this process to calculate the number of covered individuals in each group for a scheme compared with the total population can be helpful in determining the scheme's sustainability and the extent of coverage of the benefit.

[1] Labour force participation rate is the proportion of the population that is currently working or is actively looking for a job.

4.5. Demographic forces in ILO/PENSIONS

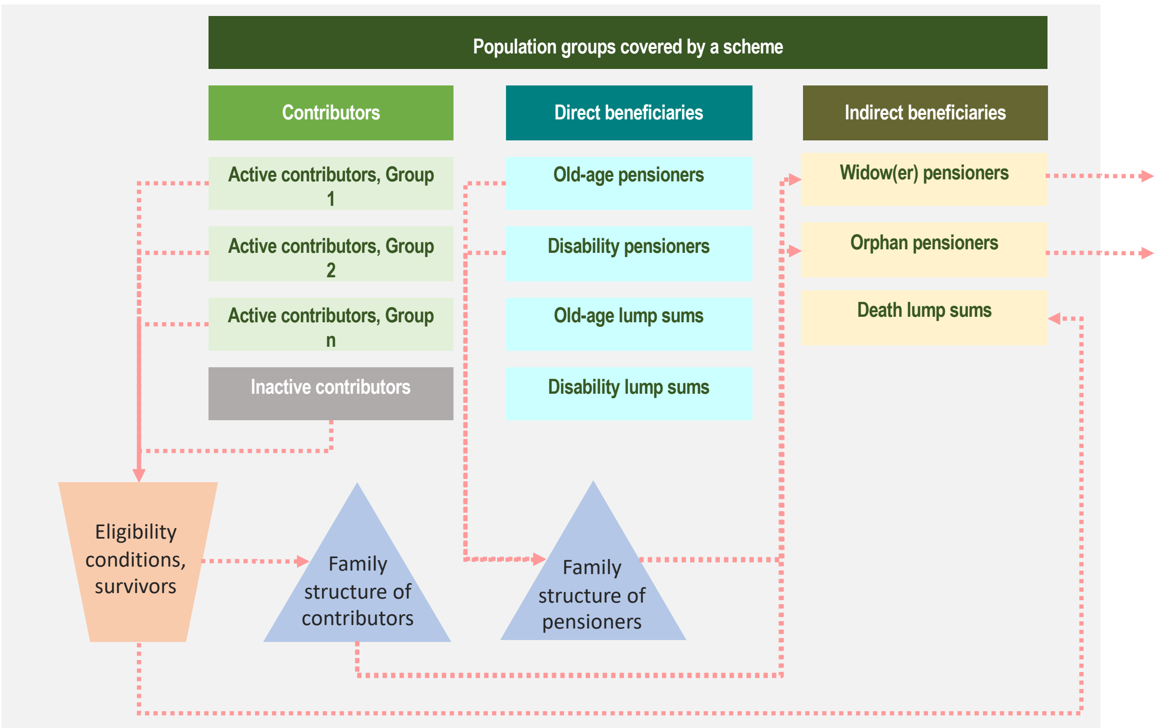
The following sections explain the different demographic forces considered in ILO/PENSIONS.

4.5.1. Mortality

The first effect considered is mortality. To understand the demographic dynamics of this effect requires two additional concepts:

The eligibility conditions for survivorship benefits distinguish members whose family is entitled to receive a widow(er) or orphan pension from those who family is not according to the number of accrued contributions. The family structure of the contributors and the family structure of the pensioners relate the age of the principal insured with the age distribution of their potential beneficiaries.

Figure 12 – Dynamics of mortality in ILO/PENSIONS



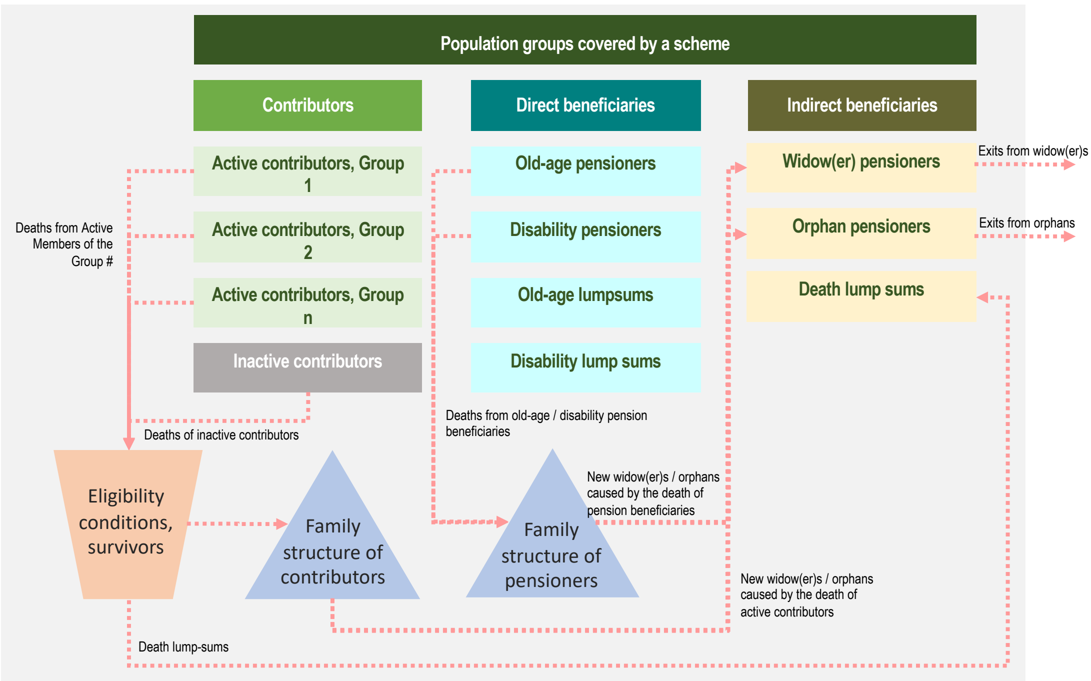
The mortality rate decreases the size of the different groups according to their exposure to death. Sometimes it is as straightforward as increasing mortality with increasing age. The dotted red lines (Figure 12 – Dynamics of mortality in ILO/PENSIONS) show this effect across some groups. In the case of widow(er)s and orphans, the red arrow points outside of the picture as they do not have additional effects. The deaths of direct beneficiaries lead to increases in indirect beneficiaries depending on the family structure of the direct beneficiaries. Finally, in the case of the contributing members, death can drive the increase in indirect beneficiaries when eligibility conditions are met; otherwise, death lump sums are affected (red arrow).

Mortality dynamics define the size of the following stocks: death lump sums, widow(er) pensioners, orphan pensioners.

4.5.1.1. *Demographic flows*

All arrows pointed outwards, towards or between population stocks are demographic flows. When demographic flows increase, financial flows also increase, everything else being equal. Additionally, demographic flows affect the age composition and the accumulation of rights, exercising a lasting effect on the demographic and financial soundness of the scheme.

Figure 13 – Demographic flows as a result of mortality



In some cases, demographic flows are not related to a financial flow that needs to be highlighted; hence, their specifics are not found as outputs in ILO/PENSIONS.[2]

The red arrows originating from:

[2] To keep the complexity of the tool manageable.

- *Active groups* show deaths from active contributors of group #;
- *Inactive members* show deaths from inactive contributors;
- *Direct beneficiaries* show death from old-age pension beneficiaries and death from disability pension beneficiaries; and
- *Indirect beneficiaries* show exits from widow(er)s, exits from orphans.

The red arrow towards death lump sums shows death lump sums.[3]

The arrow from family structure of contributors towards widow(er)s shows new widow(er)s caused by the death of active contributors.

The arrow from family structure of pensioners towards widow(er)s shows new widow(er)s caused by the death of pension beneficiaries.

The arrow from family structure of active contributors towards orphans shows new orphans caused by the death of active contributors.

The arrow from family structure of pensioners towards orphans shows new orphans caused by the death of pension beneficiaries.

4.5.1.2. *Effects on financial flows*

As explained in section 4.3, a parallel structure exists between population stocks and financial flows. Demographic flows thus also have a parallel structure with financial flow changes, and deaths and exits from different stocks decrease the size of their related flows.

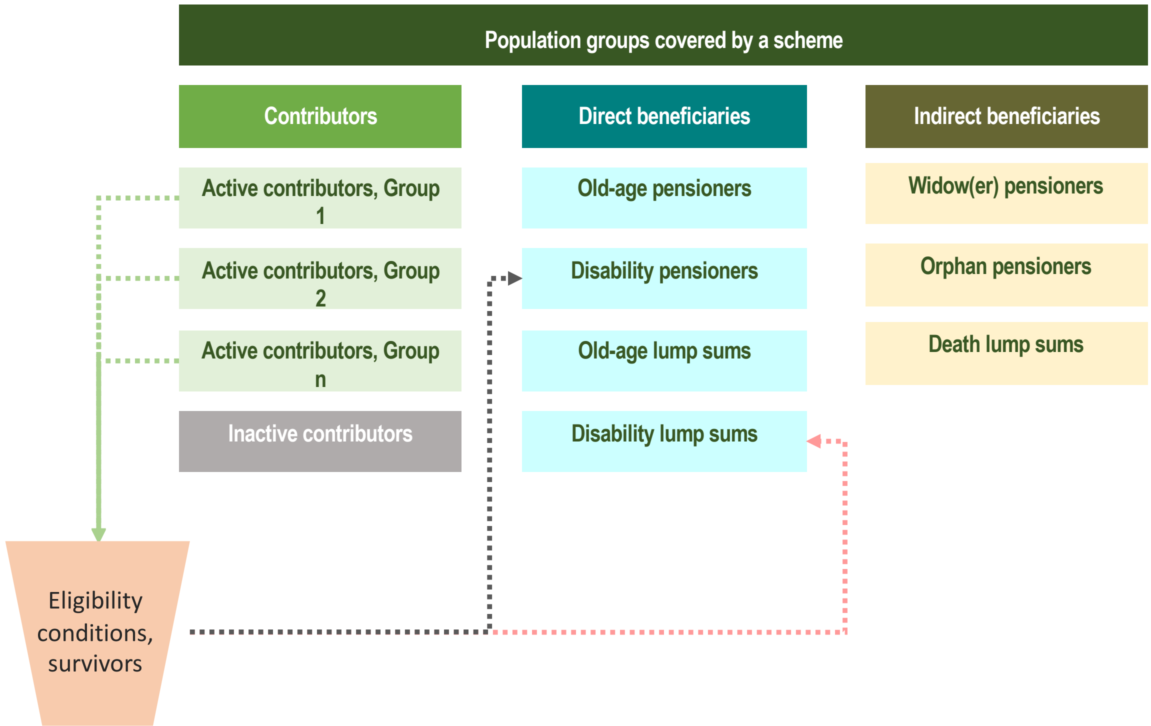
New pension beneficiaries caused by death increase the related flows. The effect of the increase depends on the amount of new pension benefits. ILO/PENSIONS has a pension calculation feature that applies the pension formulas for the new pensions.

4.5.2. Disability

The second effect to consider is disability. Exits from pension scheme contributions due to disability reduce the number of active members in the different groups. The green arrows demonstrate these effects. Exits owing to disability are tested against the respective eligibility conditions (expressed as a minimum required number of past contributions). The new disabled beneficiaries are divided into two groups: new disability pensioners and those who receive a lump sum.

[3] Lump sums are one-time stock, meaning that for demographic and financial purposes, the stock value is equal to the flow.

Figure 14 – Dynamics of disability in ILO/PENSIONS



New values of stocks of disability lump sums and disability pensioners are calculated by factoring in mortality and disability.

4.5.2.1. *Demographic flows*

The green arrows from the active contributors' groups are exits because of disability from Group #.

The red arrow shows disability lump sums

The black arrow demonstrates new disability pensions

4.5.2.2. *Effects of financial flows:*

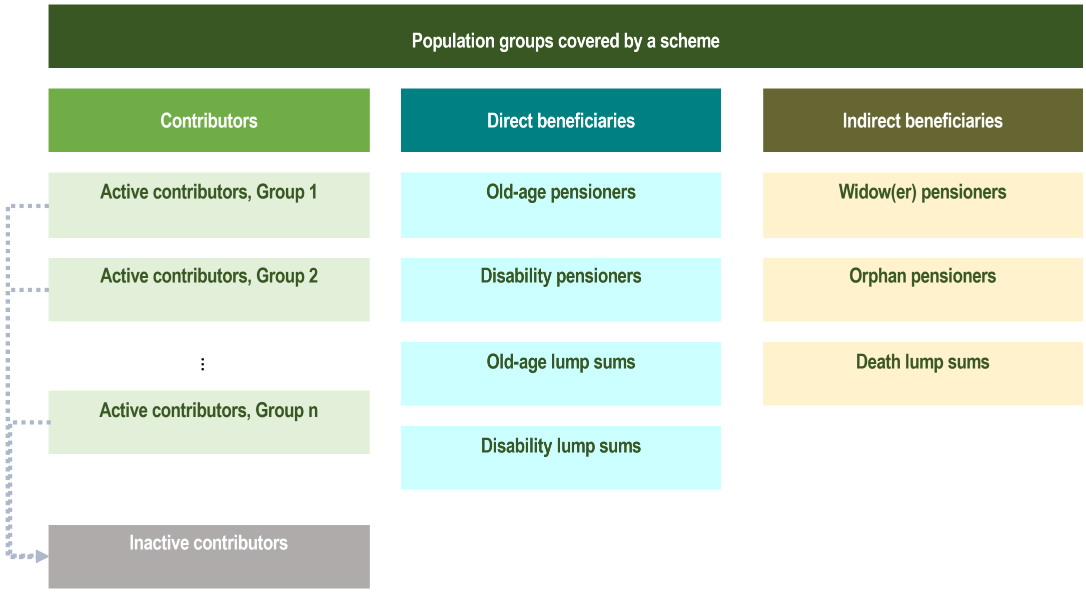
Exits from different stocks owing to disability decrease the size of their related flows.

New disability pension beneficiaries caused by disabilities increases related flows. The effect of the increase depends on the amount of new pension benefits. ILO/PENSIONS has a pension calculation feature that applies the pension formulas for the new pensions.

4.5.3. Exits other than death, disability or retirement

Other exits from active status correspond to any exit not related to death, disability or retirement. The red arrows in the figure below demonstrate the transition from activity to inactivity.

Figure 15 – Dynamics of other exits



4.5.4. Survivors from previous contingencies and retirement

Members of groups unaffected by death, disability and exits in the period are survivors of external contingencies whose risk exposure is updated in several ways.

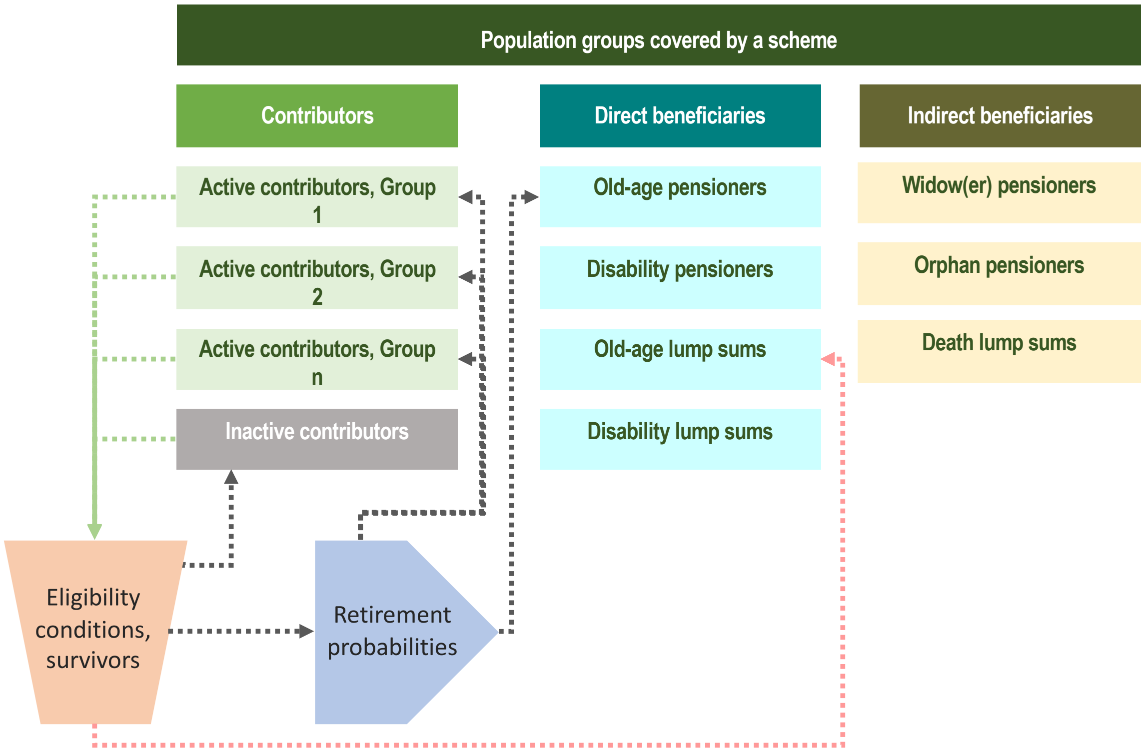
First, these survivors may add an additional year of age for active and inactive members, as well as direct and indirect beneficiaries. Second, if they are active members, survivors accumulate additional contributions. Third, the eligibility retirement conditions for all active and inactive contributors are tested, for which reason they can opt for retirement or remain in the same status. Fourth, if they reach the upper contributory age limit, they take retirement if conditions are met; otherwise they receive an old-age lump sum.

This can be illustrated as follows: the green arrow in Figure 16 shows the testing of retirement conditions for all active members. Retirement conditions correspond to different combinations of age and past contributions.[4] Those who do not comply with age and age-accrued contributions stay in the group (with a different age and number of contributions) unless they have reached the age limit, in which case they receive a lump sum (red arrow), and those who meet the conditions can opt for retirement.

Those choosing to retire are new old-age pensioners joining the stock of old-age contributors (black arrow in bold). Those postponing retirement stay in the active contributors' group (again adjusting age and contributions). Nearly everything is the same for inactive contributors, except that in the case of neither retirement nor lump sum, the contributions do not need to be adjusted.

[4] The conditions could be interpreted as a logical function of "AND", meaning that to be eligible, a person must be at least as old as the age stipulated by the condition, AND have made at least the minimum number of contributions the condition requires– satisfying only one of the conditions is insufficient.

Figure 16 – Transition of survivors from death, disability and other exits in ILO/PENSIONS



4.5.5. Entries

Up to this point, all dynamics are within the scheme's original populations, as survivors' pensions are delivered to potential indirect beneficiaries.

This section discusses the dynamics of the scheme with respect to the labour force, current and future coverage, and survivors. In this context, "entries" to the scheme are new entrants to the scheme (active contributors) that were not included in previous years. Similarly, re-entries to the scheme are individuals who stopped contributing for a period but are now contributing to the scheme again.

If the projected number of individuals covered by the scheme extracted from the process explained in 4.4 is larger than the surviving active contributors from all previous dynamics, then the difference stems from entries to the group. Otherwise, there are no entries at all.[5] If the total active contributors extracted (Figure 11 – Covered population of a group as a subset of total population exceeds the number of survivors in a group, such as in Figure 16 – Transition of survivors from death, disability and other exits in ILO/PENSIONS, the difference between groups will correspond to entries.

Entries are equal to the sum of the increase in coverage and the sum of exits from: retirement, death and disability in the event that the scheme is increasing its number of contributions; otherwise, it is the maximum between the difference of total exits from retirement, death and disability and the decrease in the number of contributors, and zero.

The entries are distributed by age and sex by the entry distribution (a probability distribution). For each age, the entries are distributed between two possible sources: Reactivation from inactive contributors and new entries (entries from the remainder of the labour force)[6].

The probability of originating from one source or the other is given, and changes per age and sex. The re-entry probability is the probability of an individual who was contributing in earlier periods and is contributing to the current period but has not contributed to the previous period.[7] ILO/PENSIONS will try to reactivate as many inactive contributors as this probability predicts. If the number of inactive contributors is insufficient, all inactive contributors will re-enter and the remainder of the entries will come from new entries.

TIP: By inputting a re-entry probability of 100 per cent, users will ask the model to always prioritize the re-entry of inactive contributors before the addition of new members in the scheme. The result will be an accumulation of longer work lives. Lower re-entry rates will imply more contributors and potentially more beneficiaries. By checking for both scenarios, users can test the scheme's sensitivity to reactivation.

[5] If the expected number of active contributors in a group is lower than the number of survivors, ILO/PENSIONS will use the survivors even if they are higher than projected by the coverage modelling. From a modelling standpoint, if the number of different exit probabilities cannot explain the reduction, it cannot be forced by any other unidentified probability. If users require that active contributors are equal to the projected coverage, they will need to review the exit probabilities to fit the calculation.

[6] Whenever the stock of inactive contributors is less than the required number of reactivations, the deficit will come from new entries.

[7] Users should avoid confusing this with other probabilities, such as reactivation probability, that is, the probability of an inactive contributor of a given age re-entering the active contributors' group, or the distribution of re-entries per age, that is, the probability of re-entering as a given age given a re-entry. Those probabilities are not used as inputs as they are highly dependent on the number of entries, meaning that coverage assumptions will influence the re-entry behaviour, which will complicate modelling.

4.6. Financial modelling in ILO/PENSIONS

In addition to demographic forces, the model's financial results are affected by a few financial trends. Nevertheless, with few exceptions, the effects of demography on the financial results prevail over the impact that prices or interest rates may have on the sustainability of a pension scheme. This section discusses the way the model weighs demographic changes to estimate the main financial aggregates: earnings and benefits.

Demographic behaviour, especially the modelling of survival as a contributor behaviour, is crucial in assessing overall sustainability, especially in income and expenditure projections. The other key factor for the assessment is the modelling of personal income. The two key personal income aggregates to model are earnings and benefits.

4.6.1. Salary

The model calculates earnings as a weighted average between observed salary: average salary per age in the base year and a theoretical relationship between salary and age (earnings curve). The earnings curve is expected to be the best estimate for all entries, while the observed salary are continually adjusted by wage push inflation and age increase for the surviving population. This is how ILO/PENSIONS reconciles expectations of salary behaviour (earnings curve) with observed deviations. Both the past observed salary as well as the earnings curve are affected by the expected salary growth between periods. Additionally, the observed earnings are affected by the change in earnings by age modelled in the earnings curve.

4.6.2. Benefits

ILO/PENSIONS calculates two kinds of benefits: lump sums (or one-time payments) and pensions (predictable periodic payments).

In the case of lump sums, their value is product of a simple formula, multiplying the reference salary by a replacement factor. They are calculated for each year's recipients.

The yearly pension bill is a weighted average of the value of benefits for surviving beneficiaries (subject to pension adjustments) and the value of new pensions.

The value of new pensions is calculated using highly customizable pension formulas applied to the reference salary (section 6.2.1 offers a more detailed explanation).

The pension formula takes the reference salary and multiplies it by a replacement rate that is a function of the number of contributions accrued by the contributor. The results are added to the flat pension component (which can be zero). The amount calculated through this process is compared to a minimum and a maximum pension (only if the maximum pension is greater than 0).

4.6.2.1. *Calculation of reference salary*

ILO/PENSIONS requires users to input a reference period to estimate the reference salary on which the pension amount will be calculated, as the reference salary are usually considered to be the average of a certain number of contributions (input in months).

ILO/PENSIONS estimates the reference salary as the average of earnings of several years. The number of years approximates the average number of years that contributors of a given age and accrued contributions would require to contribute the reference number of months (fewer years for younger contributors with a large number of accrued contribution months, more years for older contributors with fewer contributory periods).

Depending on the choice of users, ILO/PENSIONS can calculate the reference salary as a simple average of the salary or an inflation-adjusted average of the same salary.

5. Working in ILO/PENSIONS

This section is for:

- *Any user that will use ILO/PENSIONS, including those entering data, consulting results and reports*

In this section, users will learn:

- *How ILO/PENSIONS looks and works*
- *How to enter the ILO/PENSIONS as a first-time user*
- *How to set up a model*
- *How to create and manipulate scenarios within a model*
- *How to manipulate matrices within a scenario*

5.1. Logging in to ILO/PENSIONS

Most users will be familiar with the login protocol of ILO/PENSIONS. The combination of email and personal password is common in most online platforms. Options to recover or change the password are available.

ILO/PENSIONS requires users to have access to their email for certain communications, hence it is recommended that users provide an email address they can access when the model is being used.

Box. Types of users

ILO/PENSIONS makes provisions for three kinds of users: Reader, Editor and Global Administrator.

A **Reader** can see the parameters of models, read and export the input and output matrices of all available scenarios.

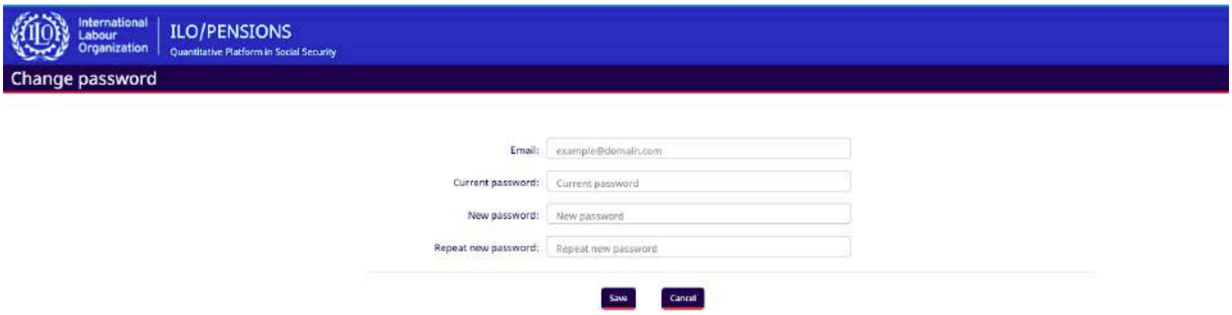
An **Editor** can do everything the Reader can, as well as create new models and scenarios. The Editor can edit the matrices in any scenario and run scenario calculations. Most of this manual focuses on Editors. Useful parts for Readers are also highlighted. Notwithstanding, Readers should try to gain an understanding of the functions since they may become Editors for other projects.

A **Global Administrator** can do everything the Editor can. The Global Administrator also has administrative functions. They can add, modify and eliminate users, including other Global Administrators. The functionalities that are exclusively for Global Administrators are listed in another document.

5.1.1. First-time users

Once an administrator registers a new user, the user will receive an email containing the link to ILO/PENSIONS and a provisional password. The first time users visit this page, they should enter their email address and select the "Change password" option. **Users should not enter the password emailed to them**.

On the change password screen, users should enter the email address used to register in the email field, the password the Global Administrator sent to them as "current password", and the new password chosen (the stronger the password, the better). Then, after retyping the new password to confirm it, users should save changes.

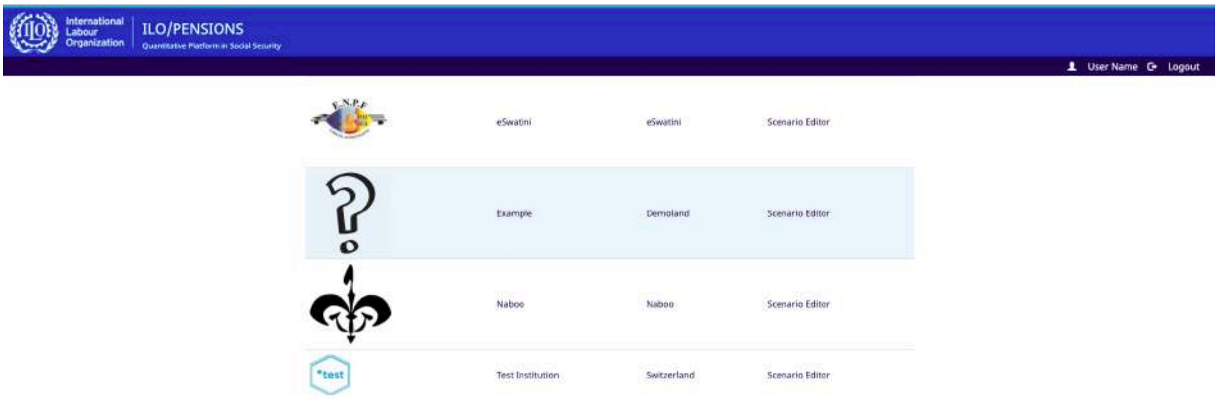


Once the password is changed, users can enter the ILO/PENSIONS website with the chosen password as long as the administrator allows it.

In ILO/PENSIONS, the provisional password will be valid only for the first session, meaning that users will not be able to log in a second time unless the administrator resets the password.

5.2. Models

In ILO/PENSIONS, a model is at a higher level than a scenario. A social security system can be simulated by a collection of ILO/PENSIONS models, all related to a country or institution and all fully independent, meaning that changes to a model do not affect any other model in ILO/PENSIONS. Under a model, users can insert scenarios, which while independent from one another, are all limited by the rules of the model they belong to. Using the same model with different scenarios facilitates their comparison and their capacity for sharing information.[8]



ILO/PENSIONS stores and processes information at the scenario level: this means that a model cannot run on its own but rather through a scenario.

The rules of a model define its scenarios' size and calculation path.

Size of a scenario refers to the number and size of its matrices. This includes the number of dimensions in some matrices.

In a model definition, the following attributes determine the size of the scenarios:[9]

- number of schemes
- number of population groups
- initial and final projection year for the calculations
- maximum lifespan allowed in the calculations

[8] This does not mean that scenarios from different models are not comparable, only that it is easier to compare scenarios from the same model.
[9] The list is ordered according to the potential impact on the size of the model each item may have

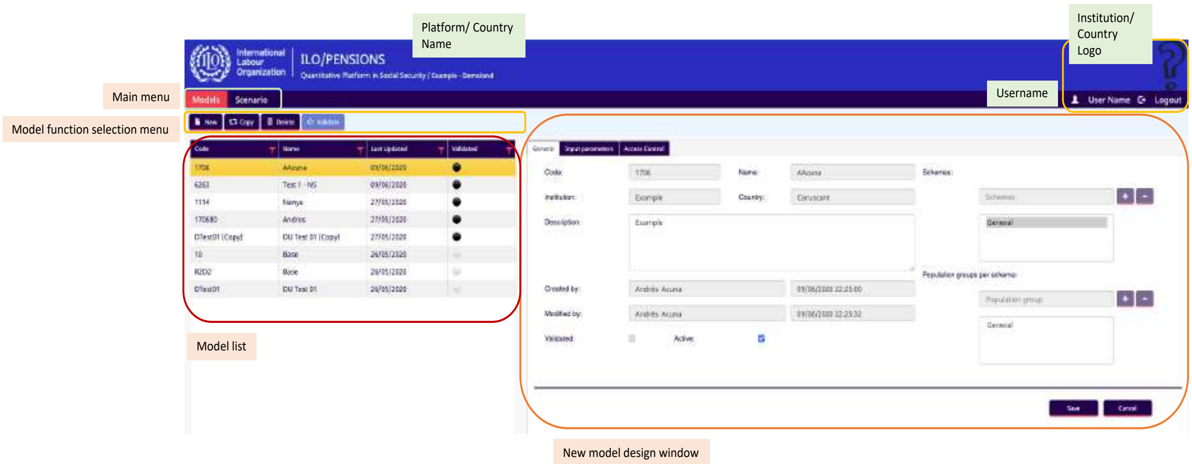
- lower and upper limit for the contributing age
- earliest legal retirement age
- maximum age for receiving an orphan pension, and
- number of years of historical data to report.

The calculation path corresponds to a set of equations or other information according to some attributes. In the model definition, users determine the calculation path by choosing whether or not the pension benefits are calculated using the inflation-adjusted reference salary for each scheme.[10]

5.2.1. Exploring a model

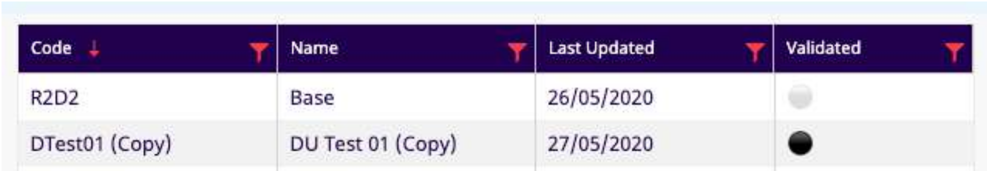
In a context where previous quantitative exercises were performed, newcomers to ILO/PENSIONS, should explore the model definition of a previous exercise before editing scenarios or creating a new model.

By choosing models in the main menu, three sections appear: the Models menu consisting of four tabs, a list of all the models available (models added by any user) in the system and the Model window that shows the details of the highlighted model.



[10] In a multi-scheme model, users can easily include schemes both with and without an inflation-adjusted reference salary.

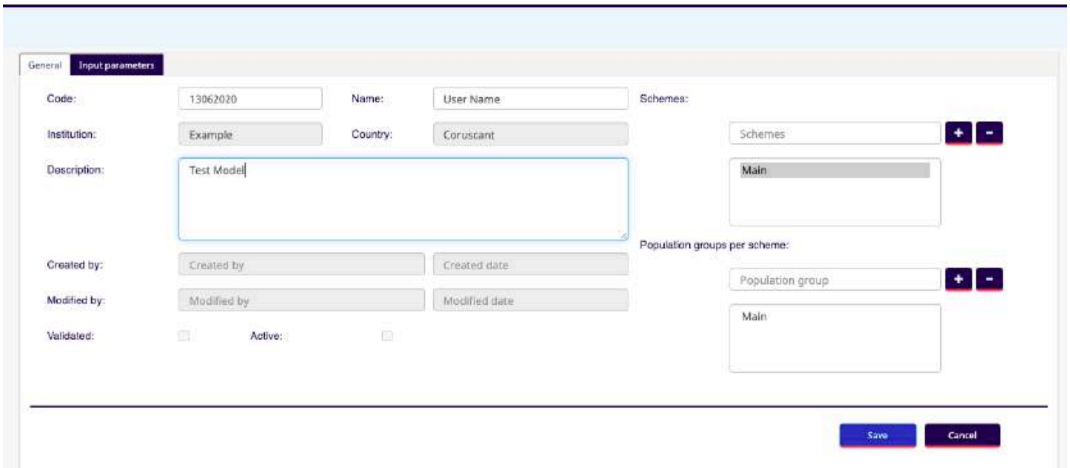
The list has a set of columns: Code, Name, Last Updated (date format) and Validated (checkbox). Users can easily browse the list in any of the columns, filter the list by any field (the only filter available is to check if the field contains a set of characters).

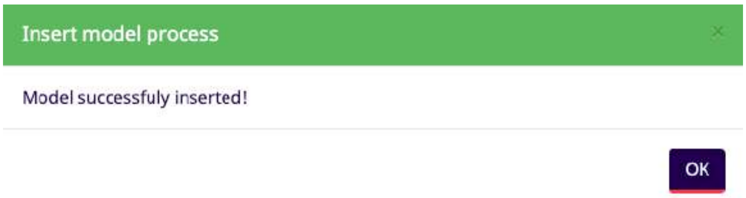


Code	Name	Last Updated	Validated
R2D2	Base	26/05/2020	
DTest01 (Copy)	DU Test 01 (Copy)	27/05/2020	

By selecting a model from the list, users can access the description of the selected model in the Model window to view two pages accessible by tabs: General and Input Parameters.

The General tab contains information on basic attributes of a specific model:





- the code used for creation;[11]
- the name used to create the model;
- the institution being modelled;

[11] The nomenclature for the definition of model and scenario codes is a decision for the final users. It is a good practice to keep a consistent code nomenclature that allows users to navigate through multiple models and scenarios.

- the country (automatically entered into the system) given that the system is created to work in only one country;
- description of the model, including the reasoning behind model creation, the specifics that make the model unique and necessary and all other information considered important for future potential users;
- creator of the model (date and time of creation);
- last modification to the model (by whom and when);
- the names of the schemes included in the model;
- the names of the population groups covered by the selected scheme model
- validation status (checkbox); and
- active status (checkbox).

Scheme names should be different, as should the names for population groups belonging to the same scheme. Population groups belonging to different schemes can have the same name.[12]

The decision on the number of schemes and their population groups has a direct impact on the size of the scenarios. Scenarios created under a model will have a full set of matrices (input and output) for each scheme listed in the General tab. Many of these matrices will have a population group dimension (i.e., they will have a population group selection menu) and most will have a sex dimension. It is always important to weigh the increased precision achieved by expanding the model against the data management complications inherent in increasing model size.

Section 6.1.2 offers an example of how to fill in these parameters when setting up a model.

Users can validate the model with the full set of parameters in Input by selecting Validate in the Models menu.

[12] The system will not assume that these groups correspond to the same population. If they are the same population, the demographic matrices will need to be filled in each time.

A model is active when scenarios of the model exist. If no scenarios exist under a model, the model is inactive.

The Input parameters tab has more detailed information on the parameters defining each scheme defined in the General tab.

The customizable parameters for each scheme are:

- **Lifespan:** Maximum age attainable in the calculations;
- **Lower limit for contributing age:** Earliest age people can legally contribute;

- **Upper limit for contributing age:** Maximum age people are assumed to contribute;[13]
- **Retirement age:** Earliest legal retirement age, which is different from the expected retirement age or the statistical mode of the retirement age;
- **Upper age limit** for receiving orphan's pensions;
- **Initial projection year:** The first year for which the model will project values (Year 1). The last year with historical data and the base year of the projection is the year before the initial projection year (Year 0);
- **Final projection year**;
- **Years of historical data in the model:** Useful for reporting and comparison purposes;
- **Inflation-adjusted reference salary (checkbox):** It is checked if the pension formula in the scheme calculates the reference salary using the current value of the contributing salaries. The box is not checked if the reference salary uses nominal salaries without adjustment.
- **Notional defined contributions (checkbox):** It is checked if users are modelling a NDC scheme. Otherwise, it is not checked.

Section 6.1.3 offers an example of how to fill in these parameters when setting up a scenario.

The last parameter on the list guides the calculation flow in the system to determine whether the reference salary used to calculate benefits has been adjusted for inflation.

The other parameters directly affect the size of the matrices in the scenarios include, for example:

- **The length of the projection period** raises the number of intermediate results and the number of input parameters;
- **The lifespan** directly affects the size of the life tables to be entered as dimensions of output matrices regarding pension beneficiaries. The size of the contributory age gap similarly affects the matrices related to contributing populations; and
- **Retirement age** modifies the size of the input information in terms of pension requisites and the size of matrices related to new retirement benefits. The upper age limit for orphan benefits does the same for orphans.

Coherence among parameters and matrix size can be easily checked by exploring a scenario from an existing model.

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[13] Normally, people can contribute up to any age. Defining the upper age limit for contributions depends on data availability for statistical inference. Higher ages have less evidence in terms of salaries, exit and even retirement behaviour while inferences from smaller samples have less credibility.

5.2.1.1. *Scheme*

A scheme is a social protection system whose members share the same set of rules for obtaining pensions or pension-related benefits. Correspondingly, the definition of a scheme is in accordance with the rules and laws related to that scheme.

5.2.1.2. *Population group*

A population group is a set of people that have statistically different and identifiable attributes that differentiate them from the rest of the population in at least one characteristic that affects their potential access to pension benefits under the rules of the scheme.[14] Attributes that may be used to set up a population group include:

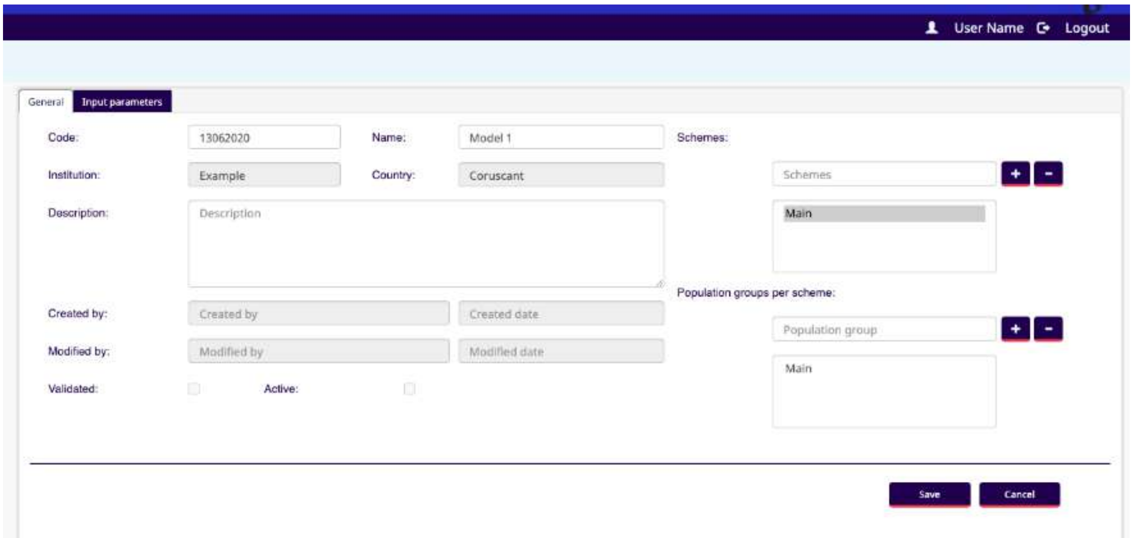
- different past access to the scheme;
- different death or disability probabilities;
- different exit behaviour;
- different entry distribution by age;
- different retirement behaviour;
- different coverage potential;
- different family structures;
- different salary structure by age; and
- different expected salary growth.

5.2.2. Setting up a model

Users can set up a new model in ILO/PENSIONS, especially if there are no existing models or if no existing ones can be adapted to user needs.

[14] The rules are not different; rather, their interaction with the rules is.

Users can access a blank form by selecting New in the Models menu. After filling in the boxes for Code, Name and Institution, providing a description, and adding at least one scheme and at least one population group for each scheme added, users can save the new model.



TIP: The proper documentation of a model and its scenarios is extremely important because it informs different users of a particular model about the specific features of that model and its scenarios. Users should include a detailed but concise description of the model in the Description field. Future first-time users of the model and those responsible for producing actuarial reports will appreciate this effort.

When users select Save, the model will be added to the list of models. Users can then enter quantitative parameters in the Input parameters tab. They should save the desired changes by selecting the Save tab. Users can modify the model as long as the specific model has not been validated.

Section 6.1.2 offers an example of how to fill in these parameters when setting up a model.

To validate the model, users must save the changes and select Validate in the Models menu.

The validation process takes a few seconds as it verifies the basic coherence of the model's dimensions. This includes checking to avoid a final projection year that is earlier than the initial projection year, or a retirement age or contributing age that is higher than the possible lifespan.

Once the model is validated, users can create scenarios within the model, thus activating the model. The validated model cannot be changed. If users discover that the model does not meet their needs, they can make a copy of the model, make the required changes to the copy and delete the previous one.

The initial formulation of a model requires adequate planning. The model setup is pivotal to the success of any projection exercise. Failing to choose the right schemes, population groups, time and age dimensions and calculation methods can potentially increase the workload for users and their teams.[15] It can even lead to improper designs that will ultimately fail to achieve the desired objective of the model formulation. Therefore, users should discuss the matter with their teams (and explore the empty matrices) before filling in matrices. They should also discuss the model with users of the results outside the actuarial team.

> **TIP:** Users should take their time setting up the model. They should thoroughly discuss the conditions under which a particular model will be defined in ILO/PENSIONS with their teams and analyse how the conditions will affect future policy scenario modelling work, as well as practical applications. They should focus on the availability of specific data; for example, if different population groups are being modelled, each group requires separate data: contributory livelihoods and past credit, biometrics and income parameters, among others. The legal framework and international ILO standards on social security ratified by the country should also be considered.

[15] The default parameters in the Input parameters tab of the Model window are only placeholders and should not be interpreted as recommendations of any kind.

5.2.3. Copying a model

Users can make a copy of any validated/non-validated, active/inactive model by selecting Copy in the Models menu.

A copy is a non-validated model with the same parameters of the original model (except for the word *Copy* added to the Code and Name), which can be modified prior to validation. This is especially useful for modifying some parameters of elaborate models that would otherwise require many hours to set up from scratch. One routine copy procedure would be the modification of the projection period for an existing model when it is time for a new application.

5.2.4. Deleting a model

The Delete function in the Models menu allows users to delete a model from the list. This reduces the list of models available, helping to reduce redundancy and noise.

TIP: To ensure transparency and comply with good actuarial practice (see the *ISSA-ILO Actuarial Guidelines*), users should consider retaining in the web application an inactive version of the models that have been used to support technical studies or actuarial valuations conducted and that support official technical reports. An external data backup, properly administered, is also advisable. See section 5.3.5 Exporting a full scenario.

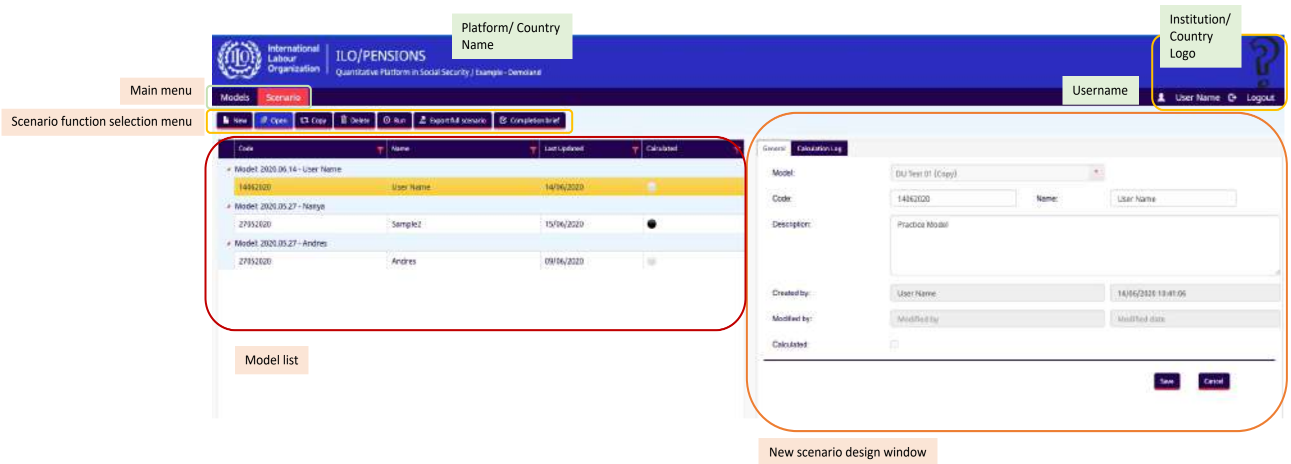
Deleting a model ensures that no new scenarios of the model are possible. ILO/PENSIONS only allows the deletion of models that are in "inactive" status. If users need to delete an "active" model, they first need to delete all scenarios of the model in question (to make the model "inactive") before deleting it. This is a safety feature to avoid losing the attributes of models that support useful scenarios. Also, users may require additional scenarios from past models.

5.3. Scenarios

A scenario is one instance of a model. The scenario houses a set of matrices, which interact among themselves according to the constraints of the model and procedures set up in ILO/PENSIONS. The matrices in the scenario store the inputs and assumptions for the calculations, as well as the outputs of the calculations if the scenario were run.

Users can explore, create, copy, run, delete, export and manipulate their matrices. Section 5.5 discusses matrix manipulation.

After selecting Scenarios in the main menu, users can view three sections: the Scenario menu consisting of seven tabs, the list of scenarios and the Scenario window.



The list of scenarios has four fields: Code, Name, Last Updated and Calculated (checkbox) as its counterpart for models. The list can be filtered and sorted. By default, all scenarios are grouped by their model, and the Sort command sorts the scenarios within each model by field.[16]

The Scenario window shows details of the highlighted scenario on the list: the model used, the code, name and description, who created it and when, the last person that modified it, and if and when the scenario was calculated. The code, name and description may be modified by an editor at any time after selecting the respective box to make and save changes.[17]

[16] The default clusters are sorted according to the modification date of the scenarios. The most recently modified scenarios are listed first.

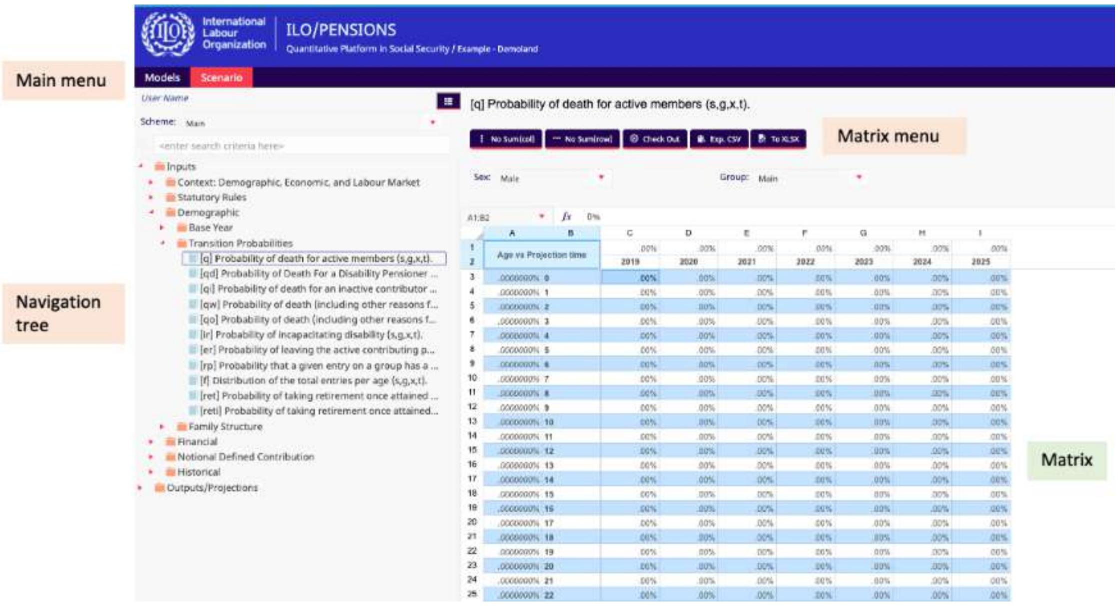
[17] A good institutional practice is to develop a consistent naming system to assign the code and the name of the scenarios to enable all editors on the actuarial team to understand the date of creation and other details of each scenario they are editing and running.

Section 6.1.3 offers an example of how to fill in these parameters when setting up a scenario.

5.3.1. Opening an existing scenario

Selecting a scenario from the list and using the Open function in the Scenario menu shows the details of the selected scenario.

The scenario detail has two parts: the navigation tree of matrices, where folders of matrices allow users to navigate scenario information, and the Matrix window with the Matrix menu and matrix contents. Section 6.2 explains how to open a scenario and explore its matrices.



5.3.2. Creating a new scenario

Users should select New in the Scenario menu to open a blank form.

Users can then choose the model for which their new scenarios will be an instance. They may choose from among the full list of validated models (shown by name).

Users must then add the Code, Name and Description.

After users select Save for the first time, ILO/PENSIONS proceeds to create a new scenario. The process occurs in the ILO/PENSIONS server and can take some time. Users will receive a notification within ILO/PENSIONS informing them that the process has begun. They will also receive an email when the scenario has been created. They can perform other tasks within or outside of ILO/PENSIONS while the scenario is being created.

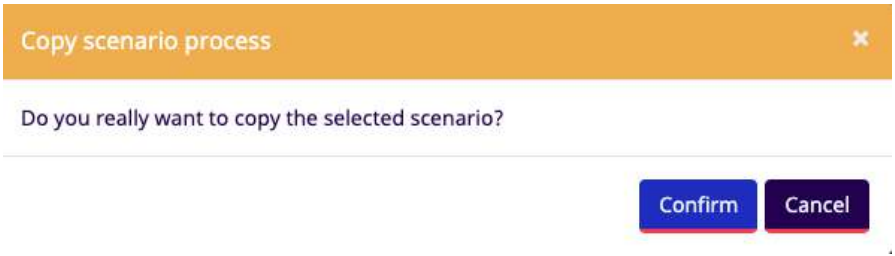
A new scenario created through this process is a blank scenario without any information in the input and output matrices.

5.3.3. Copying a scenario

Often, the information from an existing scenario can serve as the base for the creation of another scenario of the same model. This is especially true when performing stress tests, sensitivity tests and best- and worst-case scenarios that accompany base scenarios in reports.

While ILO/PENSIONS provides easy ways to quickly complete the matrices within a scenario, the easiest procedure is often to copy an existing scenario and later modify the matrices that need changing.

To do this, users should select Copy from the Scenario menu. As this will again create full set of matrices in the server, ILO/PENSIONS will notify users by email when the process begins and ends. The time needed depends on the size of the scenarios (number of projection years, number of schemes, number of population groups, etc.).



Hi

Scenario copy process completed!

```
Code:     14062020
Name:     User Name [Coruscant/Example]
Status:   Success
```

Message: -N/A-.

Once the process is completed, the new scenario will be included to the lists, with the word (Copy) added to the code and name of the original scenario. Users can change the code and name as desired and save those changes.

The scenario created through this process will contain the same matrix information as the original one. At this point, users can edit and define the new scenario according to the requirements.

5.3.4. Running a scenario

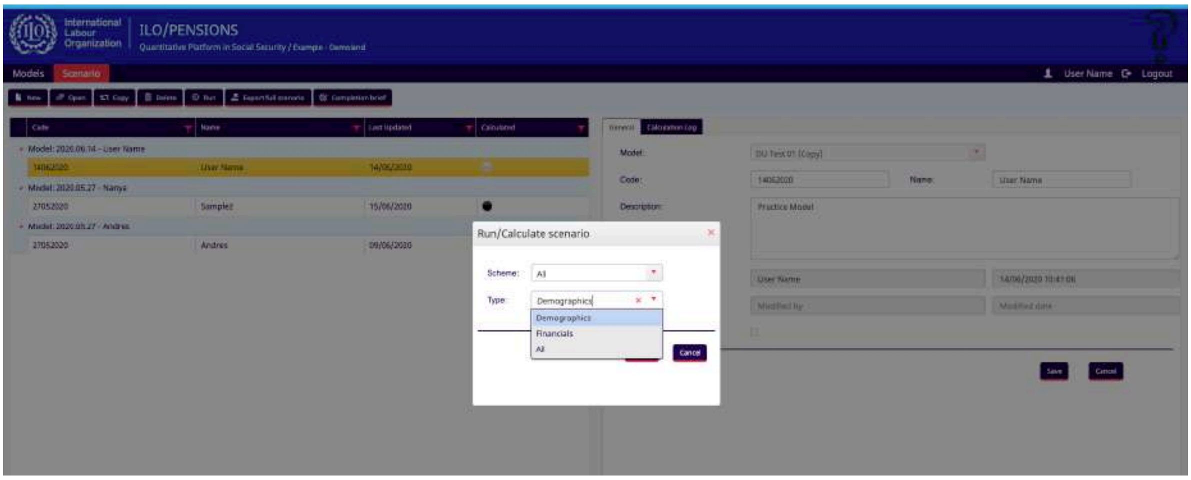
ILO/PENSIONS run scenarios through its server. The calculations are done in a remote location. During a scenario calculation, the scenario currently running is locked from further changes, but users can work on different scenarios. Section 6.3 provides an example of this process.

A scenario can be run by selecting Run in the Scenario menu. ILO/PENSIONS will show the Run Scenarios message box, where users can choose among three options:

- Running the Demographic Projections
- Running the Financial Projections
- Running both Demographic and Financial Projections

A demographic projection calculates active and inactive contributors, pension (retirement, disability, widow(er)s and orphans) beneficiaries per age, sex and projection year, and also estimates the total number of lump sum recipients per year. See section 6.4.2 for more details.

A financial projection calculates salaries per age, reference salaries for pension calculation, benefit amount for new pensions and total amount of pension payments, by sex, age and year, as well as the number of lump sums per year. The full set of indicators and the reports are listed in section 6.4.1. The process will generate an error message if users attempt to run the financial projection before the demographic projection.



The running process can take time, especially for complex large scenarios. ILO/PENSIONS will send users an email when the process has ended and inform them whether it was successful. In a few cases, the email will inform of an error caused by some lack of information or a mistake in the inputs.

5.3.5. Exporting a full scenario

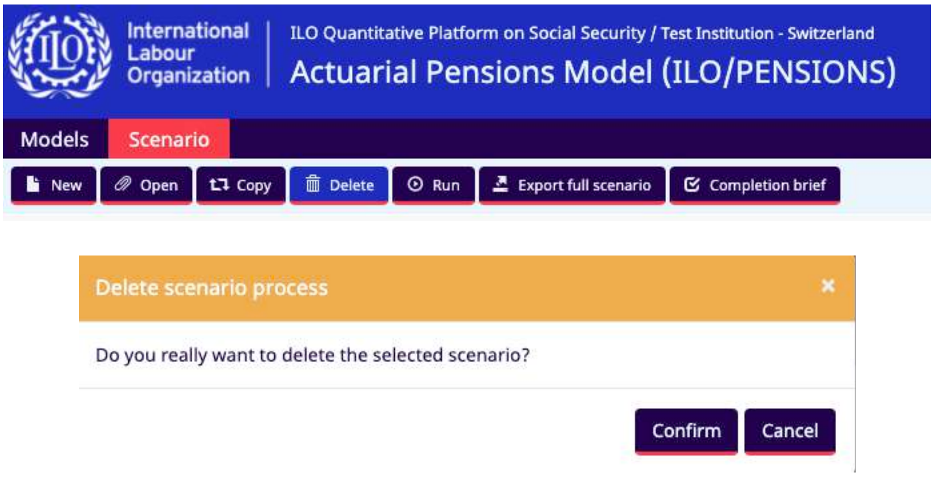
By selecting Export full scenario in the Scenario menu, users instruct ILO/PENSIONS to create a copy of all matrices that belong to the scenario in an Excel-friendly format (csv). For more information on working with Excel, see sections: 5.5.2, 5.5.3.8 and 6.2.1.5.

The process will occur in the remote location (server). The email informing users that the process has been completed contains a link to download a zip file with all the matrices.

The zip file exists in the server for a limited time (about 24 hours). This maintains the server memory for performing all required tasks. The link works for everyone, so users can share it with their teams.

5.3.6. Deleting a scenario

Users with editing rights can select a scenario and select Delete in the Scenario menu. As for other requests, ILO/PENSIONS will require a confirmation from users about the action.[18] Once the action is confirmed, the scenario will disappear from the server and all data will be lost.



Scenarios not being used for analysis should be deleted to avoid redundancy and maintain a clean workspace. However, as deleted scenarios cannot be recovered, **it is crucial that users discuss permanent decisions such as deletion** with the team.

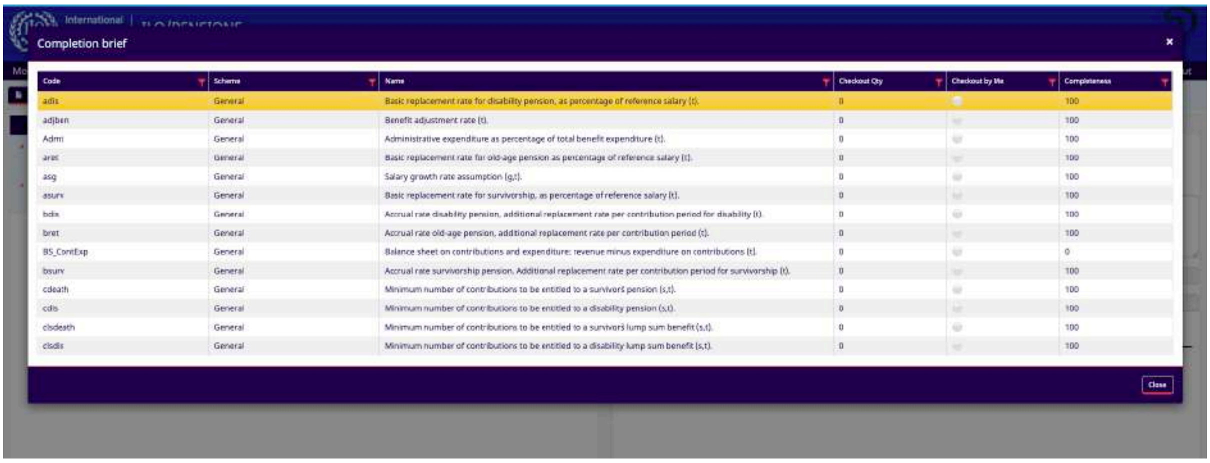
TIP: Make local backups of scenarios that are considered important for historical and administrative purposes, for example, those that support official actuarial reporting calculations. Carefully documenting each model and its scenarios is crucial.

5.3.7. Completion brief

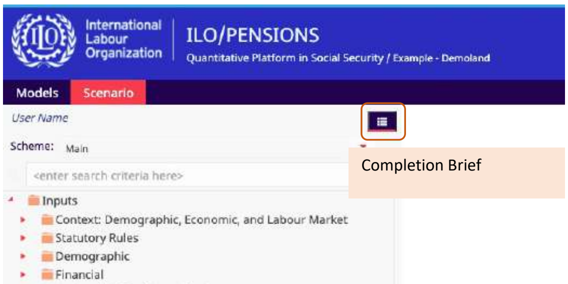
Users can select a scenario and select the Completion brief in the Scenario menu. This opens a window with a list of the full set of input matrices in the scenario. The list has five columns relating to matrices: Code, Name, Number of users who have currently checked out the matrix, whether the matrix is currently checked out by users, and completion percentage.[19] Filter and sort options are available. **The list is a useful for determining which matrices require additional attention to complete the work**. Section 6.2.1.3 provides more information on the Completion brief.

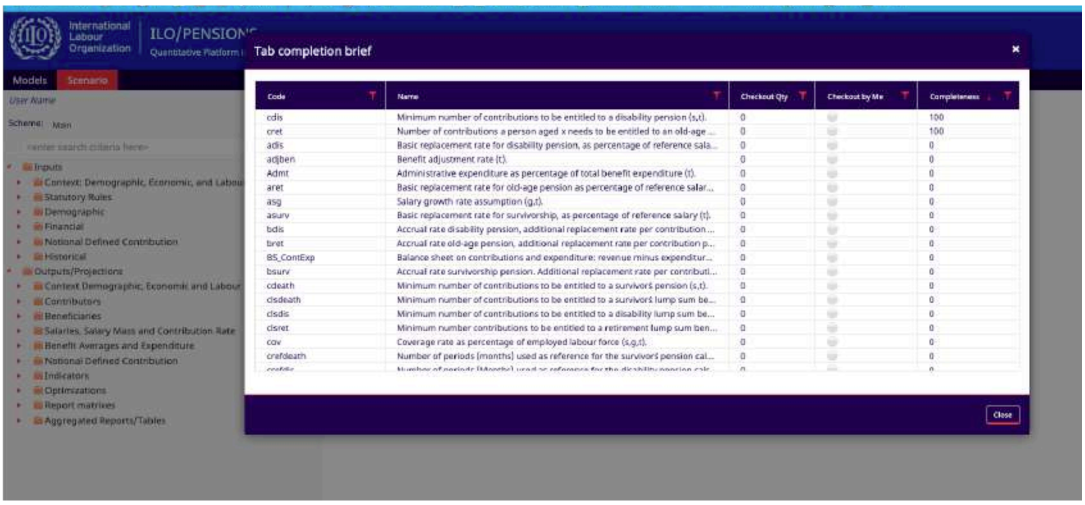
[18] A Confirm/Cancel message box will ask: Do you really want to delete the selected scenario?

[19] The percentage of matrix tabs that have at least been opened, checked out and checked in (with or without changes). This does not refer to the percentage of proper completion, as this is a decision for users.



The Completion brief can also be opened from within an open matrix by selecting the blue icon with three lines above the navigation tree (circled in red below). The navigation tree is the menu on the left with all the files related to inputs and outputs.





5.4. Navigation tree

After opening a scenario, the navigation tree appears, accompanied by the Matrix window. The navigation tree is divided into two main sections, Inputs and Outputs. The Inputs section is designed in to easily locate matrices and helps guide the process of filling in the model. The Outputs section attempts to facilitates the inspection and analysis of results in an intuitive way.

5.4.1. Inputs

The **Inputs** folder contains a subfolder reserved for **Context** information, which is mainly national level data that enables users to frame the projections in the whole context. The Context folder extends to a Demographic and Labour Market folder that contains projections of relevant population aggregates and demographic rates. The other folder, Economic, contains assumptions about the main aggregates and two key assumptions on prices and interest rates.

Moving from the national context to the scheme's description, the second folder under Inputs is **Statutory Rules**. It contains three sections: a self-explanatory Contribution Rate, a section on Eligibility Requirements and a section on Benefit Formulas. The section on Eligibility Requirements is classified according to the contingencies of Retirement, Disability and Death. The matrices in this section normally show the number of contributions needed to access certain benefits. The section on Benefit Formulas is also contingency classified, with matrices that enable users to simulate several pension and lump-sum formulas.

The third input folder, **Demographic**, relates to group demographics that differ from the country demographics of the first folder. There are three types of demographic information the user needs to provide: Base Year, Transition Probabilities and Family Structure.

The Base Year sub-folder contains initial populations of contributors and beneficiaries. These are the starting point for any demographic transition – they constitute the link between historic information and projections and their accurate input is key for accurate projections.

Transition Probabilities or actuarial assumptions are probabilities or frequency distributions that allow the model to simulate the most probable demographic path, which begins with the initial population and extends through the projected future. Probabilities can be obtained through careful analysis of the scheme's past, theoretical assumptions or a combination of both. Their impact on final results is crucial, for which reason they demand the highest level of attention from the actuarial team.

Finally, the Family Structure folder corresponds to the structure of expected dependency between family members and contributors or beneficiaries. They are used to connect the death of direct covered members of the scheme to their indirect beneficiaries in the event that death occurs.

A fourth folder, **Financial**, contains the financial information for the scheme. It has two subfolders: Base Year and Financial Assumptions. Base Year provides the financial averages related to the initial populations of the Demographic folder. While the Demographic folder requires the number of contributors, the Financial folder requires their average salary per age, or the average pension in the case of beneficiaries. The coherence of the demographic and financial base year information with the scheme's financial reports is a key indicator of the consistency and accuracy of input. The platform cannot perform the necessary verifications for the actuarial team. Users should double check this information. The Financial Assumptions folder contains assumptions about expenditure flows unrelated to contributions and benefits, with the exception of assumptions related to salary growth and benefit adjustment.

Two other folders belong to the Inputs section of the tree. The first is **Notional Defined Contributions** inputs, which applies to the few countries that have that type of scheme, and which are discussed in a separate manual. The second contains **Historical** information required to perform consistency checks between the past and projections. Projections are independent of the data in this last folder.

5.4.2. Outputs

On the outputs side, the folders follow a parallel structure with some minor adjustments.

The first **Outputs** folder is **Context**. It contains the projections of some demographic and economic aggregates laid out in the inputs. This folder is mainly used to check whether the combination of assumptions in the inputs leads to outputs that are consistent with the sources of these assumptions.

The second folder, **Contributors**, displays the demographic projections for active and inactive contributors, as well as the transitions between them. The subfolders contain different levels of detail on such information, for example, yearly aggregates by sex, details by age and sex, and details by age, sex and accrued contributions.

The third folder, **Beneficiaries**, is another folder of demographic information, this time highlighting the beneficiaries of pensions and lump sums by contingency. Subfolders are divided into total beneficiaries, surviving beneficiaries and new beneficiaries. Data by age and sex are the most common; nevertheless, some matrices also contain data on accrued contributions.

The subsequent folder, **Salaries**, corresponds to salary information, mainly salaries by age, salary mass and contributions as a percentage of salaries.

The following folder, **Benefit Averages and Expenditures**, is related to benefits according to contingency and has special sections on new benefits and total benefit expenditure.

The sixth folder is **Notional Defined Contributions** (Annex 3: Notional Defined Contributions).

Users should focus on the folder on indicators**. Indicators** correspond to data series employed to highlight certain aspects of projections. They are results of comparisons between projection results and are replicable. ILO/PENSIONS calculates indicators automatically as they are often requested in actuarial valuations.

ILO/PENSIONS provides two types of demographic indicators:

Coverage rates are ratios between demographic aggregates and help users analyse how much the schemes reach their target population. There are three kinds of coverage: active coverage, which compares the active contributors over time with the labour force or over the working age population; affiliate coverage, which compares the total number of affiliated members to the working age population; and beneficiary coverage, which compares the number of beneficiaries over a certain age (60 or 65) to the national population over the same age. The higher the rate, the greater the progress in achieving universal coverage of the scheme.

Average age of contributors or beneficiaries of different sex over the years. This is useful to assess the attributes of typical beneficiaries or contributors and their changes over time (for example: ageing of the contributors, younger widow(er)s, etc.). ILO/PENSIONS has values for active contributors and pensioners, as well as for new contributors and new pensioners from different contingencies.

In addition to the demographic indicators, there are three types of financial indicators in ILO/PENSIONS: Financial Results, Expenditure Ratios and Others.

They are extractions of financial results of the projection placed under a single matrix to facilitate the work of users. The three financial results are: Reserve, Reserve Ratio and General Average Premium. Reserve has the projected value of the scheme's reserve per year of projection, Reserve Ratio compares the reserve with the scheme's expenditure and is an indication of the expected level of robustness of the reserve. The higher the ratio, the greater the financial threat the scheme can endure while maintaining some level of sustainability. General Average Premium (GAP) corresponds to the contribution rate needed to keep the scheme running with positive reserves for the full projection period. If the current statutory contribution rate over the period is lower than the GAP, the scheme will exhaust all reserves before the end of the projection period. Otherwise, the scheme will finish the projection period with some reserves.

Expenditure ratios are comparisons of certain expenditure items or total expenditures with other aggregates for two reasons: The first is to assess their magnitude with respect to the economy. This is true in the case of expenditure on pension benefits as a percentage of GDP and total expenditure as a percentage of GDP. The second reason is to evaluate the relative efficiency of the expenditure, such as in the case of administrative expenditure as a percentage of total expenditure.

The other two groups of indicators correspond to: yearly projections of the average value for each sex's individual salary or benefit, and the expected growth in this value (Average Amounts and

Growth Rates respectively). These values provide information on the adequacy of the scheme's benefits, especially in the short term.

The next two folders shown are internal workings of the platform and they are not particularly useful for analysis. Users are free to consult them, but the most useful information is outside the folder **Optimizations** (mostly for IT improvements) and Report matrixes. These folders contain the same information as the reports but without the convenient column structure that facilitates comparisons.

The final folder is **Aggregated Reports/Tables**. This is important for the display of output indicators.

Many users first consult the Main Financial Aggregates Table [RPT_MFAT]. This table identifies the main financial projections of the scheme, which are crucial to the sustainability of the scheme. The table has three parts: Male, Female and Total. The first two sections show the aggregates related to female and male contributors or beneficiaries for each year of the projection. The sex division applies to salary mass, contributions and benefits; other financial aggregates depend on values of other aggregates and cannot be disaggregated by sex.

Of the three parts, the most important is the total, which is placed at the top due to its importance. It contains three sections in its columns: Revenue, Expenditure and Results. In the Revenue section, the first column is the Salary mass, showing the level of potential insurable earnings. The second column shows the Contributions (calculated over the Salary mass), followed by Interest income and Other income. The final column of the section is the Total Income (the sum of Contributions, Interest and Other income).

The Expenditure section has a subsection, Benefits, that lists the value of pensions for Old age, Disability, Widow(er)s and Orphans, a sum of all Lump Sums and a total of all Benefit Expenditures. In addition to Benefits, the section has Administrative Expenditures, Other Expenditures and finally a Total of all Expenditures (sum of the total of Benefit expenditures, Administrative and Other Expenditures).

The Results section sheds light on relationships between the aggregates of other sections. The first result corresponds to the difference between income and expenditure. This is followed by the PAYG rate, which demonstrates the ratio between expenditure and salary mass. Reserve follows, which shows the expected value of the fund's reserve. Finally, Reserve Coefficient lists the periods in which the reserve pays annual expenditures.

Once users are satisfied with the calibration of a model and consider the results final, the column Reserve shows two critical points: year when the reserve declines below zero for the first time and the first year the reserve decreases. The column result (below zero) shows an additional critical point when the result is negative for the first time.

The Main Financial Aggregates as a Percentage of GDP [RPT_MFAPG] lists all the same information, expressed as a percentage of GDP. This allows users to view income and expenditures in relation to the size of the whole economy and to assess the magnitude of the potential impact of the scheme(s).

The Main Average Table [RPT_MAT] lists the values of average salaries and benefits such as pensions and lump sums by sex. This is useful for exploring the adequacy of benefits over time.

In addition to the three financial reports, the Main Demographic Aggregates Table [RPT_MDAT] shows the sizes of key demographic aggregates. This report has Total, Female and Male sections with annual information.

The columns have two main sections: First, the contributors-related section, with information on the labour force and the total active contributors. Second, the beneficiary-related section, with information on the number of beneficiaries of recurrent benefits (pensions) and lump sums according to the contingency.

5.5. Manipulation of matrices

The largest and most interesting part of the work in ILO/PENSIONS occurs at the matrix level. Matrices are always part of a scenario and their number and size depend on the model set up by users. ILO/PENSIONS offers many options to develop the matrices. ILO/PENSIONS prioritizes remote access, teamwork and peer reviewing in modern actuarial practice in social security, in accordance with *ISSA-ILO Actuarial Guidelines*.

Users should become thoroughly familiar with the options within scenarios to properly manipulate matrices. Section 6.2 explains this process.

An open scenario shows its name, a selection menu to pick the scheme, the navigation tree and the Matrix window. Through the navigation tree, users can choose the matrix they need. The selected matrix is shown in the Matrix window.

The tree consists of logically arranged folders and matrices.[20] Users can navigate through the model as they would with any file explorer.

The naming of the matrices consists of two parts: the matrix code shown in brackets, which is assigned by ILO/PENSIONS and is immutable, and the matrix name describing the expected contents of the matrix, its use in the modelling process and its dimensions. The matrix name can be

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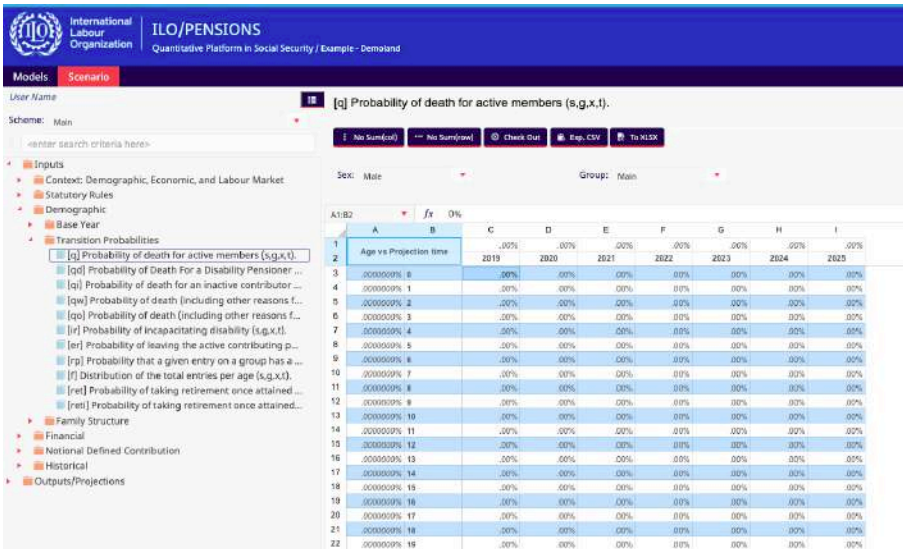
[20] For calculation purposes, ILO/PENSIONS never refers to the matrices in terms of their location in the navigation tree. This means that a rearrangement of matrices is possible without affecting the calculation functionality of the application. The ILO welcomes recommendations for improving the tree.

changed over time to improve the description and improve user experiences. Frequent users should familiarize themselves with the code as much as possible.[21]

Inside the Matrix window, users can see: the Matrix menu with a set of tabs that change according to the matrix, one or two list boxes for tab selection, and the selected tab shown in Excel-like columns and rows.

Users can select a matrix by clicking on its name in the navigation tree on the left. Selecting the red arrows next to the folder names (e.g., Inputs or Outputs/Projections) will open the folder(s); users can then select the matrix's name to open it.



5.5.1. Aesthetic commands: Hide and show sums of rows and columns

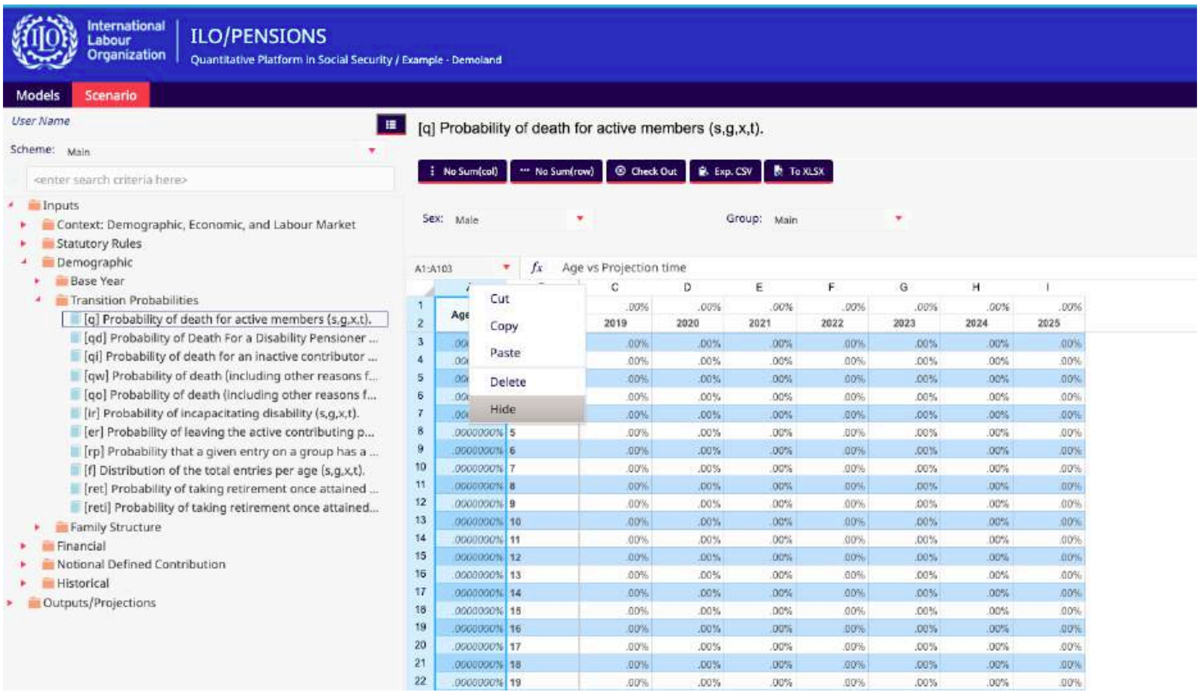
By default, ILO/PENSIONS lists the totals of the values in the row (in the case of the first column)

By default, ILO/PENSIONS lists the totals of the values in the row (in the case of the first column) and the totals of the values of the column (in the case of the first row). Users can hide the total in on the matrix they are working on by right-clicking on the desired row or column and then selecting Hide or Unhide from the menu or alternatively, by clicking on the option No Sum (col) or No Sum (row). However, these totals are often useful for double-checking data entered over multiple years or categories to ensure proper inputs were used.

Selecting No sum rows/columns in the Matrix window (or right-clicking and then choosing Hide/Unhide) hides/shows the first row/column of the matrix. The command is merely aesthetic

[21] The code will be extremely useful when working with exported files.

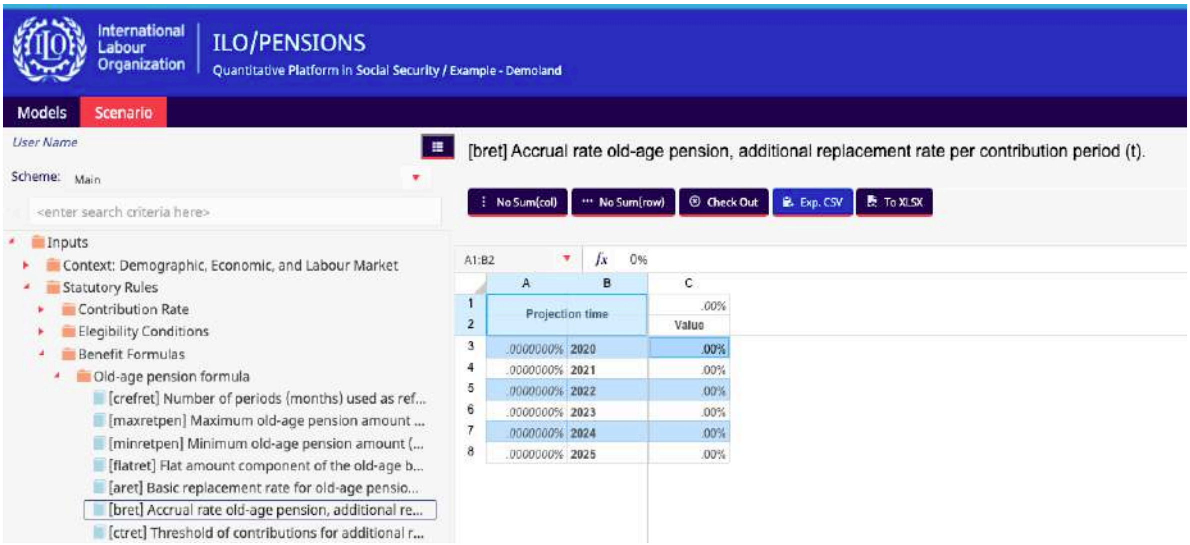
and does not affect the calculations. The rows/columns will reappear the next time the matrix opens and will reappear in the next selected matrix.

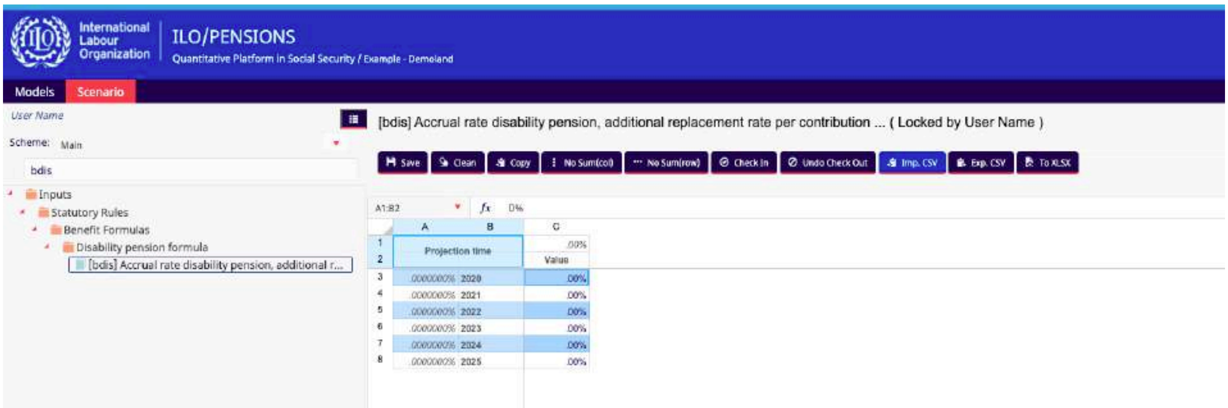


There is no way to hide the rows/columns permanently. Users are advised to work without focusing on them and to hide them if they are distracting for tasks that require lengthy periods viewing the same matrix. Hiding them every time a matrix opens will take a considerable amount of time.

5.5.2. Exporting commands: Exp.CSV and To XLSX

While ILO/PENSIONS offers an adequate environment for storing information and running projections on pensions, some tasks may be easier to perform in a traditional worksheet programme (such as MS Excel or Google Sheets). Fortunately, ILO/PENSIONS offers export options to facilitate the integration of ILO/PENSIONS with some of the more popular spreadsheet programmes.





Working on ILO/PENSIONS in MS Excel is easier when users' Excel format aligns with that of ILO/PENSIONS. There are two ways to resolve problems that may arise when working with csv files:

1. Changing MS Windows system preferences in terms of number formatting settings, date and time, region, additional date, time and regional settings, region (change date, time or number format) and additional settings. Users should change the decimal symbol for ".", while changing the digit grouping symbol to any other except "."
2. Changing only MS Excel preferences: Users should select the File tab, and then Options. In the Excel options dialog box, in Advanced, they should enter the Use system separators checkbox. In the appropriate fields, users should enter symbols for the decimal separator (".") and for the thousands separator (",").

The two possible formats for exporting the data are csv and xlsx. The former is a flat format similar to txt. The format transforms each row of a table into a line of text. The end of a column is marked by a comma (hence comma separated values, csv). The csv files only record text values but not how those values were calculated (values only, not formulas). Section 6.2.1.5 provides an exercise on exporting and importing matrices.

5.5.3. The Check Out command

The real manipulation of matrices requires the proper use of the Check Out/Check In commands. These commands are the key to all teamwork and remote access capabilities of ILO/PENSIONS.

Selecting the Check Out command gives users the exclusive right to edit a matrix up to the moment they Check In. While one editor/user holds the editing rights to a specific matrix, all other users with editing rights can only read the latest version of the matrix in the scenario. To protect the integrity of the information, no one can edit any matrix without first checking it out.

Establishing protocols for who can check out and edit the matrices is crucial for avoiding conflicts and managing resources while working as a team. The Check Out tab opens a set of additional options for working with the matrices.

5.5.3.1. *Direct writing*

Users who do not first check out the available matrix will be unable to manipulate it.

When users check out, they will be able to edit existing information or add new information as easily as in any other spreadsheet programme: they type the numbers, use '.' as the default decimal separator and then select enter.

5.5.3.2. *Using cell references*

Users can alternatively use an Excel-like reference of one entry for the value of another entry. As in Excel, users should start writing their formula with '=' (not '+'), followed by the typical mathematical operators: '+', '-', '*', '/' and '^' for sum, subtraction, multiplication, division and powers, respectively, parenthesis and a collection of functions. [22] Users can directly write the entry reference in the formula or use the mouse (or keyboard) to select the entry.

[22] Unlike in Excel, '+' is not allowed for formula reference.

ILO/PENSIONS will always save entries as numbers. Even if users obtained these numbers by entering calculations or using formulas, the software records or copies them from other sources as numbers. The Functions option helps save users time by allowing them to copy and spread calculations through ranges. However, when users exit the matrix, all formulas in the matrix will be replaced by their results, expressed as numbers without a record of the calculation method.

Users should also pay attention to the format of each cell –remembering to enter numbers without any spaces or commas, and where applicable, to check percentages after entering them to confirm that they are correct. (Problems can be resolved by dividing or multiplying by 100.)

5.5.3.3. *Using Ctrl+C to copy*

Users can change the value of a set of entries by copying the entries from another region of the matrix, another matrix or another programme. They can copy them in the matrix by pressing Ctrl+C (or Cmd+C on a Mac OS). An alert will appear if the size of the copied area does not match the size of the destination area. This method should not be confused with the copy function, which is explained in section 5.5.3.7.

5.5.3.4. *Clean method*

By selecting the Clean tab, users can erase all information entered into the matrix. This function helps users avoid confusion between new and old data. In the event the wrong selection is made, users should select Undo Check Out.

5.5.3.5. *Undo Check Out*

This tab allows users to go back to the matrix in the pre-check out version, meaning that none of the changes (writing, formulas and cleaning) made from the check out have any effect and the matrix returns unchanged. The option is available until the user selects Save.

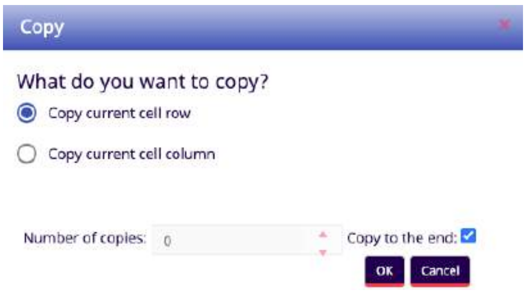
5.5.3.6. *Save*

All changes made by selecting Save are saved in the matrix. This function helps to save progress on work on a matrix before continuing to other sections of the matrix. Should ILO/PENSIONS unexpectedly close, any checked-out matrices will be stored in the last saved version available. Once users select Save, the saved version is stored and the option to return to the pre-check out version disappears.

5.5.3.7. *Copy mechanisms*

ILO/PENSIONS has a copy function that differs slightly from those in familiar programmes. This option allows users to copy:

- the values of a given row to a set number of rows that follow (below the given row);
- the values of a given column to a set number of columns that follow (to the right of the given column);
- the values of a given row to all rows that follow; and
- the values of a given column to all the columns that follow.



All those options are possible by selecting an entry, selecting Copy and choosing the combination of options in the menu box shown here.

5.5.3.8. *Imp CSV*

A primary goal of ILO/PENSIONS is to be able to exchange information with other spreadsheet platforms wth ease. The Imp CSV function allows users to import full data sets stored in a csv format into a matrix in the ILO/PENSIONS platform as long as they have the same dimensions. This allows users to utilize information from other spreadsheet platforms to easily fulfil ILO/PENSIONS requirements.

5.5.3.9. *Check In command*

Upon finishing editing a matrix, the user must use the Check In command to save all changes made in the matrix and to allow other users to make changes.[23] Users should always check in their matrix after they have finished working on it to save changes, input it into the system and increase the completion rate.

[23] The Check In command is equivalent to Save and then Check in. If users do not want to save changes, the only alternative is Undo check in. If users previously saved changes, the Undo check in is not available. Exiting the matrix without further saving will enable users to return to the last saved version of the matrix.

6. ILO/PENSIONS Walkthrough

This section is for:

- *All practitioners who will interact frequently with the platform, especially those leading actuarial teams*

In this section, users will learn:

- *How to log in to ILO/PENSIONS, create a practice model and baseline scenario*
- *Tricks and tips to manipulate matrices in the practice scenario in the model and in MS Excel (See ILO/PENSIONS Platform Walkthrough Cheat Sheet of commands)*
- *How to fill in demographic and financial matrices and the intuition behind them*
- *How to complete and run the model*
- *How to explore output matrices with key demographic and financial indicators*

This section will use some of the functions explained in section 5 to give prospective users some hands-on experience with ILO/PENSIONS and introduce them to tricks that will make easier to fill in the matrices needed. Steps are indicated with the following arrow: "→"

6.1. Logging in, creating your practice model and a practice base scenario

As mentioned, the main idea of this section is to practice and interact with ILO/PENSIONS; the results are secondary.

6.1.1. Log in

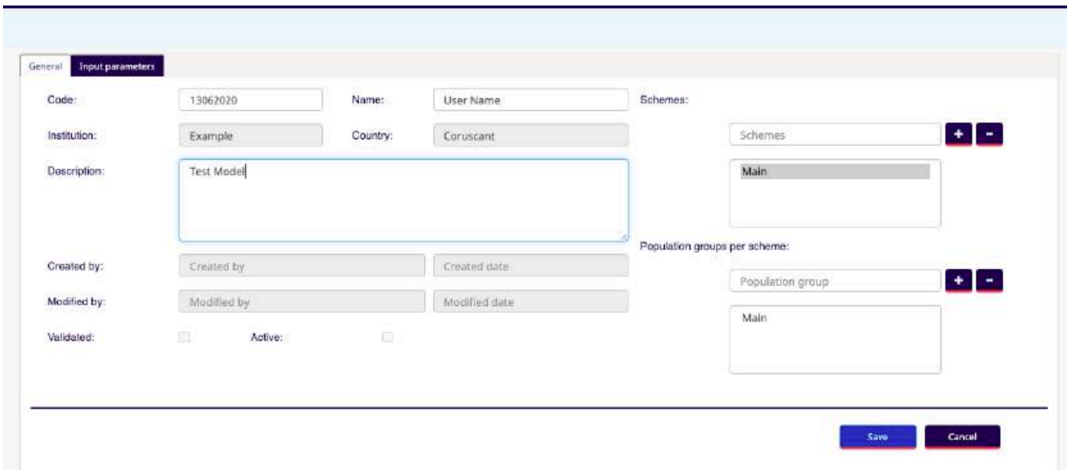
→ Users should check the email account used for registration to obtain their login credentials for ILO/PENSIONS. See the ILO/PENSIONS webpage: https://qpss.ilo.org:9080/. The first time users visit this page, they should enter their email address, **but should not enter the assigned password.** Instead, they should select the "Change password" option, create a secret password,[24] and log in.

[24] Users should remember that it is their responsibility to respect colleagues' working spaces. Sharing login credentials means taking responsibility for any irreversible changes that the user with whom credentials have been shared may make.

6.1.2. Create a practice model

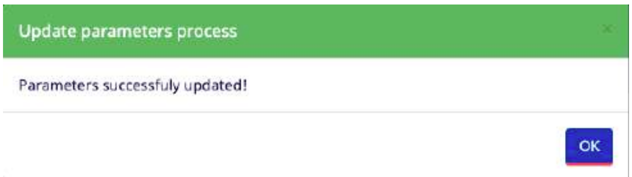
In ILO/PENSIONS, users can explore existing models and scenarios. For this trial run, they should avoid modifying existing work done. To begin:

- ➔ Select Models in the main menu, then in the Models menu that appears, select New.
- ➔ Create a new model in the Model window as follows: input user's birthdate in the Code and name in the Name. In the description, enter 'Test model'.
- ➔ Add one scheme named Main with a population group also called Main.



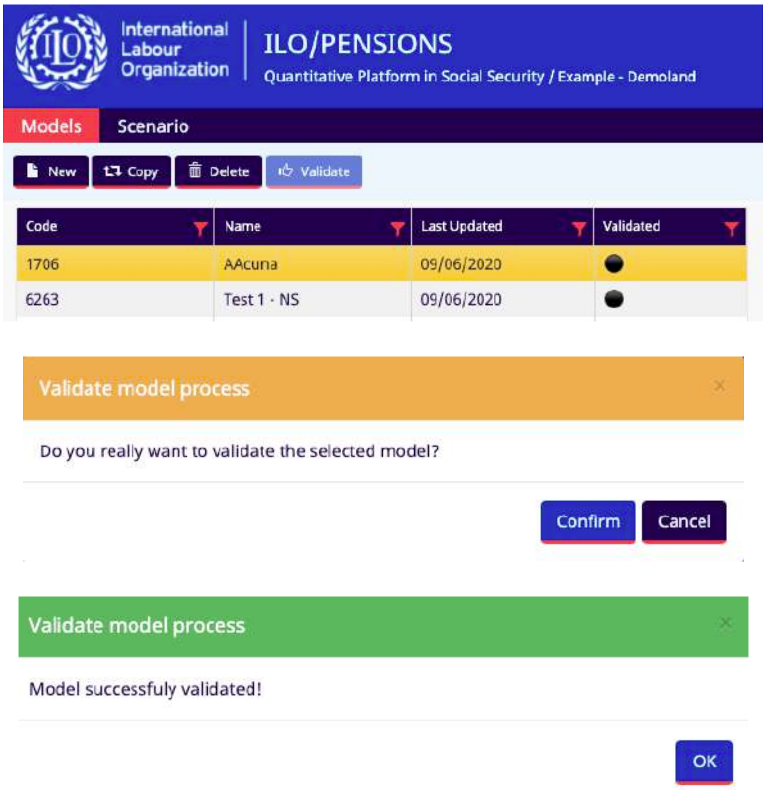
- ➔ Save changes, select OK when the model is successfully inserted (see green validation box for reference) and go to Input Parameters.

- ➔ Change input parameters as follows: maintain lifespan at 100, contributory age from 15 to 69, with earliest retirement age at 55. Keep orphans at 21, historical data at 10 years, a projection period of only six years (this is particularly important, as it will shorten the running time of the scenarios).[25] Then select the box for inflation-adjusted salary. Do not choose the box for NDC as this example will focus on a Defined Benefit scheme. Save the input parameters and click OK in the green pop-up box to confirm.



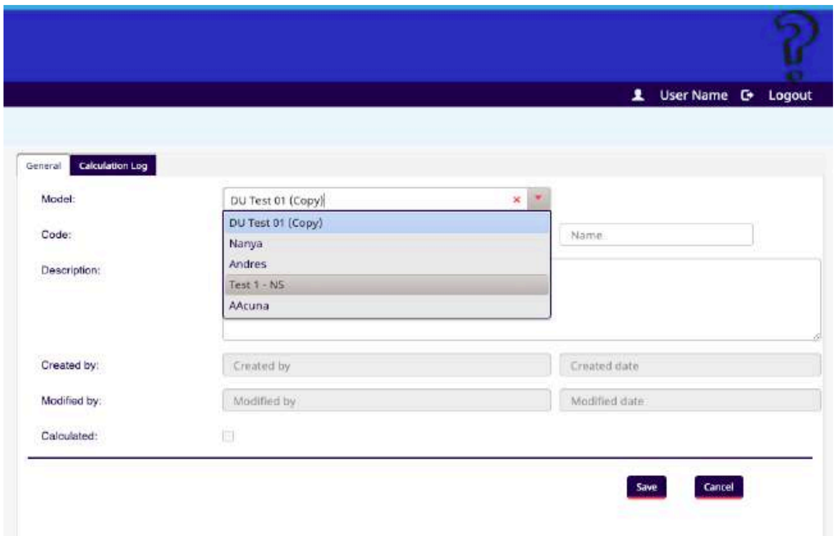
➔ To validate the model, select the model name in the menu (if not already selected) and select the Validate tab in the Models menu (above the models). Then, choose Validate and select OK in the green pop-up box that confirms that the model is successfully validated.

[25] Projections should be set for six years, so the year entered in the model under initial projection year is not the base year (Year 0), but rather the first year projections will be made (Year 1). The length of the projection period is the difference between the last projection year and the base year (or one plus the difference between the last projection year and the initial projection year). For example, if users have data for 2019, that can be the base year, and the initial projection year would be 2020. For six years of projection, users would need to input 2025 as the last projection year.



6.1.3. Create a practice scenario

➔ To create a practice scenario, select Scenario in the main menu, and New in the Scenario menu. In the dropdown Models menu, choose the model with their name. Fill the code with the user's birthdate, use the name for the Name and use 'Practice scenario' as the description. Then select Save and OK.



➔ Users should then log in to the email used for registration and wait for a message that the model was successfully created. This will take a few minutes as ILO/PENSIONS is assigning space for all the matrices required for the model.

6.2. Opening the scenario and filling in a set of matrices

For this practice run, the idea is to fill in as few matrices as possible to still be able to run the model. The objective is to learn:

- tricks for filling in matrices;
- how to assess progress;
- how to run a scenario;
- how to navigate the output matrices; and
- how to copy the scenario to create an alternative one.

For this exercise, all matrices in a new model will contain zeros. This facilitates the exercise. Although it is not a common practice, it is the way users will model a new scheme. Users may choose to skip all the matrices, but the recommended practice is to check out and check in the matrices to ensure that the Completion brief shows an increase in the completion rate.

Also, where applicable, users should remember to perform each step for both sexes. A convenient way to check progress is to see if the Completion brief reads 100 per cent completed for all matrices. When a matrix reads 0 per cent completed in the Completion brief it means that the matrix has not been Checked Out or Checked In. When a matrix reads 50 per cent completed, the matrix needs to be filled out for both sexes.

6.2.1. Filling in the benefit formula matrices

There are two types of benefit formulas in ILO/PENSIONS: pension formulas and lump-sum formulas.

Pension formulas are calculated as follows:

- **Calculate the Reference Salary ($\boldsymbol{RefSal}$)** as the average salary of the last $cref_t$ months of contribution, inflation-adjusted or not, depending on the option selected during model creation.

- **Calculate the number of contributions for additional replacement ($\boldsymbol{car}$)** using the floor of contributions for additional replacement ($\hat{c}_t$). The number of contributions for additional replacement for a new beneficiary with c accumulated contributions is: $max(c - \hat{c}_t, 0)$.
- **Calculate the Reference Pension ($\boldsymbol{RefPens}$)** using the Reference Salary, the flat amount component of the pension ($flat_t$) and the basic and additional replacement rates (a_t and b_t). The reference pension is $flat_t + (a_t + b_t \cdot car) \cdot RefSal$.
- **Calculate the pension ($\boldsymbol{Pens}$)** by comparing and adjusting the Reference Pension to the minimum pension ($minpens_t$) and the maximum pension ($maxpens_t$)[26]. So $Pens = min[max(minpens_t, RefPens), maxpens_t]$.

Lump sums are calculated as follow:

- **Calculate the Reference Salary ($\boldsymbol{RefSal}$)** as the average salary of the last $cref_t$ months of contribution, inflation-adjusted or not, depending on the option selected during model creation.
- **Calculate the Lump sum value ($\boldsymbol{lumpsum}$)** by multiplying the number of accumulated contributions by the replacement rate for lump sums (z_t) and the Reference Salary. $lumpsum = c \cdot z_t \cdot RefSal$.

As the different parameters for the benefit formulas can change for each contingency, ILO/PENSIONS has different matrices for each parameter of each contingency. The matrices all have one entry per projection year, so users can simulate benefit formula changes over time. The table below shows the matrices by parameter and contingency.

Table 1 – Benefit formula parameters

Parameter		Contingency		
Parameter	Description	Old-Age	Disability	Survivors
$cref_t$	Months of contribution for reference salary	[crefret] Number of periods (months) used as reference for old-age pension calculation (t).	[crefdis] Number of periods (months) used as reference for the disability pension calculation (t).	[crefdeath] Number of periods (months) used as reference for the survivor's pension calculation (t).

[26] Only if the maximum pension is higher than 0.

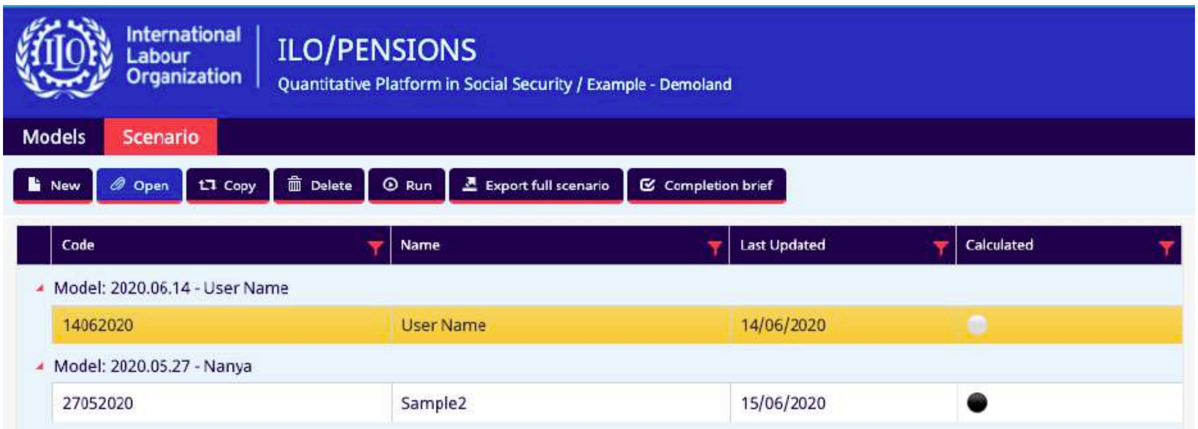
Parameter		Contingency		
Parameter	Description	Old-Age	Disability	Survivors
$\hat{c}_t$	Floor of contributions for additional replacement	[ctret] Threshold of contributions for additional replacement rate for old-age pension (t).	[ctdis] Threshold of contributions for the additional replacement rate for disability pension (t).	[ctsurv] Threshold of contributions for additional replacement rate for survivorship (t).
$flat_t$	Flat amount component of the pension.	[flatret] Flat amount component of the old-age benefit (t).	[flatdis] Flat amount component of the disability pension benefit (t).	[flatsurv] Flat amount component of the survivor's benefit (t).
a_t	Basic replacement rate (representing the proportion of the benefit not linked to the number of contributions	[aret] Basic replacement rate for old-age pension, as a percentage of reference salary (t).	[adis] Basic replacement rate for disability pension, as a percentage of reference salary (t).	[asurv] Basic replacement rate for survivorship, as a percentage of reference salary (t).
b_t	Additional replacement rate. Portion of the benefit linked to the number of contributions	[bret] Accrual rate of old-age pension, additional replacement rate per contribution period (t).	[bdis] Accrual rate of disability pension, additional replacement rate per contribution period for disability (t).	[bsurv] Accrual rate of survivorship pension. Additional replacement rate per contribution period for survivorship (t).
$maxpens_t$	Maximum pension	[maxretpen] Maximum old-age pension amount (t).	[maxdispen] Maximum disability pension amount (t).	[maxsurvpen] Maximum survivorship pension amount (t).
$minpens_t$	Minimum pension	[minretpen] Minimum old-age pension amount (t).	[mindispen] Minimum disability pension amount (t).	[minsurvpen] Minimum survivorship pension amount (t).

Parameter		Contingency		
Parameter	Description	Old-Age	Disability	Survivors
z_t	Lump sum benefit	[zret] Lump sum benefit per contribution period as a percentage of the reference salary for old age (t).	[zdis] Lump sum benefit per contribution period as a percentage of the reference salary for disability (t).	[zsurv] Lump sum benefit per contribution period as a percentage of the reference salary for survivorship (t).

The first step to complete the model in this exercise is to fill in the set of 24 parameters. To simplify this task, the parameters are as follows:

All $cref_t$ will be 12 (only the last year will be used as reference salary for all contingencies), the $\hat{c}_t$ floor of contributions for additional replacement will be 0, so every contribution increases the replacement rate of the pension benefits. The basic replacement rate is 0, meaning no guaranteed replacement for beneficiaries. Additionally, there is no flat amount component, minimum pension, maximum pension or lump sums. The additional replacement rate (accrual rate) is such that a 40 per cent total replacement is achieved after 30 years of contributions.[27]

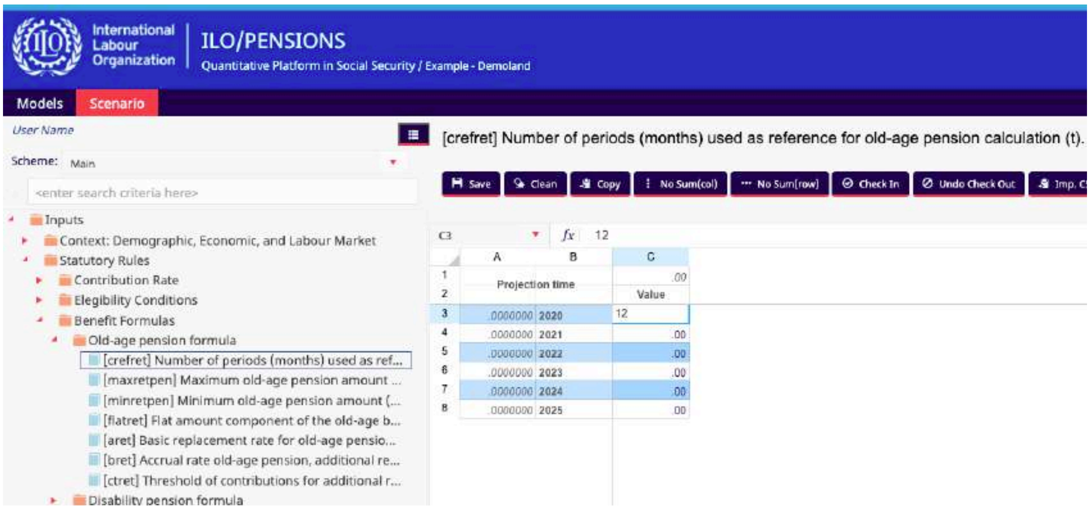
- ➔ Log in to ILO/PENSIONS and go to the Scenario menu. In the list of available scenarios, users should choose with their name under the model of the same name. In the Scenario menu, select Open.

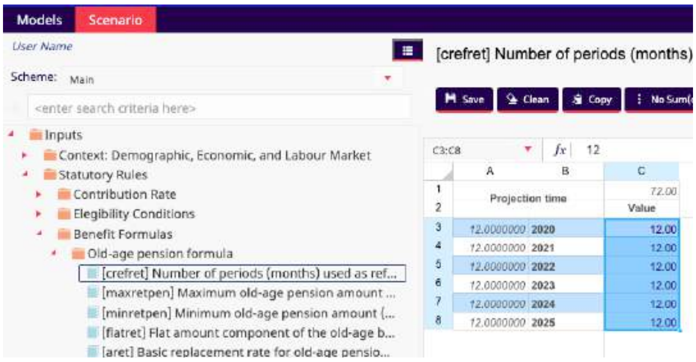


[27] All parameters are chosen to simplify work in the web application. None of these should be considered recommendations. Benefit formula parameters are important as they influence compliance with ILO conventions.

6.2.1.1. *Writing and copying*

➔ In the navigation tree of the model, choose: Input->Statutory Rules->Benefit formulas->Old-age pension formula and select the matrix [crefret]. Check out the matrix. Select the top entry and enter the number 12. Do the same for all following entries. Check in the matrix. Select the entries and press Ctrl+C.





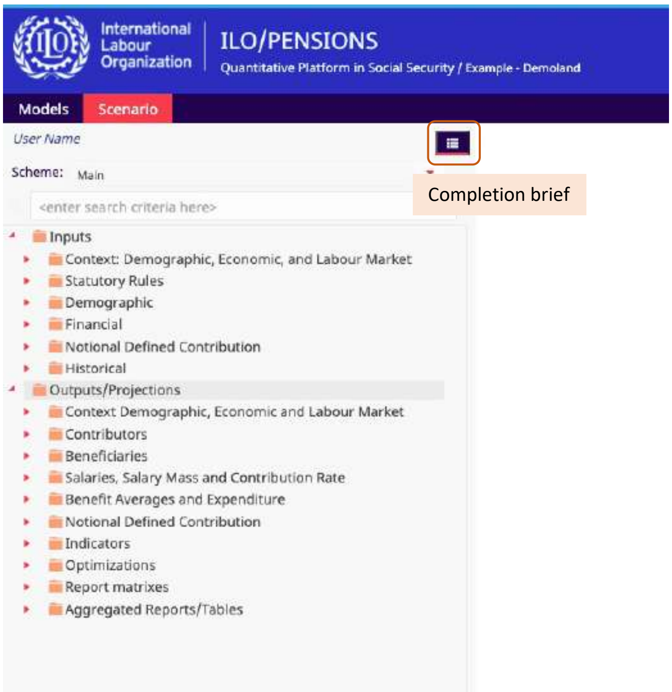
6.2.1.2. *Copying from another matrix*

➔ In the navigation tree of the model, choose: Input->Statutory Rules->Benefit formulas->Disability pension formula and select the matrix [crefdis]. Check out the matrix, select the first entry and press Ctrl+V to paste the values. Check in the matrix.

6.2.1.3. *Checking the Completion brief*

This is a good moment to check the Completion brief. There are two ways to do this:

1. Within the current scenario: Select the box with three lines above the search bar (circled in red below).



OR

2. Within the Scenario menu (*not* within the current scenario but in the menu where the desired scenario was selected): Make sure the current scenario is highlighted and select Completion brief. Sort rows by "Completeness" (highest to lowest). If all the steps have been followed thus far, users will note that there are two rows at the top with 100 per cent completeness: [crefret] and [crefdis].

See Section 5.3.7 for more information.

6.2.1.4. *Dragging a formula from a cell*

➔ Users should open the scenario they were working on again by exiting the Completion brief, selecting the scenario, and clicking on Open. In the navigation tree, choose Input->Statutory Rules->Benefit formulas->Old-age Pension Formula. Select the matrix [bret] and select the first entry. If the objective is a 40 per cent replacement when an individual has 30 years of contributions, this means that every month of those 30 years adds a

0.40/360 of the reference salary.[28] Check out the matrix. Write =0.40/360 in the entry. Now drag the entry to copy it to the end of the matrix.[29] Select Check In. Select Exp CSV. Open the csv file downloaded in Excel and save it as b_practice.csv in a location named Practice Run that is easy to locate.

6.2.1.5. *Importing from csv*

➔ In the navigation tree of the scenario, choose: Input->Statutory Rules->Benefit formulas->Disability pension formula and select the matrix [bdis]. Check out the matrix. Select Imp. CSV and select the file b_practice.csv. Check in the matrix. Now check progress in the Completion brief.

6.2.1.6. *Check Out, Check In*

The remainder of the matrices related to formulas in the exercise have to be filled in with zeros. This is already the default. Nevertheless, users must check out and check in each matrix to see them 100 per cent complete in the Completion brief, instead of 0 per cent as they appear currently to ensure the model is complete and able to run calculations without difficulty.

➔ In the navigation tree, choose Input->Statutory Rules->Benefit formulas->Old-age pension formula. Select the matrix [maxretpen] check out, then check in. The fact that a matrix was checked out and later checked in informs ILO/PENSIONS that somebody viewed it and agreed on the values (at least for the time being). This makes the scenario completion rate increase.

➔ Do the same for [minretpen], [flatret], [aret] and [ctret] in the same branch of the navigation tree. Check the Completion brief.

➔ In the navigation tree of the model, choose: Input->Statutory Rules->Benefit formulas->Disability pension formula. Do the check out, check in process for [maxdispen], [mindispen], [flatdis], [adis] and [ctdis]. Check the Completion brief again.

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[28] This matrix is an excellent example of working with percentage matrices in the model. The rules are as follows: if the matrix has a percentage in the entry values, it will show the input values as percentage. However, entry values must be input as a non-percentage value, for example, if users want 10 per cent to appear in the entry, they should enter 0.1. In the case of =.4/360, it is 0.0011. ILO/PENSIONS will show 0.11 per cent and the value will be saved with the same level of accuracy (number of decimal places).

[29] Dragging is done by:

a) Moving the cursor to the bottom right corner of a cell until the "+" sign appears
b) Pressing and holding a left click on the mouse/trackpad (or pressing down on the trackpad entirely) to 'grab' the "+" sign
c) Scrolling down to the desired cells
d) Releasing the mouse/trackpad when the desired cell is reached

- ➔ Users should follow the procedure they used to fill in the benefit formula parameters for Old Age and Disability to calculate survivor's benefits.

Users will notice that there are two additional parameters for survivor's benefits: [widp] Proportion of total survivor's pension allocated to each widow(er) (t) and [orphp] Proportion of total survivor's pension allocated to each orphan (t).

- ➔ In this exercise, fill in the widow(er) pensions [widp] with 50 per cent and orphan pensions [orphp] with 30 per cent using the procedure described in section 6.2.1.1.
- ➔ The replacement rate for all lump sums ([zret], [zdis], [zsurv]) is 0 per cent per contribution. Do the check out, check in process to increase the completion rate of the scenario.

Check the Completion brief to see that the following matrices are listed as completed.

[crefret]	**[crefdis]**	**[crefdeath]**
[ctret]	[ctdis]	[ctsurv]
[flatret]	[flatdis]	[flatsurv]
[aret]	[adis]	[asurv]
[bret]	[bdis]	[bsurv]
[maxretpen]	[maxdispen]	[maxsurvpen]
[minretpen]	[mindispen]	[minsurvpen]
[zret]	[zdis]	[zsurv]
[widp]	[orphp]	

Users should now fill in the eligibility conditions for benefits.

Like a parallel structure to that of benefit formulas, benefit conditions are divided in two groups. Conditions for pensions and conditions for lump sums.

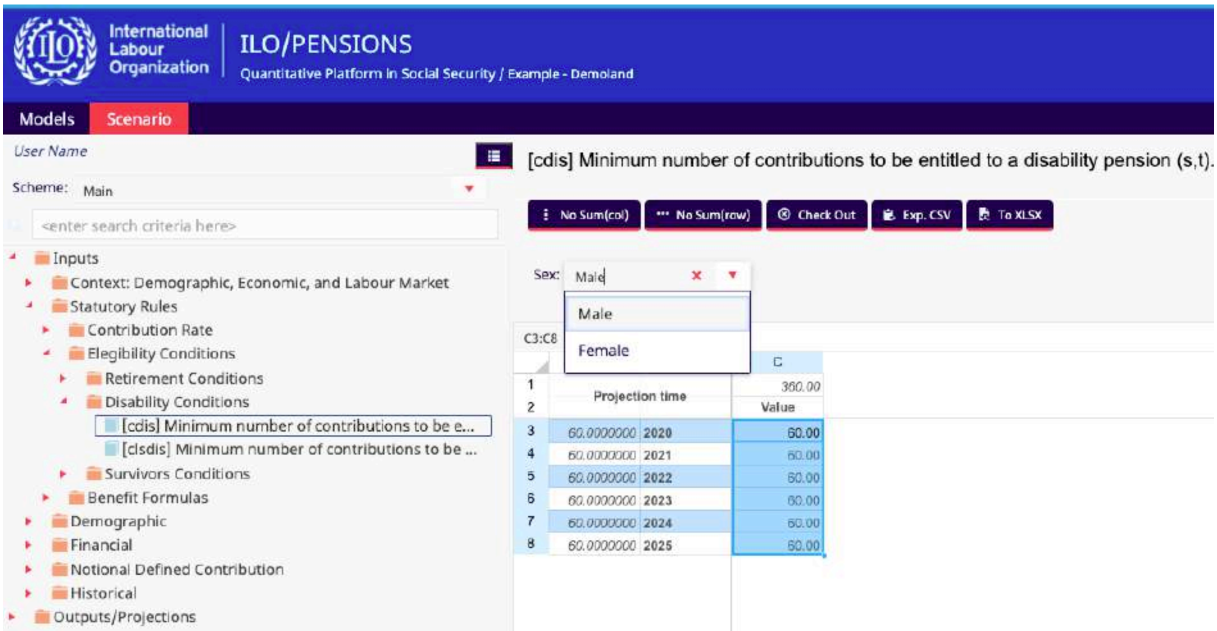
In the event of disability and death, these conditions are only expressed as the number of contribution months. Individuals with the required minimum or more accumulated contributions for a pension will receive a pension benefit. If they have the minimum or more contributions required for a lump sum, they are entitled to a lump sum. Those with fewer contributions than the minimum for a lump sum are ineligible for benefits.

In the case of old age, the conditions for a retirement pension are twofold. First, the minimum age of $xminret_t$. No one below that age can retire in the given year. Second, given the minimum age, they require at least $cret_t$ contribution months. ILO/PENSIONS works as follows: individuals younger than the given age will not be eligible for old-age benefits during the current year; those meeting the minimum age will be eligible for retirement; the group that opts no to retire will stay active, like those who have fewer contributions. Finally, all individuals who have reached the maximum age of activity that fulfil contribution requirements may retire; those who do not will receive lump sums if they have more than $clsret_t$ contributions, otherwise they will end up without benefits.

In this example, both disability and death benefits are achievable with five years of contributions. This model does not calculate lump sum benefits; leaving the requirement for lump sum at 0 is the same as asking ILO/PENSIONS not to calculate them.

➔ In the navigation tree of the model, choose: Input->Statutory Rules->Eligibility conditions->Disability conditions. Select [cdis] and fill in values of 60[30] for all years. In the same folder, check out and check in [clsdis], and open the Completion brief. Chances are that the Completion brief will show some matrices (specifically the ones just mentioned) as 50 per cent complete. This happens because both matrices have two "fronts," each representing a different matrix by sex. The sex is selected using the corresponding dropdown menu. **Make sure to modify the matrix for each sex in all the matrices that have the sex dimension.**[31]

[30] Five years expressed in months.
[31] In this example, users work with one group only. If extended to more groups, users should take the same care for the group dimension.



➔ Fill in the other dimensions for [cdis]. Check out and check in the other sex for [clsdis]. Once this is done, the completion rate will appear as 100 per cent in the Completion brief. For this exercise, it is assumed that contribution requirements are the same for male and female. In some cases, eligibility conditions may differ between sexes.

➔ Do the same for the corresponding matrices in the folder: Input->Statutory Rules->Eligibility conditions->Survivor's conditions and check the Completion brief.

➔ In the case of Old-Age, the assumption is that no lump sums are given. In the folder Input->Statutory Rules->Eligibility conditions->Old Age conditions, check out and check in the [clsret] matrix.

The requisites for old-age pensions are as follows: Anyone can retire with at least 40 years of contributions regardless of age. After age 60, contributors are eligible to receive pensions after 35 years of contributions. At age 65, 25 years of contributions are needed. Finally, at age 69, retirement is possible with 15 accumulated years of contributions.

➔ To enter these requisite conditions into the model, go to the matrix in the folder Input->Statutory Rules->Eligibility conditions->Old Age and fill in the matrix [xminret] with the minimum retirement age. As the contribution period starts at 15 years, the minimum age anyone can attain 40 years of contributions is 55.[32] Enter = this value (55) for the male and female matrix [xminret]. Remember to check the Completion brief.

Since in the practice model the minimum retirement age was set at 55 and the maximum contributory age was set at 69, the [cret] matrix in the folder Input->Statutory Rules->Eligibility conditions->Old Age for each sex will list ages 55 to 69 in the rows. In the columns are the years, starting from the base year (year before the first projection year) up to the last year of projection.

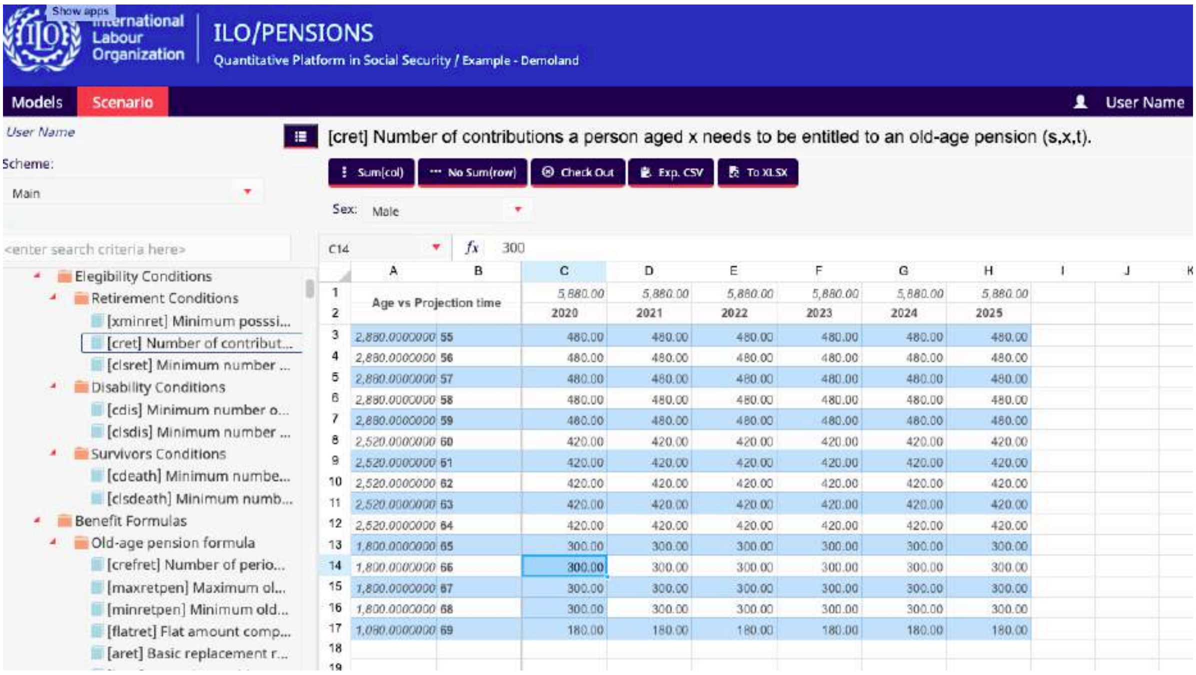
In the confluence of year of projection and age, users must input the number of contributions required to retire at that specific age in that year. The exercise assumes all years have the same eligibility conditions.

- ➔ To fill in the matrix, go to Input->Statutory Rules->Eligibility conditions->Old Age, and select [cret], check out the matrix for males. The top left of the matrix will list the conditions for retiring at age 55 in the first year. Retiring at age 55 requires 40 years, so enter 480 months in the first entry. Select Copy and in the box choose Copy current cell row. Then tick the option Copy to the end and select OK so that 480 appears in the whole column.

- ➔ Since individuals can retire at age 60 with 35 years of contributions, users should go to the corresponding row and enter 420. Any individual over age 60 and under age 65 can opt for retirement with the same 420 contributions required for 60, as the age and number of contributions are the ceiling of the requisite. Do the same copy process: copy the current row, copy to the end at the row of age 60. At age 65, enter 300 and repeat the process, at age 69, enter 180. Stay in the first column and select Copy again. This time choose Copy current cell column, and tick Copy to the end. The values of the column should be pasted in all the columns to the right. Now check in the matrix. The same values should be entered in the matrix for females.[33]

[32]Contributions from more than one job count as one per period. It is easier to understand eligibility requirements expressed in terms of contribution periods rather than contributions per se.

[33] To do this, users can enter the information, enter it with the help of the Copy function, export it and import it later, or copy with Ctrl+C and paste it with Ctrl+V.



Check the Completion brief once finished. It should now reflect the following matrices as well.

[cdis]	[cldis]	[xminret]	[cret]
[cdeath]	[clsdeath]	[clsret]	

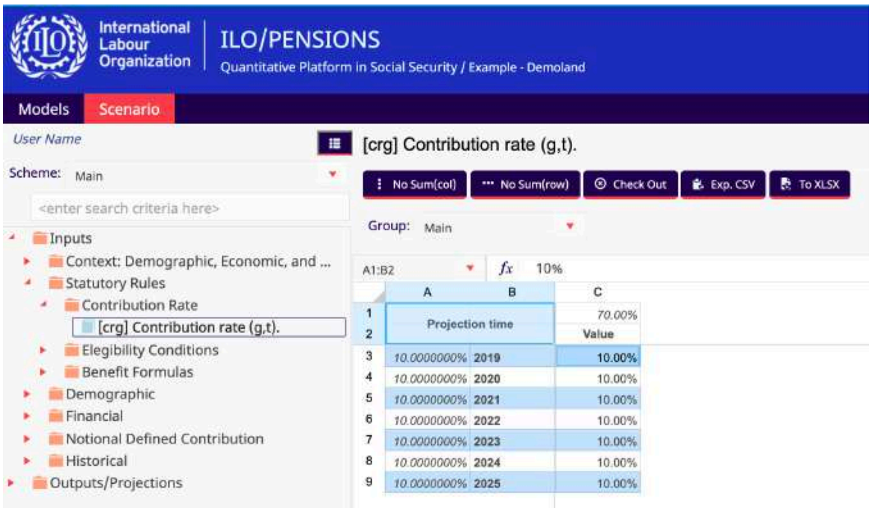
6.2.2. Filling in the contribution rate matrix

Only one matrix remains incomplete in the Input->Statutory Rules section of the navigation tree: Input-Statutory Rules->Contribution rate [crg]. The matrix requires the expected contribution rate in place for every year of the projection for each of the population groups in the model.[34] [35]

- ➔ For this exercise, the contribution rate is set at 10 per cent of the salaries for all years for the only population group included. Fill in the matrix accordingly.

[34] ILO/PENSIONS considers the possibility of different contribution rates for each group given that in many countries, different sectors or types of status in employment have different contribution rates.

[35] The entries in the matrix correspond to the full legal contribution rate as a percentage of the insurable salary (the salary simulated in ILO/PENSIONS). The distribution of the contribution rate among constituents is absent from the model as it normally does not affect the sustainability situation of the schemes. The risks that some distributions of obligations affect the liquidity of the scheme is not considered in most cases, nevertheless; if the risk is high, an alternative is to model effective contributions rather than legal ones.



6.2.3. Filling in the demographic and labour market context

ILO/PENSIONS has seven matrices in the section related to demographic and labour market context.

Three matrices are mainly needed to estimate coverage indicators. They need to be filled in correctly to obtain accurate indicators of scheme performance, especially in terms of extending protection. The four remaining matrices are key for the projection of the covered population and for defining scheme entries.[36]

For this section, all matrices can be found in the navigation tree: Input->Context: Demographic, Economic and Labour Market->Demographic.

The total covered population is calculated through the following process:

- **Inputting a projection per year of the country's total population by sex** for the whole projection period ($NATPOP_t^s$)
- **Extracting the projected labour force (LF_t^s) from the total population projection** by multiplying it by the participation rate ($Partr_t^s$) by sex and year. $LF_t^s = NATPOP_t^s \cdot Partr_t^s$

[36] This can be considered the driver of the demographic dynamics of the model. The connection between macro projection of coverage and the single age projection of demographic groups.

- **Extracting the total covered active population**[37] ($Tact^{s}_{g,t}$) of a group in the labour force by multiplying it by the coverage rate ($Cov^{s}_{,gt}$) by group, sex and year and discounting the unemployed portion of the labour force.[38] $Tact^{s}_{g,t} = \left(cov^{s}_{g,t}\right) \cdot LF^{s}_{t} \cdot (1 - unemrate^{s}_{t})$

> **TIP:** Coverage as Active Covered is calculated by group, so users should ensure that in a situation where there are multiple groups, the sum of the coverage of all groups is consistent with the total coverage. Additionally, each scheme has its own coverage assumptions, so users should take extra care when working in multi-scheme models.

For this exercise, the idea is to create a scenario with an increasing covered population as follows:

- A population that grows 2 per cent per year over the projection period and for the first projection year is a million people in total, equally composed of male and female.
- A participation rate that is constant at 70 per cent for males but increases 5 percentage points each year for females, beginning at 40 per cent to a maximum of 70 per cent.
- Unemployment rate is 5 per cent for males, 3 per cent for females.
- The coverage rate is more complicated: it is the same for males and females, but is equal to 1/6th the natural logarithm of the number of projection years, plus one.

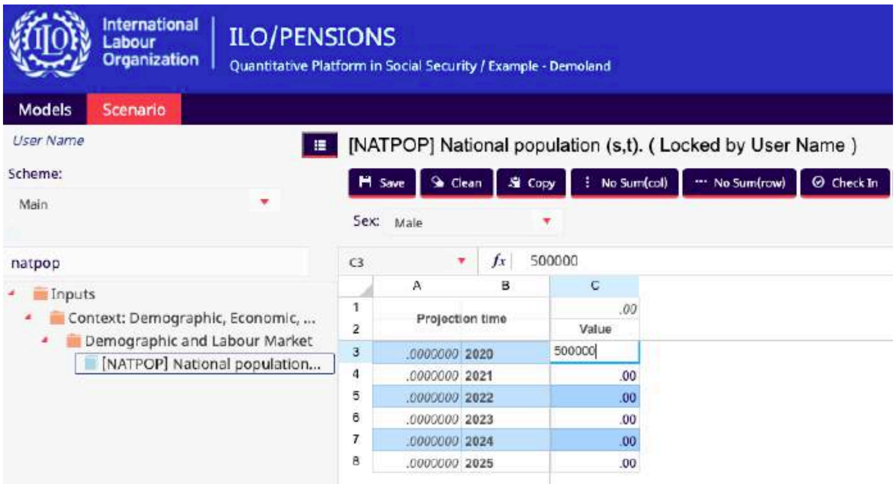
> **TIP:** Users should remember to use the Participation Rate calculated over Total Population, which differs from the one calculated over Working Age population. Users should determine which one is reported in national statistics, calculate the one required and check consistency.

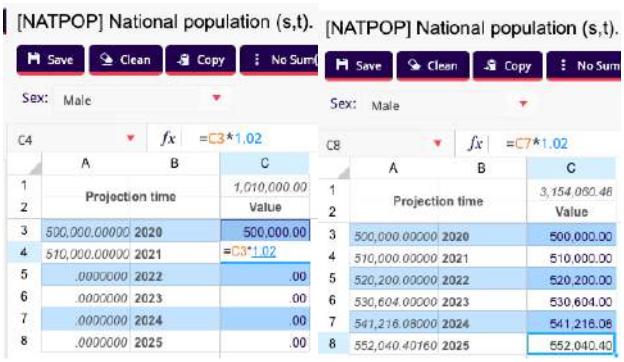
➔ Users should first attempt to fill in the corresponding matrices using the above information and then compare them to results from the method for filling them in described below.

➔ To add a population growth rate of 2 per cent per year: check out the matrix named National Population [NATPOP] by navigating to Input->Context: Demographic, Economic and Labour Market->Demographic->NATPOP. A box will appear at the indicating that this

[37] A positive change in the total covered active population over time means that the number of entries will equal the change and the exits from the covered population in the previous period. In the event that the change is zero, the number of entries will only replace the exits greater or equal than zero. In the event that the change is negative, there is a theoretical risk of negative entries. ILO/Pensions will keep entries at zero and artificially increase the number of covered populations. If users really need to adjust the total covered population to the macro projection, some changes in exit probabilities are required.
[38] Unemployment rates are usually expressed as a percentage of unemployed people in the labour force, thus fitting the definition used in this model.

is for males in the national population. In the top cell of the matrix [C3], enter 500000. This is the starting population. In the next cell, enter the formula =1.02*[C3]. (i.e., write "=1.02*" and then select cell C3). Drag the plus sign at the lower corner of the cell to the end of the column. This will provide input indicating that the population grows at a rate of 2 per cent annually.





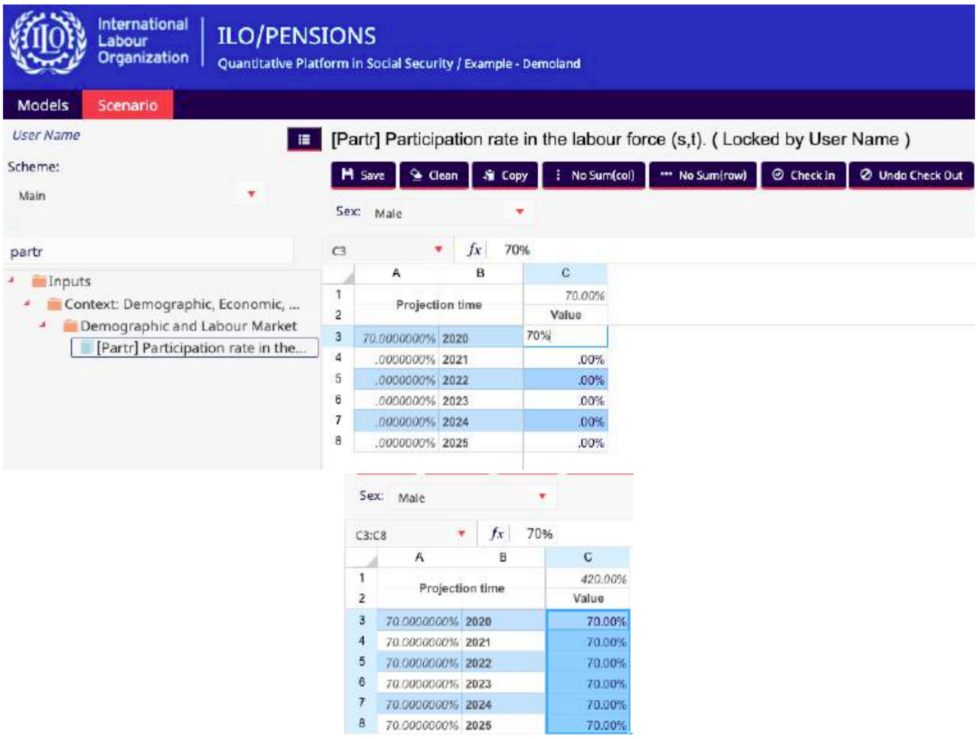
- ➔ Check in this matrix and do the same for the female matrix.

To add the respective labour force participation rates for males (70 per cent) and females (40 per cent + 5 percentage points each year):

- ➔ Go to the matrix for participation rate [Partr]. In Partr, make sure that the option "male" is selected in the dropdown menu. Check out and fill in all cells with the value 70 per cent. Check in.

➔ In the matrix for female: Enter 40 per cent in the first cell; in the second write the formula: =MIN(C3+.05,.7) and copy it in the rest of the matrix before checking it in.[39]

Male



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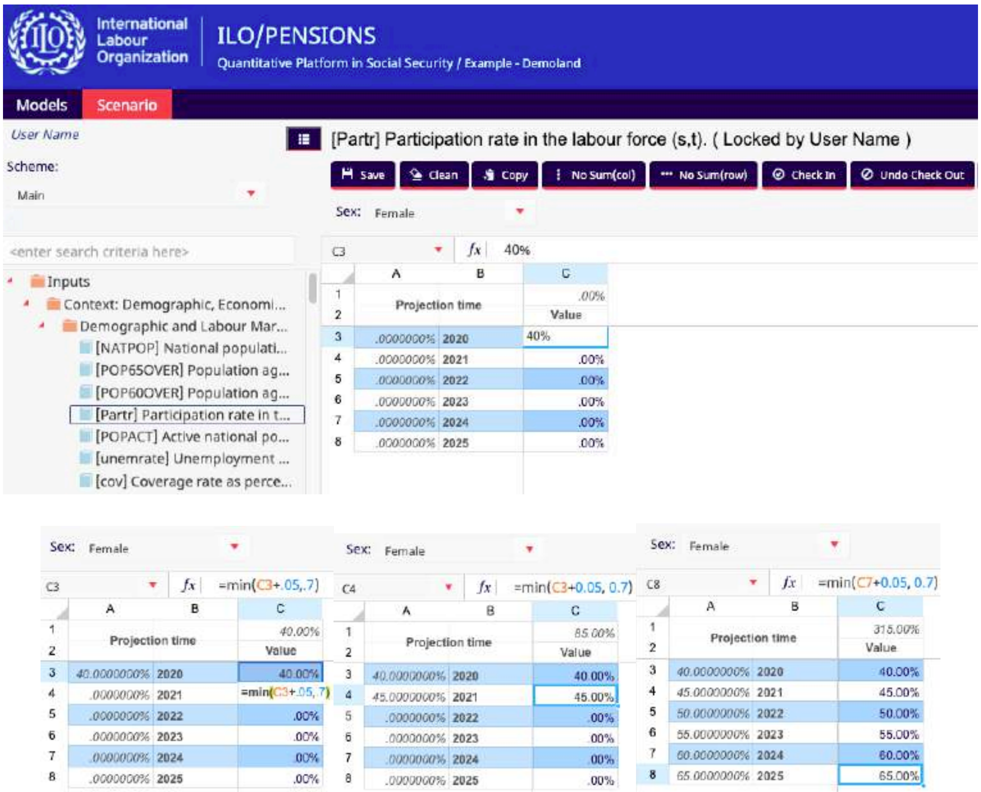
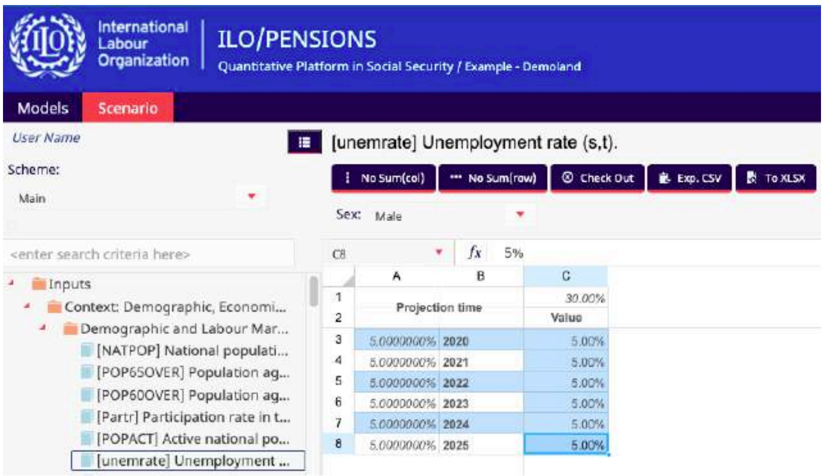
[39] This function can be explained in two parts. First, consider "C3 + 0.05". This simply means "add 5 percentage points to the selected cell", in this case, to the previous year. If the female labour force participation rate starts at 40 per cent and increases by 5 percentage points a year, the first row, C3, will be 40 per cent and the next row will be (40 + 5) per cent or 0.4+0.05.
Next, consider the MIN function, a function used to select the lowest value in a range of values. Use it to set 70 as the maximum. In this case, the two numbers are 70 (the maximum) and the value that reflects the increase in the female labour force participation rate, i.e., C4, C5, and so on. Any number in this range is fine as long as it is below 70, because the MIN function will select this number. However, as soon as the female labour force participation exceeds 70, the function starts to select 70 as the minimum number, effectively setting it as the maximum.

Female

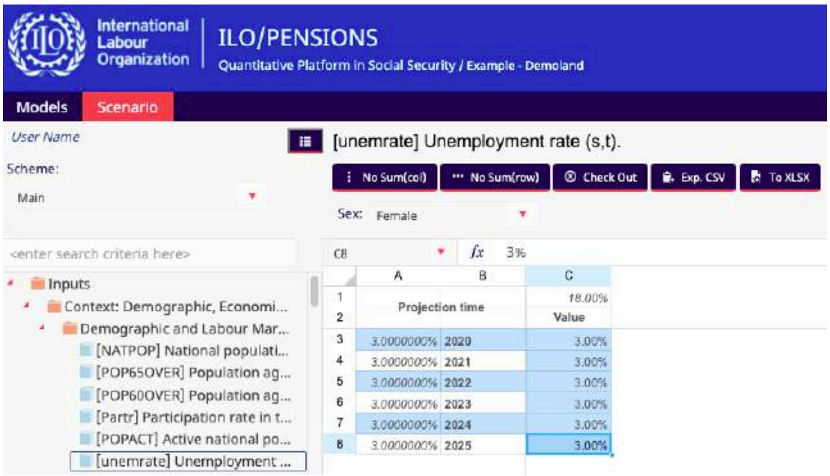


→ The matrix for unemployment rate is [unemrate]. Enter 5 per cent for males and 3 per cent for females.

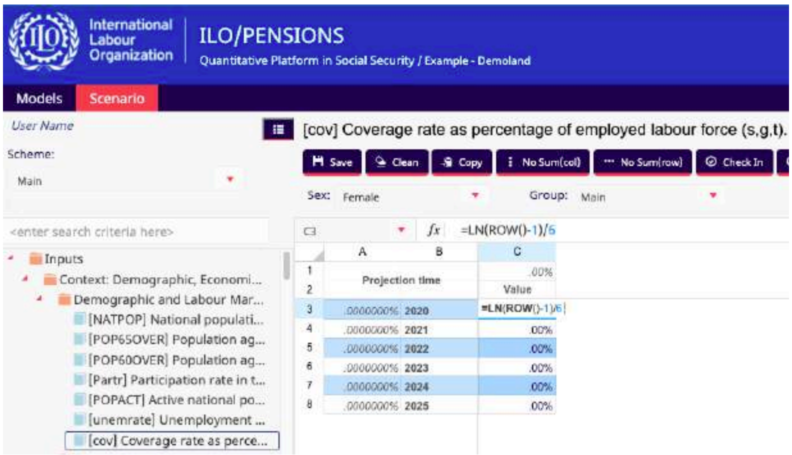
Male

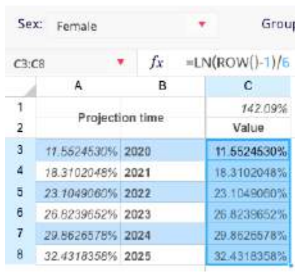


Female



➔ Finally, coverage is in the matrix [cov]. Users will normally enter their own formula for coverage, but for this exercise, they should fill in the cells with the formula =LN(ROW()-1)/6 for both male and female.[40]





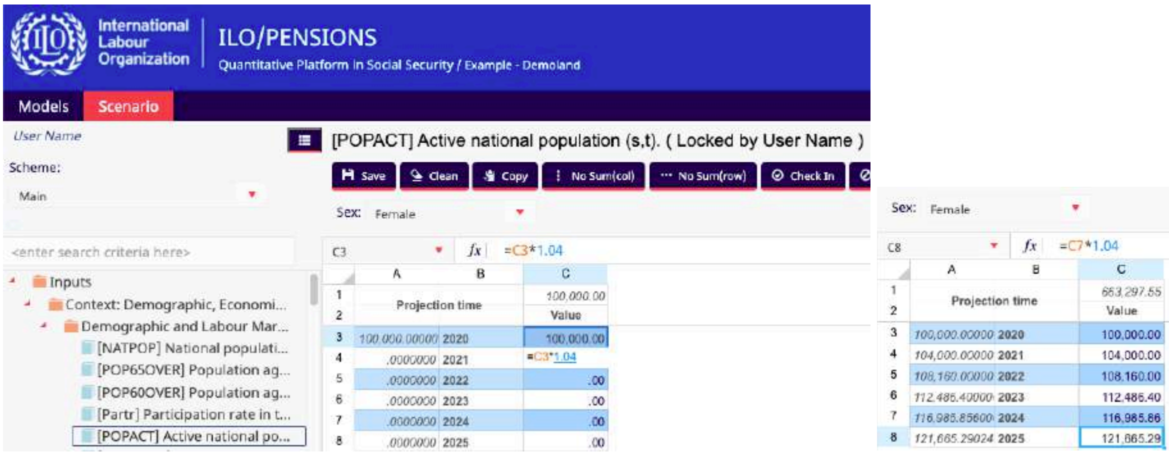
TIP: Users may choose to calculate the values in a different program (MS Excel, for instance) and paste them in the matrices if they prefer. To do this, in the Scenario menu, use the "Export full scenario" tab to export all the files as Excel files, and then modify and import each relevant file individually within an open scenario.

[40] ROW() returns the value of the row you are in, so in row 2, it will return a 2. Subtracting 1 reduces the value of every row by one in the formula. Finally, apply a natural logarithm and divide by 6.

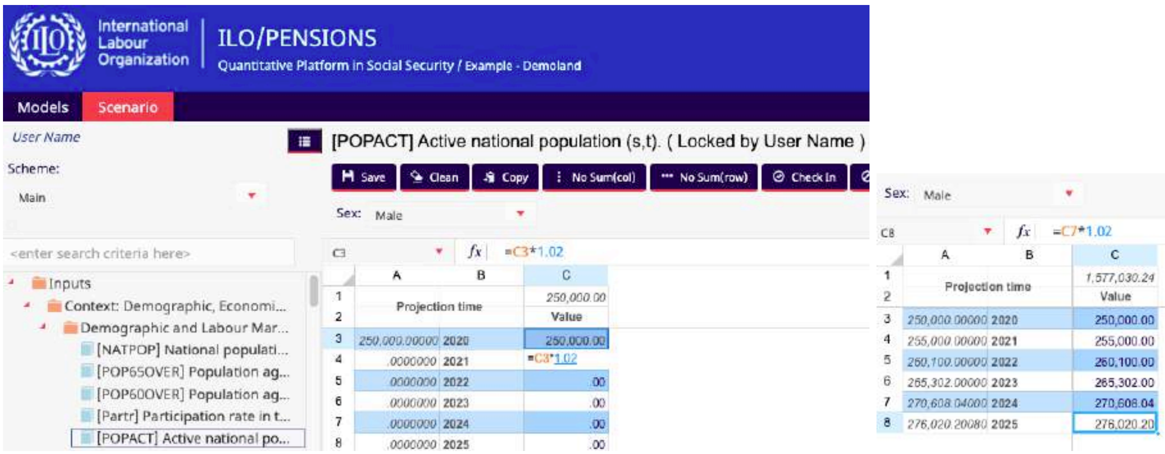
Other matrices used for indicators in ILO/PENSIONS are: Expected Population aged 60 and over [POP60OVER], Expected Population aged 65 and over [POP65OVER] and Active Population [POPACT].

- ➔ Fill in the following in the respective matrices:
  Active Population of 100 000 for females, growing at a rate of 4 per cent, and 250 000 for males, growing at a rate of 2 per cent. Population over age 60 is the same for male and female: 30 000 growing at a rate of 3 per cent. For over-65s, it is 20 000, growing at a rate of 4 per cent.

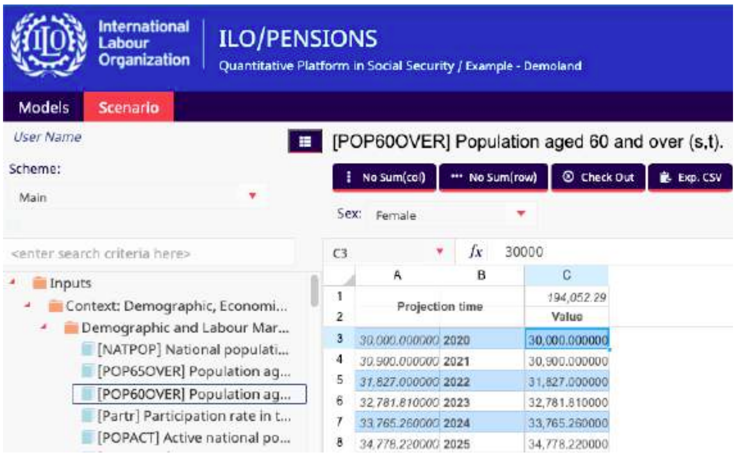
Female



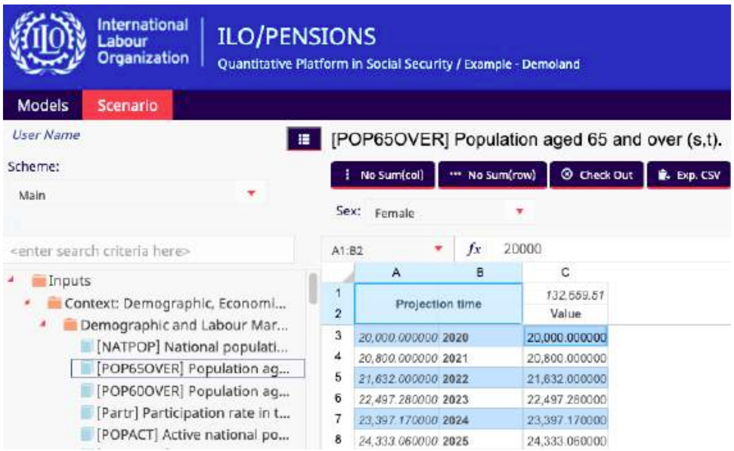
Male



Population over age 60



Population over age 65



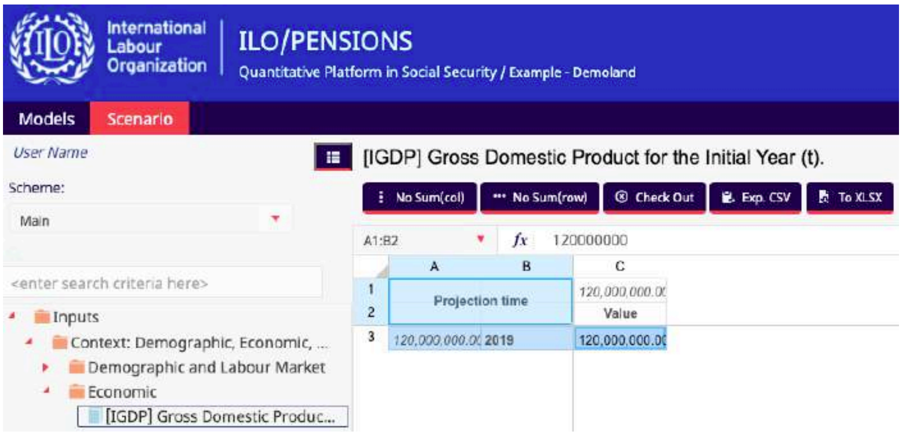
6.2.4. Filling in the economic context

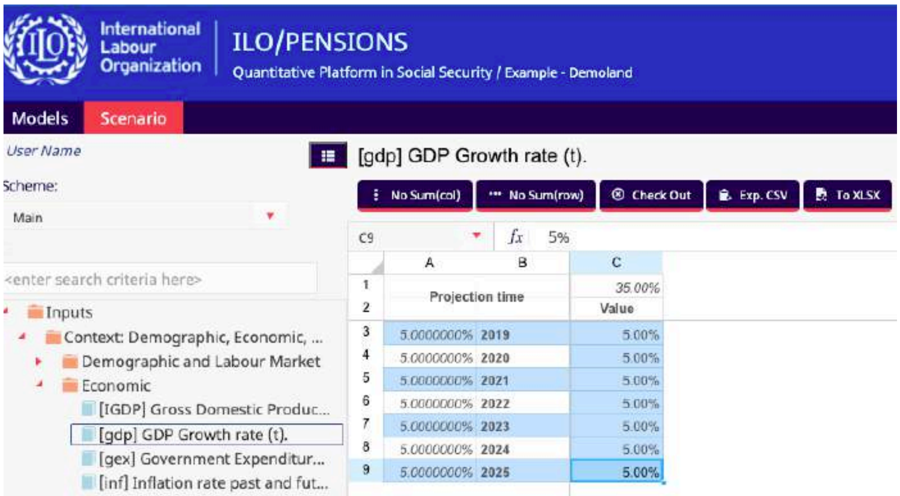
In the navigation tree, choose Input->Context: Demographic, Economic and Labour Market->Economic

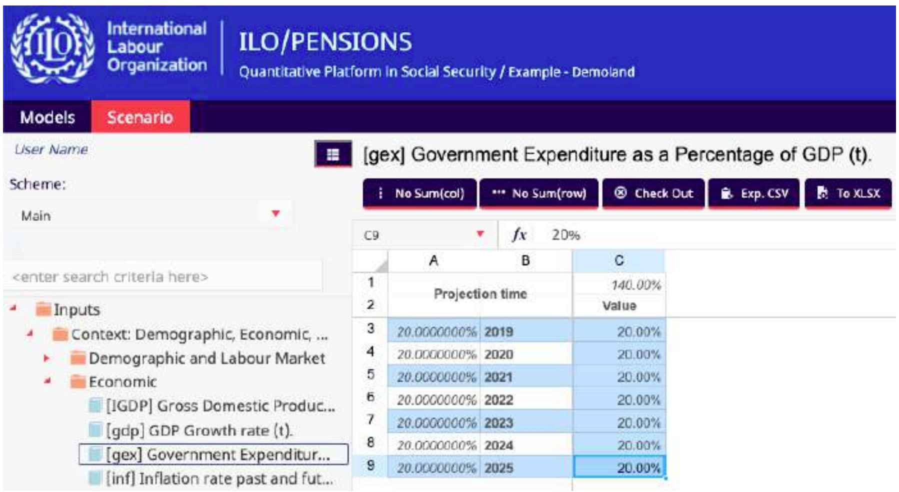
This folder contains five matrices. Two of them are critical for any projection: inflation rate, needed to adjust the salary for the calculation of the reference salary for pensions, and interest rate, to estimate the pension reserve over time. The three other matrices are used for indicators, such as comparisons of expenditure to GDP or government expenditure.

The calculation of GDP and government expenditure uses an initial value of GDP (for the year prior to the projection). Users should enter the growth rate for GDP over the projection period as well as the government expenditure as a proportion of GDP for the same period in the relevant matrices. For this exercise, initial GDP [IGDP] is 120000000 currency units, GDP growth [gdp] is projected at

5 per cent annually and government expenditure [gex] is 20 per cent of GDP during the whole period. Inflation [inf] is assumed to be 0 per cent (this can be interpreted as if the whole scenario is formulated in real values) and the interest rate is also 0 per cent. Remember to check out and check in to increase the model completion rate.







6.2.5. Filling in the demographic data for the base year

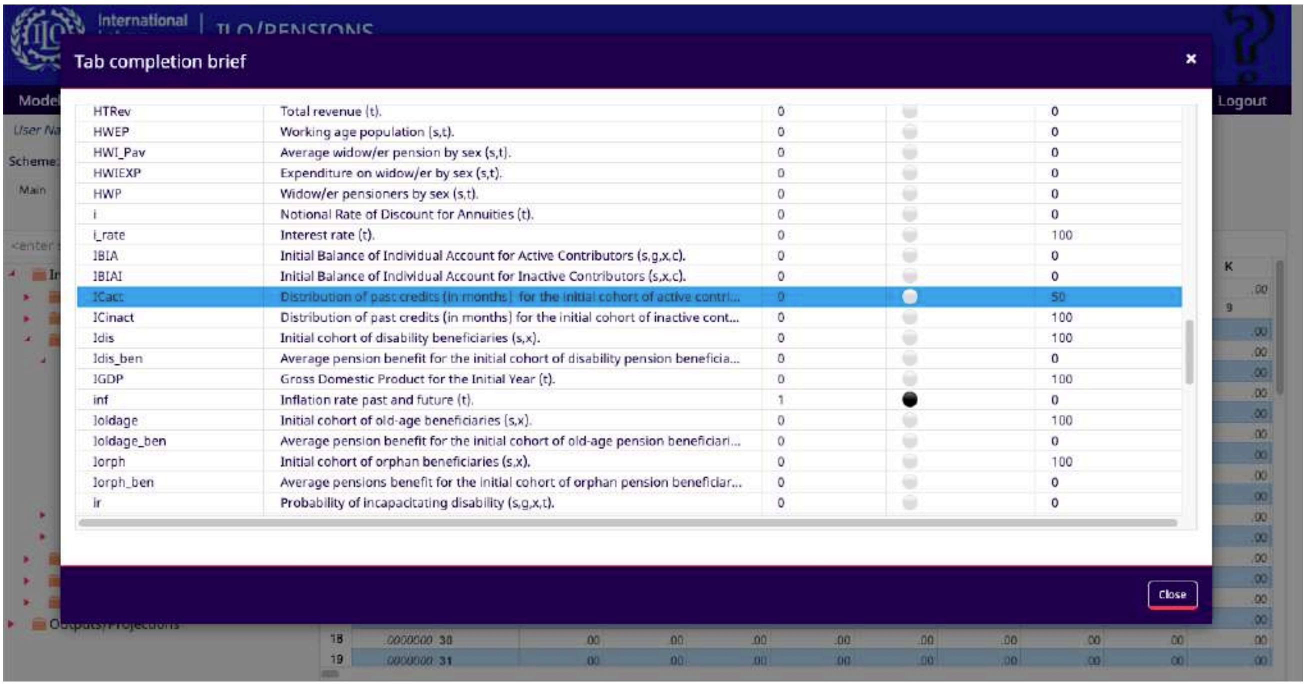
In the navigation tree, select Input->Demographic->Base year.

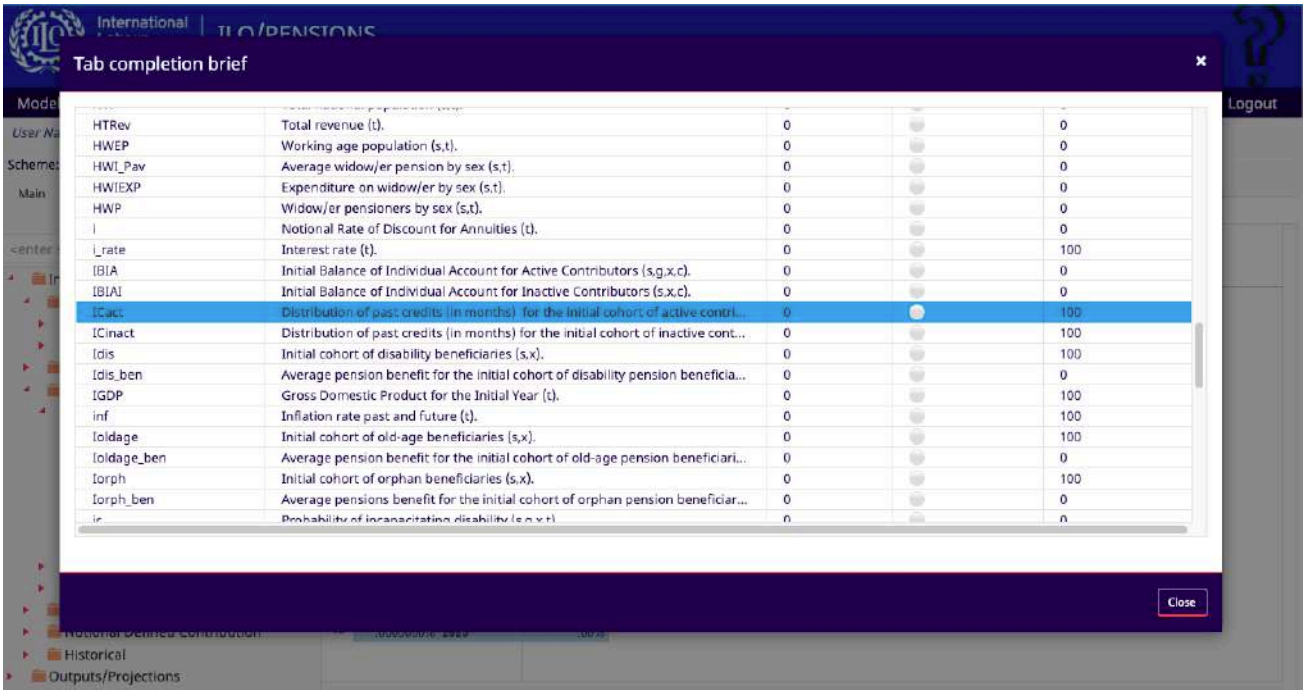
The demographic data for the previous year is key information for running a scheme because it reports the number of each type of beneficiary by sex and age, demonstrating the exposure of those populations to the risk of continuing to require benefits. The number of active and inactive contributors, by age, sex and accumulated contributions shows the exposure to contingencies as a contribution payment or benefit demand. Basically, the section on demographic data for the base year introduces all the information in Figure 9 – Population groups modelled in a scheme in the model.

The matrices in the section are: [ICact] Distribution of past credits (in months) for the initial cohort of active contributors, [ICinact] Distribution of past credits (in months) for the initial cohort of inactive contributors, [Ioldage] Initial cohort of old-age beneficiaries, [Idis] Initial cohort of disability beneficiaries, [Iwid] Initial cohort of widows(er) beneficiaries and [Iorph] Initial cohort of orphan beneficiaries (s,x).

- ➔ For this exercise, all matrices will be filled in with zeros as they appear in a new model. This facilitates the exercise for users when modelling a new scheme. Users can opt to skip all the matrices, but it is advisable to check out and check in the matrices to ensure that the Completion brief shows an increase in the completion rate.

- ➔ **Remember to do each step for both sexes.** Users should remember that a convenient way to check their progress is to verify that the Completion brief lists all matrices as 100 per cent completed. When a matrix is 0 per cent completed in the Completion brief, this indicates that the matrix has not been Checked Out or Checked In. If a matrix is 50 per cent completed, the matrix needs to be filled out for both sexes. Below, [ICact] has only been filled in only for one sex, and users have left the [inf] matrix checked out (black dot). Filling in the other sex in [ICact] and checking out the [inf] resolves this.


International
ILO/PENSIONS
Tab completion brief
HTRev Total revenue (t). 0 0
HWEP Working age population (s,t). 0 0
HWI_Pav Average widow/er pension by sex (s,t). 0 0
HWIEXP Expenditure on widow/er by sex (s,t). 0 0
HWP Widow/er pensioners by sex (s,t). 0 0
i Notional Rate of Discount for Annuities (t). 0 0
i_rate Interest rate (t). 0 100
IBIA Initial Balance of Individual Account for Active Contributors (s,g,x,c). 0 0
IBIAI Initial Balance of Individual Account for Inactive Contributors (s,x,c). 0 0
ICact Distribution of past credits (in months) for the initial cohort of active contri... 0 50
ICinact Distribution of past credits (in months) for the initial cohort of inactive cont... 0 100
Idis Initial cohort of disability beneficiaries (s,x). 0 100
Idis_ben Average pension benefit for the initial cohort of disability pension beneficia... 0 0
IGDP Gross Domestic Product for the Initial Year (t). 0 100
inf Inflation rate past and future (t). 1 0
Ioldage Initial cohort of old-age beneficiaries (s,x). 0 100
Ioldage_ben Average pension benefit for the initial cohort of old-age pension beneficiari... 0 0
Iorph Initial cohort of orphan beneficiaries (s,x). 0 100
Iorph_ben Average pensions benefit for the initial cohort of orphan pension beneficiar... 0 0
ir Probability of incapacitating disability (s,g,x,t). 0 0
Close
Logout


International
ILO/PENSIONS
Tab completion brief
HTRev Total revenue (t). 0 0
HWEP Working age population (s,t). 0 0
HWI_Pav Average widow/er pension by sex (s,t). 0 0
HWIEXP Expenditure on widow/er by sex (s,t). 0 0
HWP Widow/er pensioners by sex (s,t). 0 0
i Notional Rate of Discount for Annuities (t). 0 0
i_rate Interest rate (t). 0 100
IBIA Initial Balance of Individual Account for Active Contributors (s,g,x,c). 0 0
IBIAI Initial Balance of Individual Account for Inactive Contributors (s,x,c). 0 0
ICact Distribution of past credits (in months) for the initial cohort of active contri... 0 100
ICinact Distribution of past credits (in months) for the initial cohort of inactive cont... 0 100
Idis Initial cohort of disability beneficiaries (s,x). 0 100
Idis_ben Average pension benefit for the initial cohort of disability pension beneficia... 0 0
IGDP Gross Domestic Product for the Initial Year (t). 0 100
inf Inflation rate past and future (t). 0 100
Ioldage Initial cohort of old-age beneficiaries (s,x). 0 100
Ioldage_ben Average pension benefit for the initial cohort of old-age pension beneficiari... 0 0
Iorph Initial cohort of orphan beneficiaries (s,x). 0 100
Iorph_ben Average pensions benefit for the initial cohort of orphan pension beneficiar... 0 0
Close
Logout
Historical
Outputs/Projections

6.2.6. Filling in the financial data for the base year

To complement the demographic information, select Input->Financial->Base year.

This information complements the demographic information for the base year. With it, ILO/PENSIONS receives information for Figure 10 – Financial flows modelled in a scheme for the base year and information on the initial reserve for the scheme.

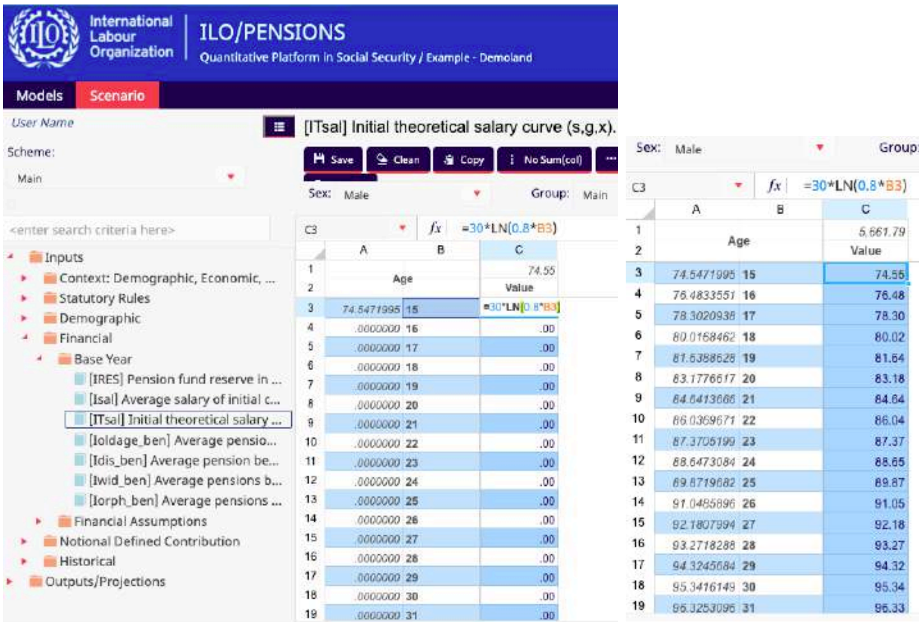
In terms of salaries, ILO/PENSIONS requests two sets of salaries per age for each sex. One [Isal] can be interpreted as the empirical monthly average salary per age observed over the base year. The other, [ITsal] is the theoretical salary curve, the expected value of the monthly salary by age. The empirical salary will be adjusted and applied to the wage workers of the base year expected to contribute in the following years, while the adjusted theoretical one applies to future contributors that are not contributing during the base year. Both series are expected to be related, e.g., the latter is calculated based on the former.
For the exercise, continuing with the idea of a new scheme without past experience, the initial reserve is zero. All average pensions in the previous year [Ioldage_ben], [Idis_ben], [Iwid_ben] and [Iorph_ben] are also zero. The empirical average salary in the base year [Isal] is zero as well.

➔ Do the check out, check in process for both sexes of these matrices to reflect progress in the Completion brief.

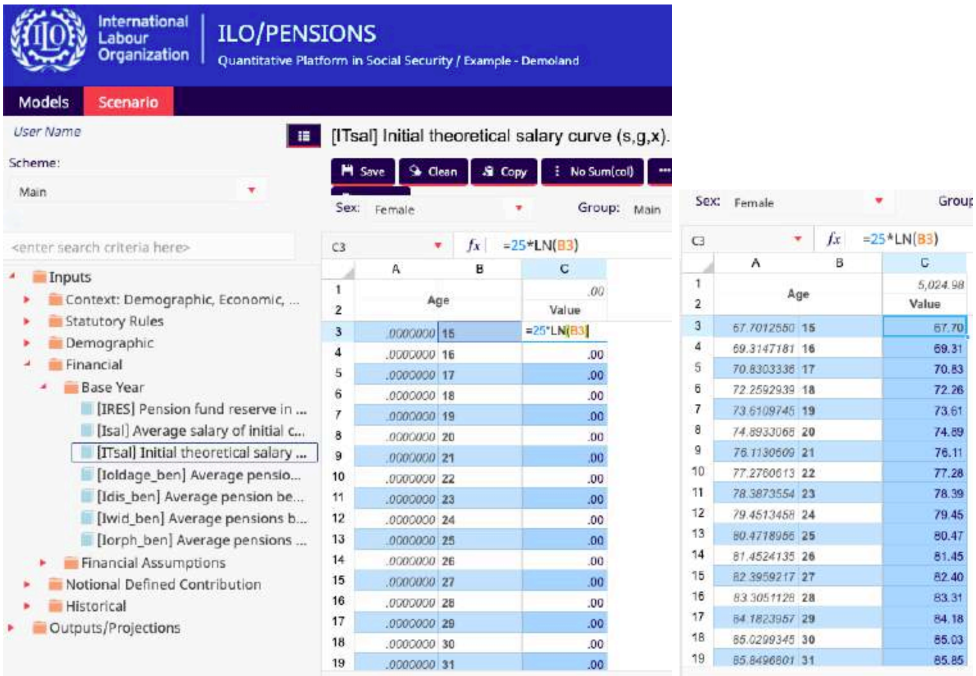
The model needs the theoretical salary [ITsal] to be different from zero to apply to all future contributors. For the example, the salary uses the formula $sal(x) = 25\ ln(x)$ for females and $sal(x) = 30\ ln(0.8x)$ for males with x representing age. Practice entering this formula in the matrix [ITsal] before proceeding.

➔ Check out the male matrix from [ITsal], select cell C3, write =30*LN(0.8*B3) and extend the formula to all rows, then check it in. For females: Check out the female matrix from [ITsal], select cell C3, write =25*LN(B3), and extend the formula to all rows, then check in.

Male


International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
Scheme:
Main
[ITsal] Initial theoretical salary curve (s,g,x).
Save
Clean
Copy
No Sum(col)
Sex: Male
Group: Main
C3
=30*LN(0.8*B3)
Inputs
Context: Demographic, Economic, ...
Statutory Rules
Demographic
Financial
Base Year
[IRES] Pension fund reserve in ...
[Isal] Average salary of initial c...
[ITsal] Initial theoretical salary ...
[Ioldage_ben] Average pensio...
[Idis_ben] Average pension be...
[Iwid_ben] Average pensions b...
[Iorph_ben] Average pensions ...
Financial Assumptions
Notional Defined Contribution
Historical
Outputs/Projections
Age
Value
5,661.79
74.5471995 15 74.55
76.4833551 16 76.48
78.3020938 17 78.30
80.0158462 18 80.02
81.6388528 19 81.64
83.1776617 20 83.18
84.6413686 21 84.64
86.0369671 22 86.04
87.3705199 23 87.37
88.6473084 24 88.65
89.8719682 25 89.87
91.0485896 26 91.05
92.1807994 27 92.18
93.2718288 28 93.27
94.3245684 29 94.32
95.3416149 30 95.34
96.3253096 31 96.33

Female


International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
Scheme:
Main
[ITsal] Initial theoretical salary curve (s,g,x).
Save
Clean
Copy
No Sum(col)
Sex: Female
Group: Main
C3
=25*LN(B3)
Inputs
Context: Demographic, Economic, ...
Statutory Rules
Demographic
Financial
Base Year
[IRES] Pension fund reserve in ...
[Isal] Average salary of initial c...
[ITsal] Initial theoretical salary ...
[Ioldage_ben] Average pensio...
[Idis_ben] Average pension be...
[Iwid_ben] Average pensions b...
[Iorph_ben] Average pensions ...
Financial Assumptions
Notional Defined Contribution
Historical
Outputs/Projections
Age
Value
5,024.98
67.7012550 15 67.70
69.3147181 16 69.31
70.8303336 17 70.83
72.2592939 18 72.26
73.6109745 19 73.61
74.8933068 20 74.89
76.1130609 21 76.11
77.2760613 22 77.28
78.3873554 23 78.39
79.4513458 24 79.45
80.4718956 25 80.47
81.4524135 26 81.45
82.3959217 27 82.40
83.3051126 28 83.31
84.1823957 29 84.18
85.0299345 30 85.03
85.8496801 31 85.85

6.2.7. Filling in the financial assumptions

Continuing with the financial set up for the model, go to: Input->Financial->Financial assumptions.

The financial assumptions are closely related to the economic context variables, the main difference being that financial assumptions can differ for each scheme.

Two financial assumptions are Other Income [OI] and Other Expenditures [OE]. They refer to scheme income that originates from sources other than contributions or returns on reserves. Additionally, expenditures differ from payment of benefits or administration. The amounts of these series are estimated outside the model and introduced as a total amount in ILO/PENSIONS.

> **Tip.** If [OI] or [OE] are known, users can maintain a given mathematical relationship to certain values from the scenario results as follows: Run the scenario with both series empty and estimate the value from the results. Insert the values in the matrices and run the model again.

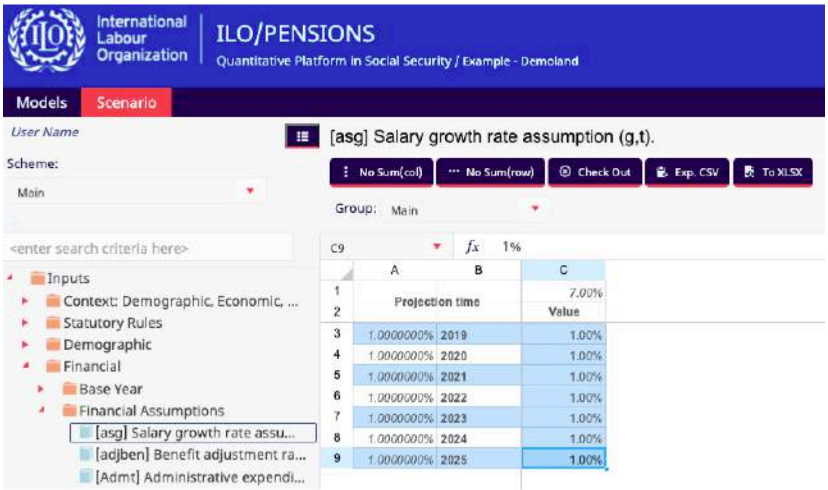
For the example, the assumption is that [OI] and [OE] are zero.

Another matrix in financial assumptions corresponds to [Admt], the expected percentage of benefit expenditure that needs to be allocated for scheme administration. For the exercise, the assumption is that 0 per cent of the benefit expenditure goes towards administration. Most schemes finance their administration with their collection from contributions. In this exercise, the assumption is that administrative expenditures are covered by the government budget and the scheme only receives contributions to pay benefits in the future.

The last two matrices in the section are closely related. The first is an assumption with respect to salary growth [asg] over the projection period while the other is associated with the growth rate applied to the benefits [adjben]. Users should take care in filling in these matrices in conjunction with the inflation assumption. If there is inflation or if the expected inflation rate is zero, fill in the two variables with their expected nominal growth.[41] If users do not want to consider inflation and prefer a model in real terms: keep the inflation matrix at zero and fill in these two matrices with the expected real growth.[42]

- ➔ For this first exercise, the assumption is no growth of salaries or benefits. This means that for all matrices in the section, users can skip or check out and check in them (recommended).

[41] Nominal growth is the growth considering inflation.
[42] Expected real growth is the nominal growth discounted for inflation.



Tip. Nominal projections are normally easier to prepare as they do not require disregarding assumptions. If users only have real rather than nominal growth statistics, they can calculate nominal values by multiplying real values (1+ inflation) and adding inflation. Nominal projections are easier to compare to actual results in the projection period. Projections in real terms are sometimes requested. Users should take special care in presenting their results. Actuaries have different preferences in working with one approach or another. Most importantly, users should ensure the internal consistency of a specific set of assumptions.

6.2.8. Filling in the demographic transition probabilities

As mentioned, many matrices can be left "empty". The section on transition probabilities found in Inputs->Demographics-> Transition Probabilities requires users to fill in most of the matrices, as they drive the dynamics of the simulation. This does not mean that ILO/PENSIONS will not work if some of the matrices are empty; it simply means the simulation will be superficial if they are.

The main and most common transition probabilities for any pension scheme correspond to mortality. All scenarios have a set of five mortality tables[43]: mortality for active contributors [q]; mortality for inactive contributors and old-age pensioners [qi]; mortality and exit probability for orphans [qo]; mortality and exit probability for widow(er)s [qw]; and mortality for disability pensioners [qd]. The mortality tables in all scenarios have two dimensions: time and age. ILO/PENSIONS will alert users if the tables have any negative values or death probabilities greater than 100 per cent. It is expected that the probability of death at the maximum age is 100 per cent.

[43] Some are combined probabilities of mortality and end of benefit, for example for widow(er)s and orphans.

In other cases, there is no effect as all survivors up to this age will exceed the maximum age limits of the model, thus technically applying a 100 per cent death probability.[44]

For most matrices in this section, users will learn a simple trick to export and import matrices so they can work on them in external programmes. This consists of selecting the matrix, exporting it as a csv file, modifying it in an external programme and finally importing the csv file.

- ➔ Select the matrix [q] and export the csv file using "Exp. CSV". Once the csv has downloaded, open and save it as "mort_male.csv" in a folder reserved for files from the model.
- ➔ Open the file and go to cell C2. In the Formulas menu (or right click Menu), select "Define name", and name the cell Base_y. In cell C3, enter the following formula:

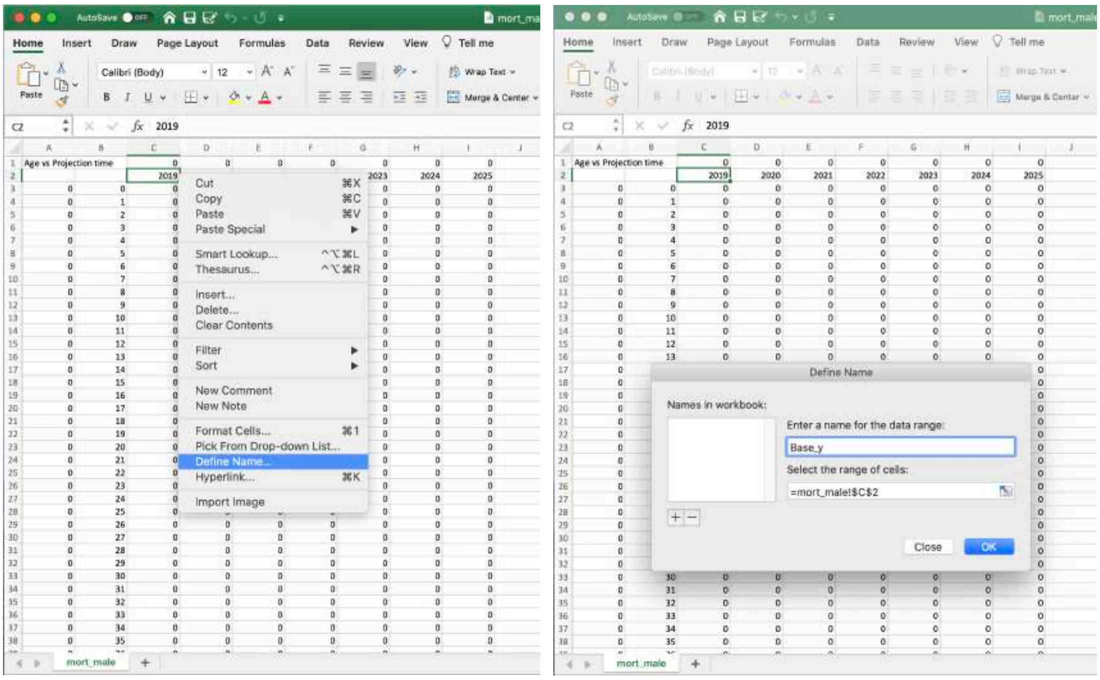
=0.098*(1-LN(1+(0.8+(C$2-Base_y)*0.001)*$B3)/LN(80+(C$2-Base_y)*0.1)) +EXP((12+(C$2-Base_y)*0.06)*($B3/100-1))

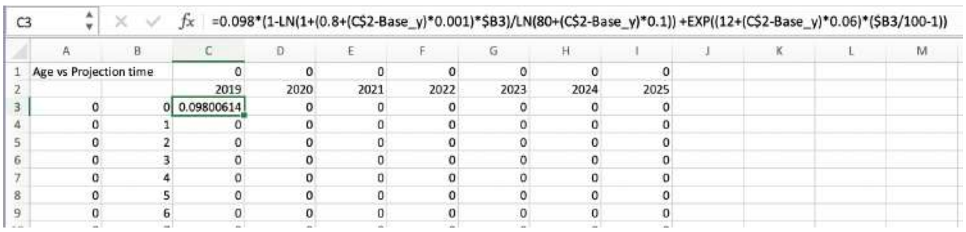
- ➔ Copy the formula into all cells in the worksheet that read 0 and save the work as a csv file. Although the programme may alert users of a potential loss of information, the csv format should be used in this case.
- ➔ Copy the formula into all cells on the worksheet that read 0. Save the book. Close Excel.
- ➔ To import these files back into ILO/PENSIONS, go to matrix [q] and check that it says "Male" in the dropdown menu above. Then, check out, import csv, find the saved folder and select the file "mort_male.csv". When the green dialog box that says the matrix tab was imported appears, check to see that the file worked on was correctly transferred to ILO/PENSIONS. Check in.
- ➔ Check the Completion brief.

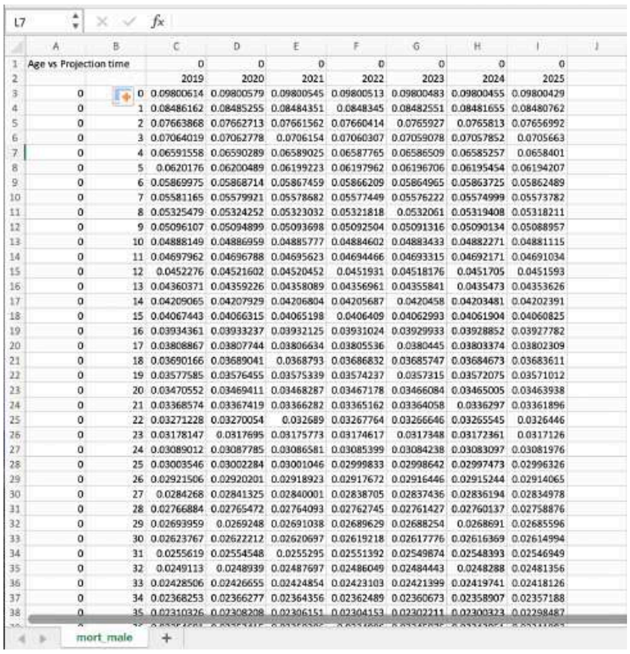
---

[44] For the example, the mortality of an active contributor follows the formula:

- $q(x) = 0.098\left[1 - \frac{ln(1+(0.8+t*0.001)x)}{ln(80+0.1t)}\right] + e^{(12+0.06t)\left(\frac{x}{100}-1\right)}$ for male
- $q(x) = 0.089\left[1 - \frac{ln(1+(0.7+0.001t)x}{ln(70+0.1t)}\right] + e^{\left(\frac{x}{100}-1\right)(14+0.05t)}$ for female

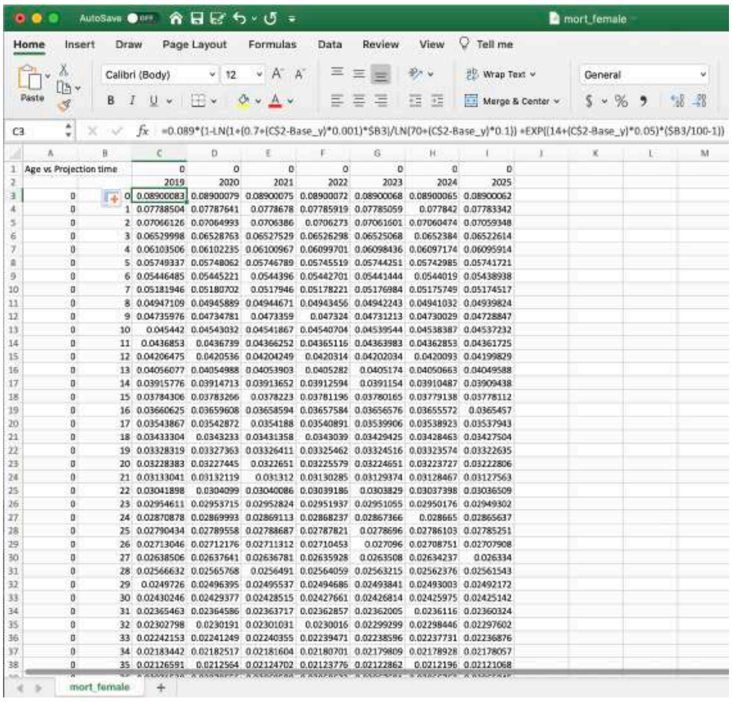

Define Name...
Define Name
Names in workbook:
Enter a name for the data range:
Base_y
Select the range of cells:
=mort_male!C2
Close
OK
mort_male


C3
=0.098*(1-LN(1+(0.8+(C$2-Base_y)*0.001)*$B3)/LN(80+(C$2-Base_y)*0.1)) +EXP((12+(C$2-Base_y)*0.06)*($B3/100-1))
Age vs Projection time
0.09800614


Age vs Projection time
mort_male

➔ To do the same for females, click Save As, and save the worksheet as “mort_female.csv”. Modify the formula in cell C3 as follows:

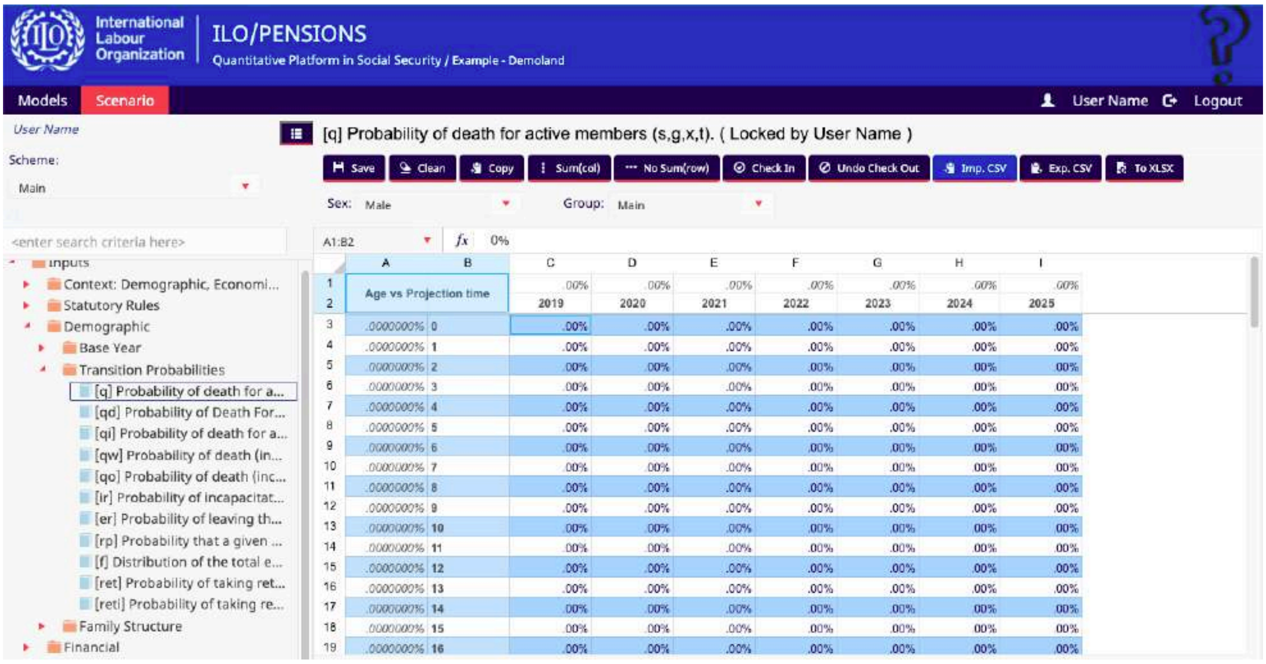
=0.089*(1-LN(1+(0.7+(C$2-Base_y)*0.001)*$B3)/LN(70+(C$2-Base_y)*0.1)) +EXP((14+(C$2-Base_y)*0.05)*($B3/100-1))

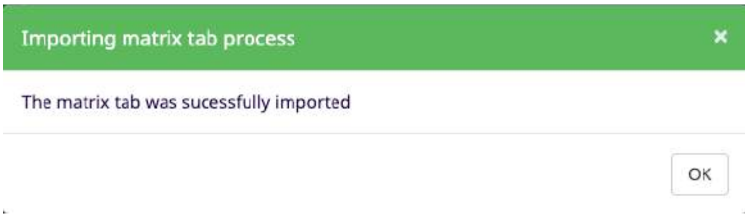


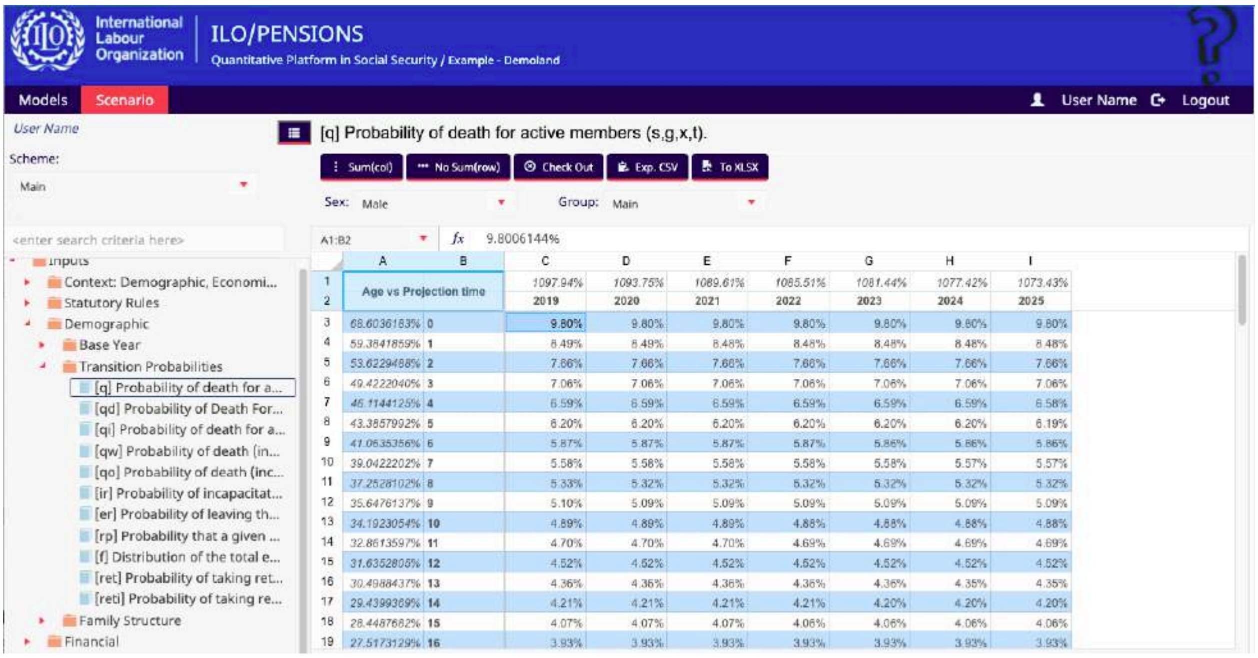
➔ Copy the formula into all cells in the worksheet that read 0. Save the book. Close Excel.

➔ To import these back to ILO/PENSIONS, go to book [q] and check that it says “Female” in the dropdown menu above. Then, check out, import csv, find the saved folder and select the file “mort_female.csv”. When the green dialog box that says the matrix tab was imported appears, check to see that the file worked on was correctly transferred to ILO/PENSIONS. Check in.

➔ Check the Completion brief.


International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
Logout
[q] Probability of death for active members (s,g,x,t). (Locked by User Name)
Save
Clean
Copy
Sum(col)
No Sum(row)
Check In
Undo Check Out
Imp. CSV
Exp. CSV
To XLSX
Scheme:
Main
Sex: Male
Group: Main
<enter search criteria here>
Inputs
Context: Demographic, Economi...
Statutory Rules
Demographic
Base Year
Transition Probabilities
[q] Probability of death for a...
[qd] Probability of Death For...
[qi] Probability of death for a...
[qw] Probability of death (in...
[qo] Probability of death (inc...
[ir] Probability of incapacitat...
[er] Probability of leaving th...
[rp] Probability that a given ...
[f] Distribution of the total e...
[ret] Probability of taking ret...
[reti] Probability of taking re...
Family Structure
Financial
Age vs Projection time


Importing matrix tab process
The matrix tab was sucessfully imported
OK


International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
Logout
[q] Probability of death for active members (s,g,x,t).
Sum(col)
No Sum(row)
Check Out
Exp. CSV
To XLSX
Scheme:
Main
Sex: Male
Group: Main
<enter search criteria here>
Inputs
Context: Demographic, Economi...
Statutory Rules
Demographic
Base Year
Transition Probabilities
[q] Probability of death for a...
[qd] Probability of Death For...
[qi] Probability of death for a...
[qw] Probability of death (in...
[qo] Probability of death (inc...
[ir] Probability of incapacitat...
[er] Probability of leaving th...
[rp] Probability that a given ...
[f] Distribution of the total e...
[ret] Probability of taking ret...
[reti] Probability of taking re...
Family Structure
Financial
Age vs Projection time

The mortality for an inactive contributor [qi] follows the formula:

=0.098*(1-LN(1+(0.8+(C$2-Base_y)*0.002)*$B3)/LN(80+(C$2-Base_y)*0.2)) +EXP((12+(C$2-Base_y)*0.03)*($B3/100-1)) for male[45]

=0.089*(1-LN(1+(0.7+(C$2-Base_y)*0.002)*$B3)/LN(70+(C$2-Base_y)*0.2)) +EXP((14+(C$2-Base_y)*0.04)*($B3/100-1)) for female[46]

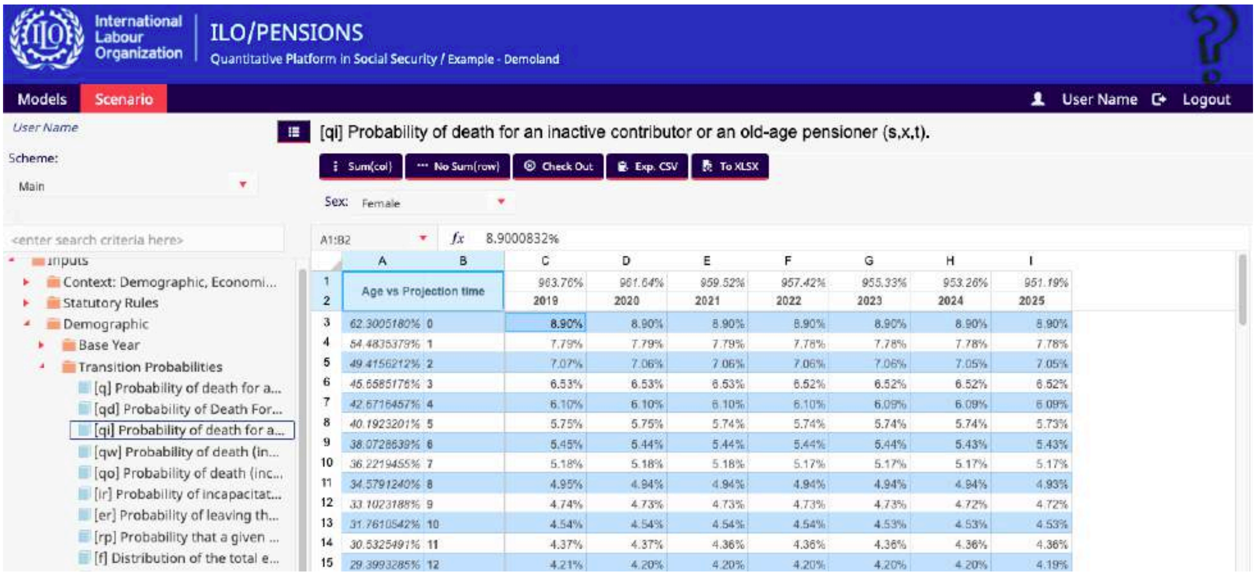
➔ Copy the same formulas from [qi] for mortality for widow(er)s [qw] – for male and female, respectively.

Male

45 i.e. $qi(x) = 0.098\left[1 - \frac{ln(1+(0.8+t*0.002)x)}{ln(80+0.2t)}\right] + e^{(12+0.03t)\left(\frac{x}{100}-1\right)}$

46 i.e. $qi(x) = 0.089\left[1 - \frac{ln(1+(0.7+0.002t)x)}{ln(70+0.2t)}\right] + e^{\left(\frac{x}{100}-1\right)(14+0.04t)}$

Female

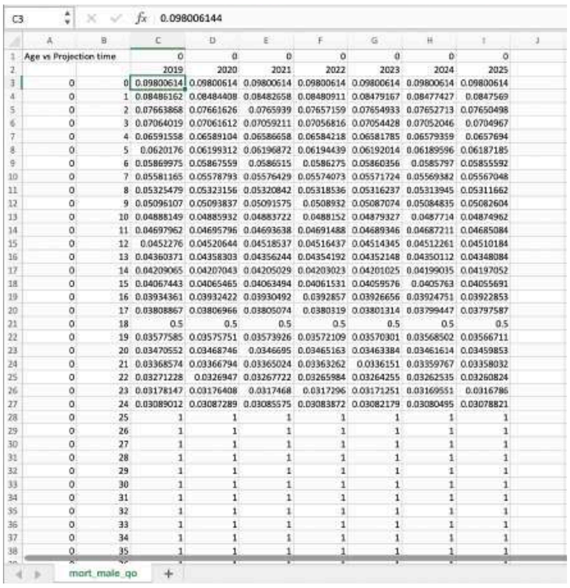


	A	B	C	D	E	F	G	H	I
1	Age vs Projection time		963.76%	961.64%	959.52%	957.42%	955.33%	953.26%	951.19%
2			2019	2020	2021	2022	2023	2024	2025
3	62.3005180%	0	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%	8.90%
4	54.4835379%	1	7.79%	7.79%	7.79%	7.78%	7.78%	7.78%	7.78%
5	49.4156212%	2	7.07%	7.06%	7.06%	7.06%	7.06%	7.05%	7.05%
6	45.6585176%	3	6.53%	6.53%	6.53%	6.52%	6.52%	6.52%	6.52%
7	42.6716457%	4	6.10%	6.10%	6.10%	6.10%	6.09%	6.09%	6.09%
8	40.1923201%	5	5.75%	5.75%	5.74%	5.74%	5.74%	5.74%	5.73%
9	38.0728639%	6	5.45%	5.44%	5.44%	5.44%	5.44%	5.43%	5.43%
10	36.2219455%	7	5.18%	5.18%	5.18%	5.17%	5.17%	5.17%	5.17%
11	34.5791240%	8	4.95%	4.94%	4.94%	4.94%	4.94%	4.94%	4.93%
12	33.1023188%	9	4.74%	4.73%	4.73%	4.73%	4.73%	4.72%	4.72%
13	31.7610542%	10	4.54%	4.54%	4.54%	4.54%	4.53%	4.53%	4.53%
14	30.5325491%	11	4.37%	4.37%	4.36%	4.36%	4.36%	4.36%	4.36%
15	29.3993285%	12	4.21%	4.20%	4.20%	4.20%	4.20%	4.20%	4.19%

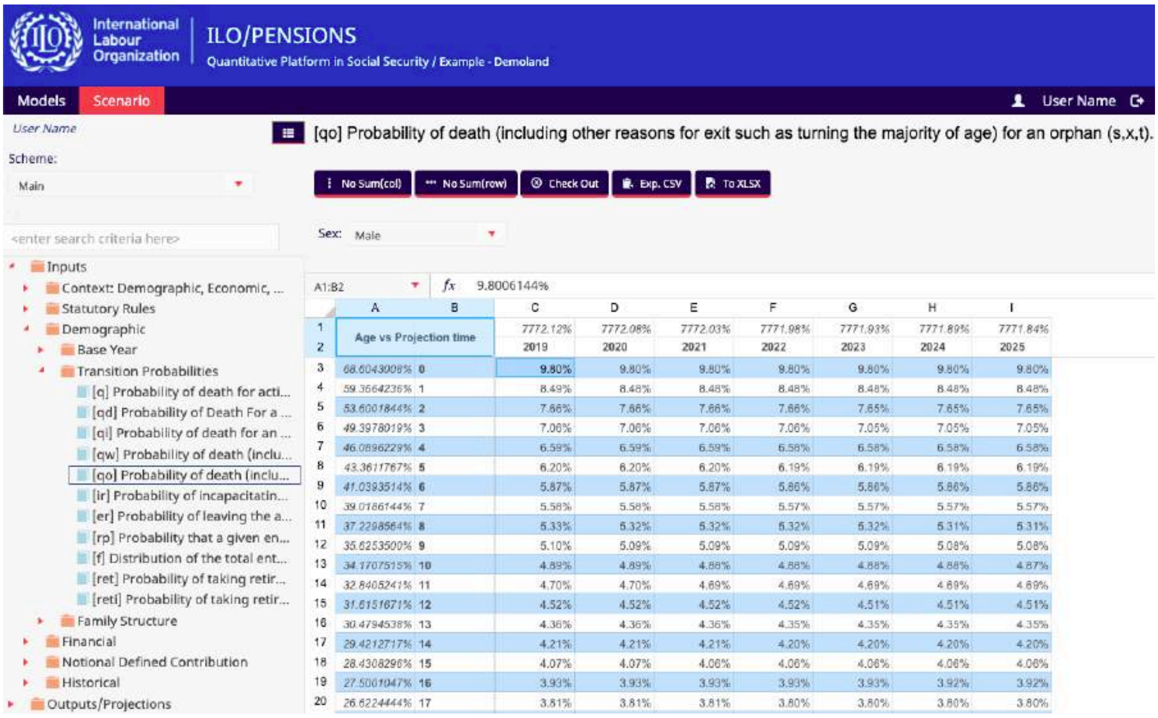
The probability of death matrix [qo] follows the same as for inactive contributors, except that orphans have a mortality [qo] of 50 per cent at age 18 and 100 per cent at age 25 for both sexes.

➔ Repeat the steps for [qi] for orphans [qo]. However, for age 18 write 0.5 in the first column and copy it across to the last year of the projection. Similarly, for age 25, write 1 in the first year and copy it across to the last year of the projection. In the subsequent cells (ages until 100), users may input 1 or 0 there is no real difference in terms of calculations.

Male

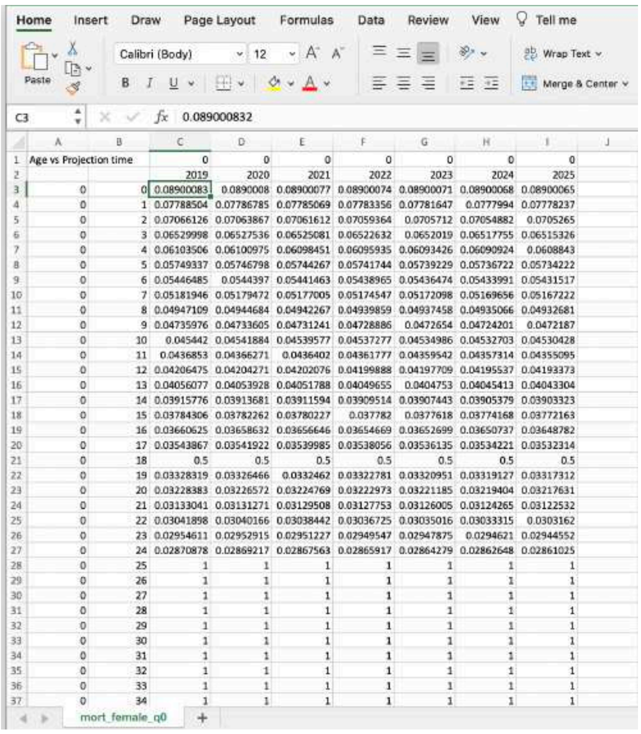


	A	B	C	D	E	F	G	H	I
1	Age vs Projection time		0	0	0	0	0	0	0
2			2019	2020	2021	2022	2023	2024	2025
3	0	0	0.09800614	0.09800614	0.09800614	0.09800614	0.09800614	0.09800614	0.09800614
4	0	1	0.08486162	0.08484408	0.08482658	0.08480911	0.08479167	0.08477427	0.0847569
5	0	2	0.07663868	0.07661626	0.0765939	0.07657159	0.07654933	0.07652713	0.07650498
6	0	3	0.07064019	0.07061612	0.07059211	0.07056816	0.07054428	0.07052046	0.0704967
7	0	4	0.06591558	0.06589104	0.06586658	0.06584218	0.06581785	0.06579359	0.0657694
8	0	5	0.0620176	0.06199312	0.06196872	0.06194439	0.06192014	0.06189596	0.06187185
9	0	6	0.05869975	0.05867559	0.0586515	0.0586275	0.05860356	0.0585797	0.05855592
10	0	7	0.05581165	0.05578793	0.05576429	0.05574073	0.05571724	0.05569382	0.05567048
11	0	8	0.05325479	0.05323156	0.05320842	0.05318536	0.05316237	0.05313945	0.05311662
12	0	9	0.05096107	0.05093837	0.05091575	0.0508932	0.05087074	0.05084835	0.05082604
13	0	10	0.04888149	0.04885932	0.04883722	0.0488152	0.04879327	0.0487714	0.04874962
14	0	11	0.04697962	0.04695796	0.04693638	0.04691488	0.04689346	0.04687211	0.04685084
15	0	12	0.0452276	0.04520644	0.04518537	0.04516437	0.04514345	0.04512261	0.04510184
16	0	13	0.04360371	0.04358303	0.04356244	0.04354192	0.04352148	0.04350112	0.04348084
17	0	14	0.04209065	0.04207043	0.04205029	0.04203023	0.04201025	0.04199035	0.04197052
18	0	15	0.04067443	0.04065465	0.04063494	0.04061531	0.04059576	0.0405763	0.04055691
19	0	16	0.03934361	0.03932422	0.03930492	0.0392857	0.03926656	0.03924751	0.03922853
20	0	17	0.03808867	0.03806966	0.03805074	0.0380319	0.03801314	0.03799447	0.03797587
21	0	18	0.5	0.5	0.5	0.5	0.5	0.5	0.5
22	0	19	0.03577585	0.03575751	0.03573926	0.03572109	0.03570301	0.03568502	0.03566711
23	0	20	0.03470552	0.03468746	0.0346695	0.03465163	0.03463384	0.03461614	0.03459853
24	0	21	0.03368574	0.03366794	0.03365024	0.03363262	0.0336151	0.03359767	0.03358032
25	0	22	0.03271228	0.0326947	0.03267722	0.03265984	0.03264255	0.03262535	0.03260824
26	0	23	0.03178147	0.03176408	0.0317468	0.0317296	0.03171251	0.03169551	0.0316786
27	0	24	0.03089012	0.03087289	0.03085575	0.03083872	0.03082179	0.03080495	0.03078821
28	0	25	1	1	1	1	1	1	1
29	0	26	1	1	1	1	1	1	1
30	0	27	1	1	1	1	1	1	1
31	0	28	1	1	1	1	1	1	1
32	0	29	1	1	1	1	1	1	1
33	0	30	1	1	1	1	1	1	1
34	0	31	1	1	1	1	1	1	1
35	0	32	1	1	1	1	1	1	1
36	0	33	1	1	1	1	1	1	1
37	0	34	1	1	1	1	1	1	1
38	0	35	1	1	1	1	1	1	1

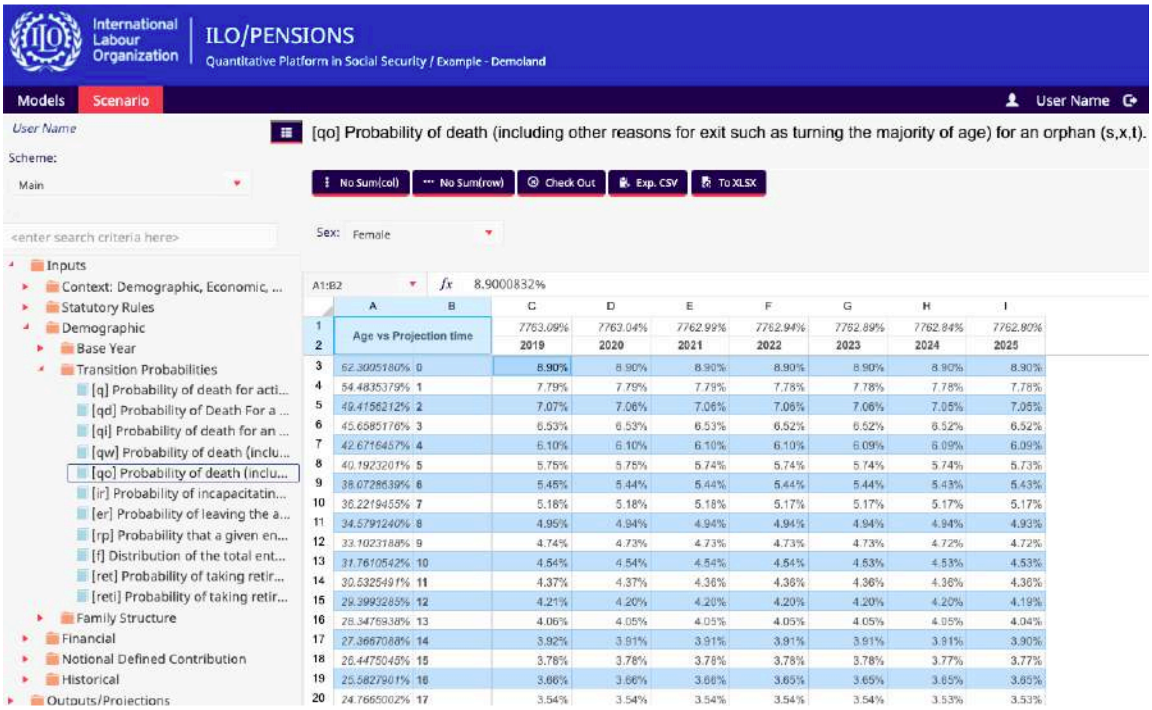


	A	B	C	D	E	F	G	H	I
1	Age vs Projection time		7772.12%	7772.08%	7772.03%	7771.98%	7771.93%	7771.89%	7771.84%
2			2019	2020	2021	2022	2023	2024	2025
3	68.6043008%	0	9.80%	9.80%	9.80%	9.80%	9.80%	9.80%	9.80%
4	59.3664236%	1	8.49%	8.48%	8.48%	8.48%	8.48%	8.48%	8.48%
5	53.6001844%	2	7.66%	7.66%	7.66%	7.66%	7.65%	7.65%	7.65%
6	49.3978019%	3	7.06%	7.06%	7.06%	7.06%	7.05%	7.05%	7.05%
7	46.0896229%	4	6.59%	6.59%	6.59%	6.58%	6.58%	6.58%	6.58%
8	43.3611767%	5	6.20%	6.20%	6.20%	6.19%	6.19%	6.19%	6.19%
9	41.0393514%	6	5.87%	5.87%	5.87%	5.86%	5.86%	5.86%	5.86%
10	39.0186144%	7	5.58%	5.58%	5.58%	5.57%	5.57%	5.57%	5.57%
11	37.2298564%	8	5.33%	5.32%	5.32%	5.32%	5.32%	5.31%	5.31%
12	35.6253500%	9	5.10%	5.09%	5.09%	5.09%	5.09%	5.08%	5.08%
13	34.1707515%	10	4.89%	4.89%	4.88%	4.88%	4.88%	4.88%	4.87%
14	32.8405241%	11	4.70%	4.70%	4.69%	4.69%	4.69%	4.69%	4.69%
15	31.6151671%	12	4.52%	4.52%	4.52%	4.52%	4.51%	4.51%	4.51%
16	30.4794538%	13	4.36%	4.36%	4.36%	4.35%	4.35%	4.35%	4.35%
17	29.4212717%	14	4.21%	4.21%	4.21%	4.20%	4.20%	4.20%	4.20%
18	28.4308296%	15	4.07%	4.07%	4.06%	4.06%	4.06%	4.06%	4.06%
19	27.5001047%	16	3.93%	3.93%	3.93%	3.93%	3.93%	3.92%	3.92%
20	26.6224444%	17	3.81%	3.81%	3.81%	3.80%	3.80%	3.80%	3.80%

Female



	A	B	C	D	E	F	G	H	I	J
1	Age vs Projection time		0	0	0	0	0	0	0	
2			2019	2020	2021	2022	2023	2024	2025	
3	0	0	0.08900083	0.0890008	0.08900077	0.08900074	0.08900071	0.08900068	0.08900065	
4	0	1	0.07788504	0.07786785	0.07785069	0.07783356	0.07781647	0.0777994	0.07778237	
5	0	2	0.07066126	0.07063867	0.07061612	0.07059364	0.0705712	0.07054882	0.0705265	
6	0	3	0.06529998	0.06527536	0.06525081	0.06522632	0.0652019	0.06517755	0.06515326	
7	0	4	0.06103506	0.06100975	0.06098451	0.06095935	0.06093426	0.06090924	0.0608843	
8	0	5	0.05749337	0.05746798	0.05744267	0.05741744	0.05739229	0.05736722	0.05734222	
9	0	6	0.05446485	0.0544397	0.05441463	0.05438965	0.05436474	0.05433991	0.05431517	
10	0	7	0.05181946	0.05179472	0.05177005	0.05174547	0.05172098	0.05169656	0.05167222	
11	0	8	0.04947109	0.04944684	0.04942267	0.04939859	0.04937458	0.04935066	0.04932681	
12	0	9	0.04735976	0.04733605	0.04731241	0.04728886	0.0472654	0.04724201	0.0472187	
13	0	10	0.045442	0.04541884	0.04539577	0.04537277	0.04534986	0.04532703	0.04530428	
14	0	11	0.0436853	0.04366271	0.0436402	0.04361777	0.04359542	0.04357314	0.04355095	
15	0	12	0.04206475	0.04204271	0.04202076	0.04199888	0.04197709	0.04195537	0.04193373	
16	0	13	0.04056077	0.04053928	0.04051788	0.04049655	0.0404753	0.04045413	0.04043304	
17	0	14	0.03915776	0.03913681	0.03911594	0.03909514	0.03907443	0.03905379	0.03903323	
18	0	15	0.03784306	0.03782262	0.03780227	0.037782	0.0377618	0.03774168	0.03772163	
19	0	16	0.03660625	0.03658632	0.03656646	0.03654669	0.03652699	0.03650737	0.03648782	
20	0	17	0.03543867	0.03541922	0.03539985	0.03538056	0.03536135	0.03534221	0.03532314	
21	0	18	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
22	0	19	0.03328319	0.03326466	0.0332462	0.03322781	0.03320951	0.03319127	0.03317312	
23	0	20	0.03228383	0.03226572	0.03224769	0.03222973	0.03221185	0.03219404	0.03217631	
24	0	21	0.03133041	0.03131271	0.03129508	0.03127753	0.03126005	0.03124265	0.03122532	
25	0	22	0.03041898	0.03040166	0.03038442	0.03036725	0.03035016	0.03033315	0.0303162	
26	0	23	0.02954611	0.02952915	0.02951227	0.02949547	0.02947875	0.0294621	0.02944552	
27	0	24	0.02870878	0.02869217	0.02867563	0.02865917	0.02864279	0.02862648	0.02861025	
28	0	25	1	1	1	1	1	1	1	
29	0	26	1	1	1	1	1	1	1	
30	0	27	1	1	1	1	1	1	1	
31	0	28	1	1	1	1	1	1	1	
32	0	29	1	1	1	1	1	1	1	
33	0	30	1	1	1	1	1	1	1	
34	0	31	1	1	1	1	1	1	1	
35	0	32	1	1	1	1	1	1	1	
36	0	33	1	1	1	1	1	1	1	
37	0	34	1	1	1	1	1	1	1	

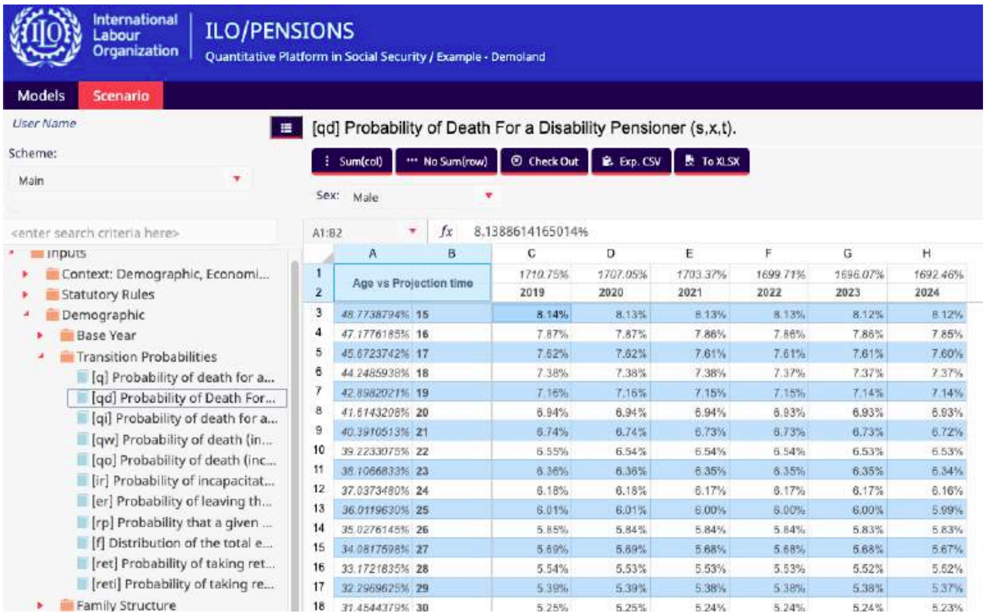


➔ The mortality for disability pensioners [qd] is double that of inactive contributors, so users should enter the following formula into the platform:

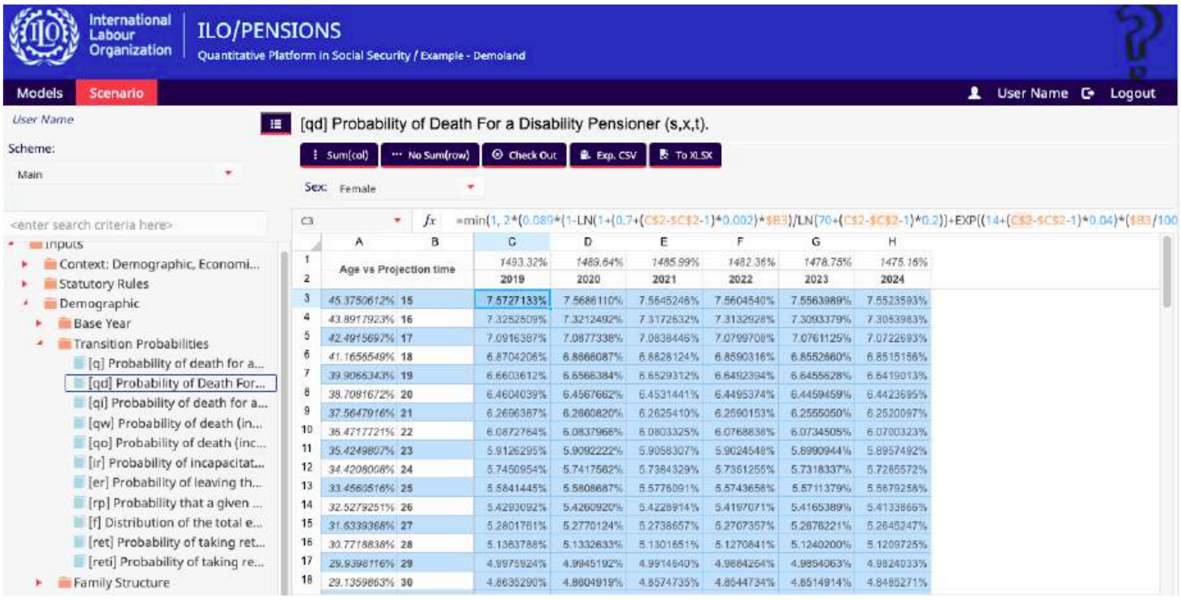
=min(1,2*(0.098*(1-LN(1+(0.8+(C$2-$C$2-1)*0.002)*$B3)/LN(80+(C$2-$C$2-1)*0.2)) +EXP((12+(C$2-C2-1)*0.03)*($B3/100-1)))) for male.

=min(1,2*(0.089*(1-LN(1+(0.7+(C$2-$C$2-1)*0.002)*$B3)/LN(70+(C$2-$C$2-1)*0.2)) +EXP((14+(C$2-C2-1)*0.04)*($B3/100-1)))) for female.

Male



Female



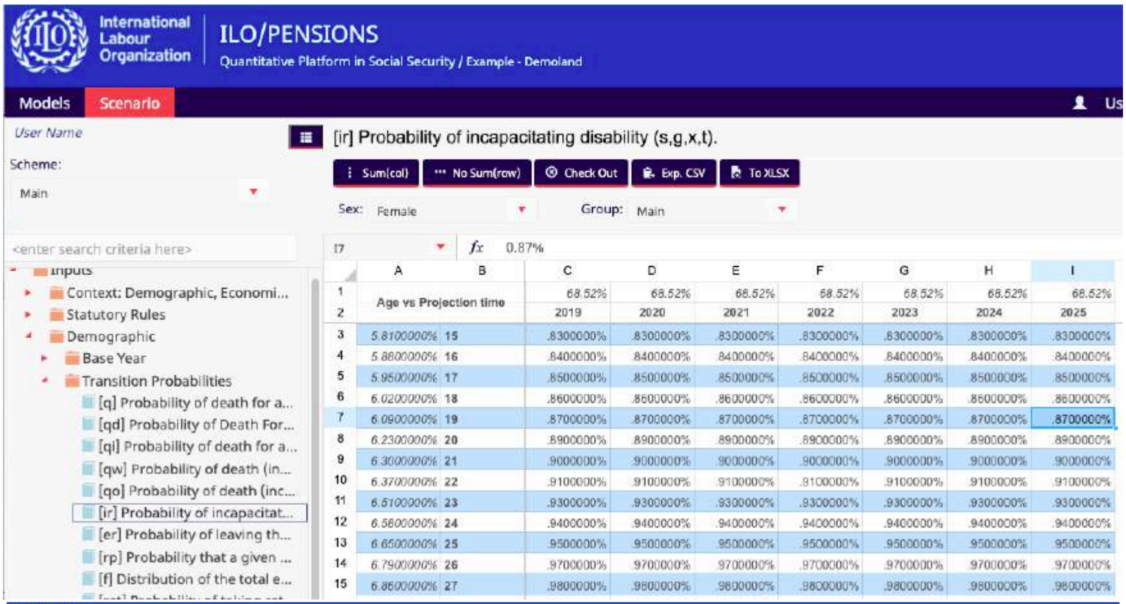
The entry to disability rate [ir] follows the formula for both sexes and is constant over time:

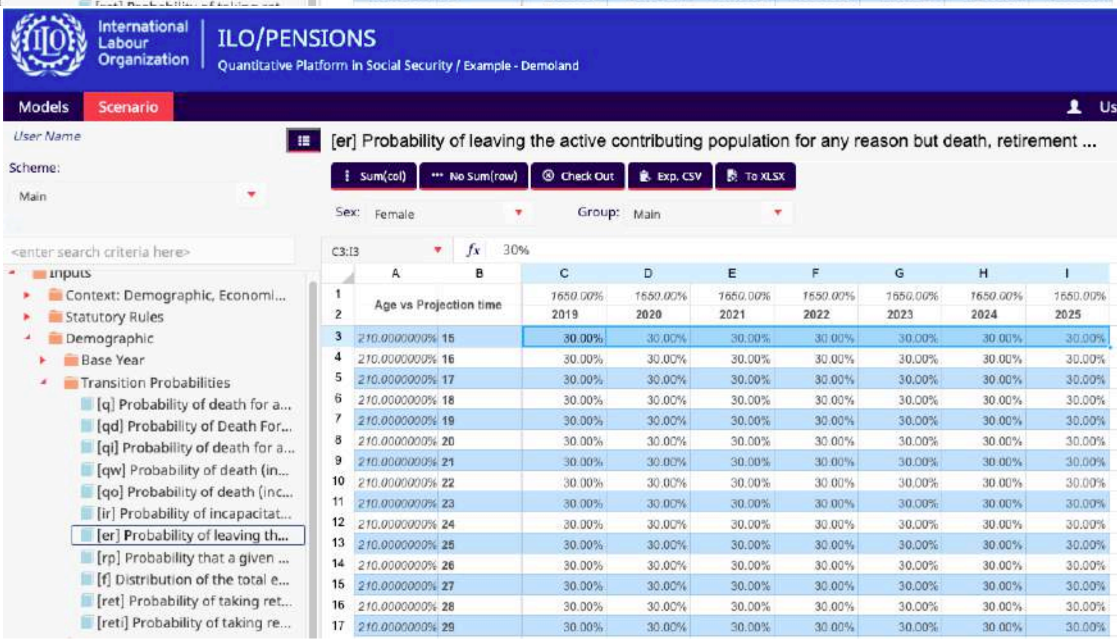
$$ir(x) = \frac{e^{\frac{x}{70}}}{150}$$

This can be inserted into the programme or into Excel as =EXP($B3/70)/150.

The exit rate [er] is a constant 30 per cent for all sexes and ages, throughout the projection.

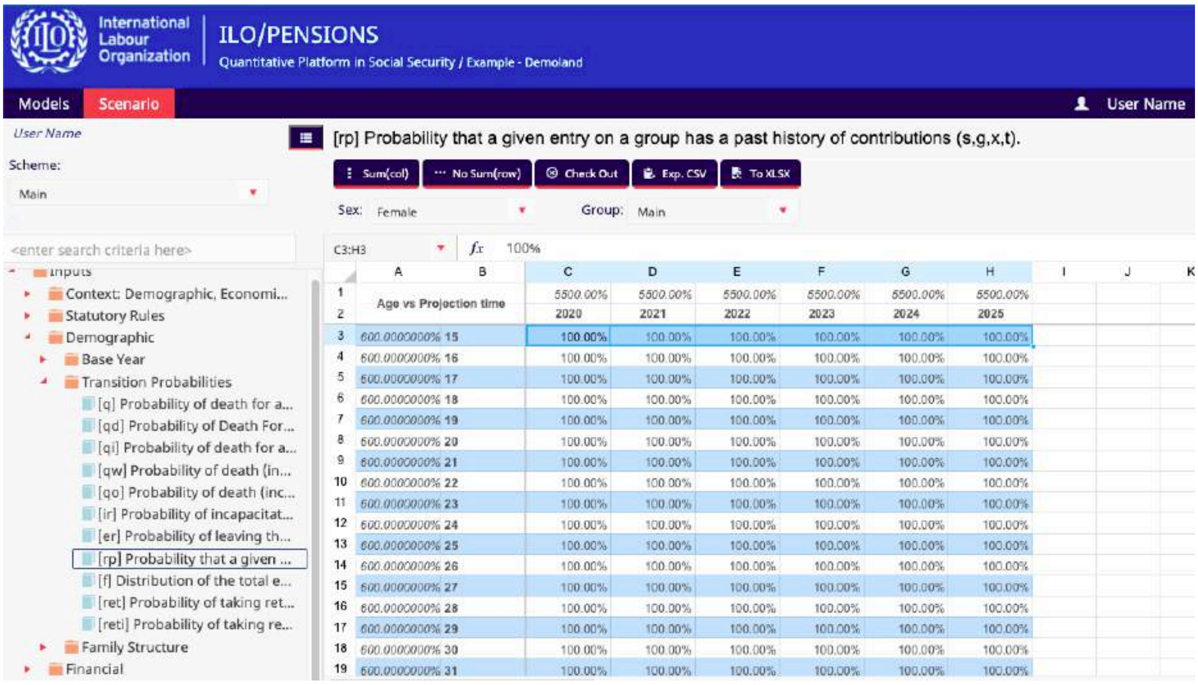
➔ Fill in the matrices for disability rate [ir] and exit rate [er] for both sexes.

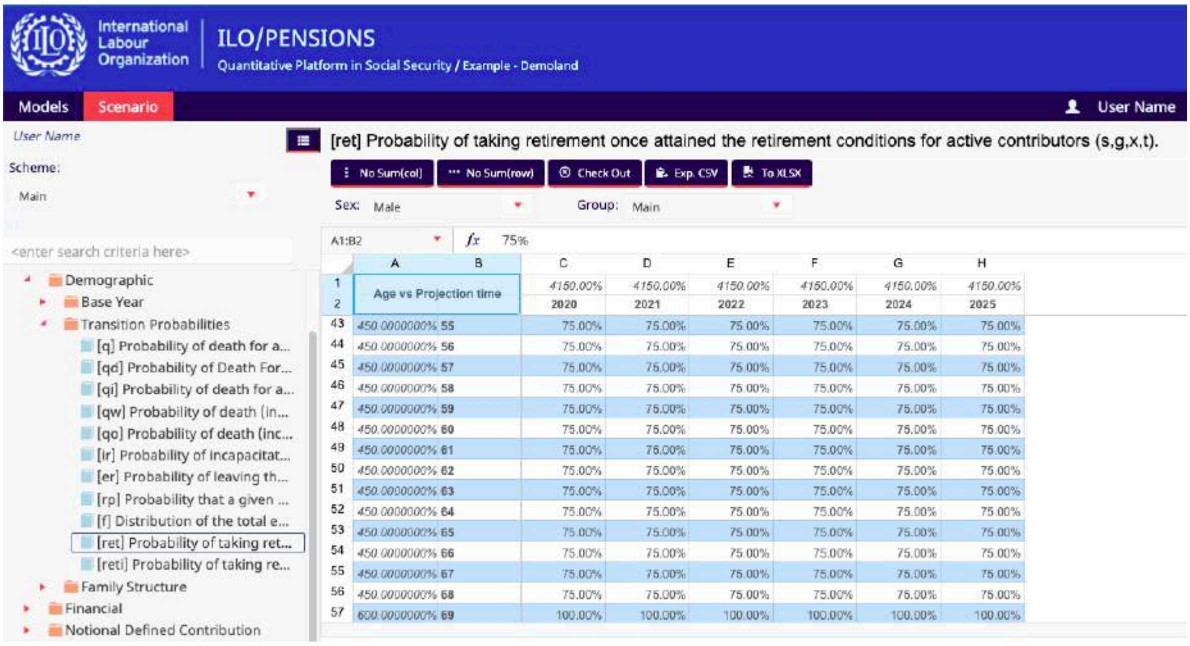


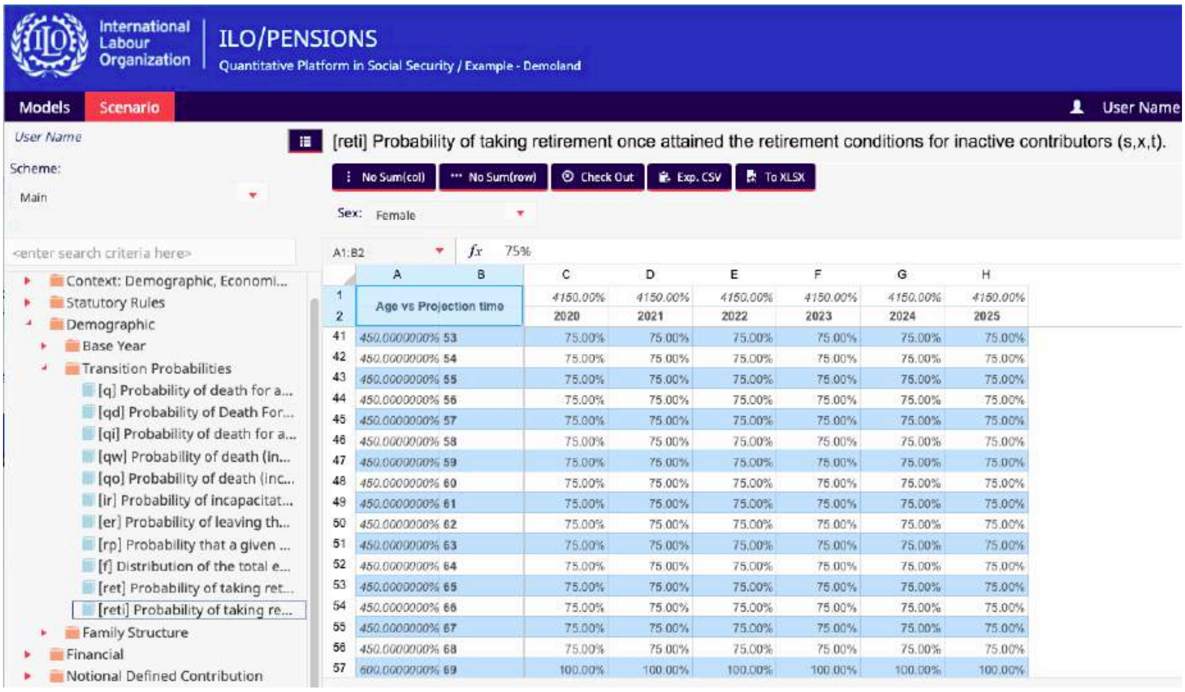


The re-entry rate [rp] is 100 per cent for all ages, sexes and years. This means that every time an entry occurs, inactive contributors will be prioritized over new entrants. The retirement probabilities [ret] and [reti] are 75 per cent for all ages except 69, where it is 100 per cent for both sexes and constant over time for both active and inactive contributors.

➔ Fill in the matrices for re-entry and retirement [rp], [ret] and [reti]. Remember, it may be easier to use the Import CSV function to fill in multiple matrices with the same values.


International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
[rp] Probability that a given entry on a group has a past history of contributions (s,g,x,t).
Sum(col)
No Sum(row)
Check Out
Exp. CSV
To XLSX
Sex: Female
Group: Main
Scheme:
Main
Context: Demographic, Economi...
Statutory Rules
Demographic
Base Year
Transition Probabilities
Family Structure
Financial
Age vs Projection time

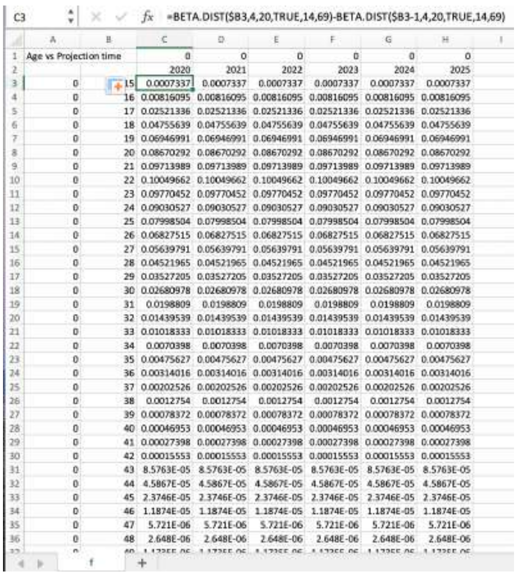

International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
[ret] Probability of taking retirement once attained the retirement conditions for active contributors (s,g,x,t).
No Sum(col)
No Sum(row)
Check Out
Exp. CSV
To XLSX
Sex: Male
Group: Main
Scheme:
Main
Demographic
Base Year
Transition Probabilities
Family Structure
Financial
Notional Defined Contribution
Age vs Projection time

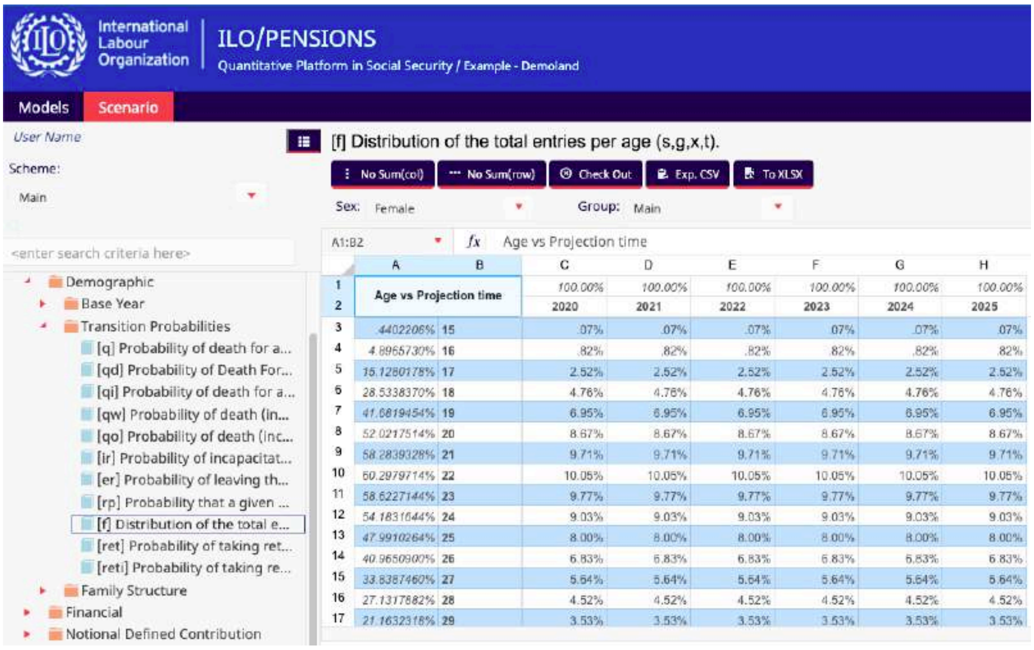


➔ The last matrix to fill in this section is the distribution of entries, [f]. The distribution will be the same for male and female – and will take the form of a beta distribution with parameters alpha = 4 and beta = 20. To do this, export the matrix to a csv file. Save it in the folder with a name such as "entrydist.csv". Open the file and use the formula:

=BETA.DIST($B3,4,20,TRUE,14,69)-BETA.DIST($B3-1,4,20,TRUE,14,69) in cell C3.

Paste the formula in all the cells that have a 0. Import the series as csv for the matrix f for male and female.





6.2.9. Filling in the family structure matrices

The last two matrices correspond to the expected family survivors after a death. It is a group of four matrices that link the age of an active or inactive contributor of the scheme (including pensioners) to the age of the potential survivors (according to survivor eligibility requirements). The rows list the age of the contributor while the columns list the age of the dependant.

For example, the [fwid] matrix for male links the age of an active male contributor to the age of their potential widow(s).

- In the row for age 65 and column for dependant age 65, a 0 means that no widows aged 65 will exist if a male aged 65 dies. If the value is 1, it means that once an active contributor aged 65 dies, a widow of the exact same age will claim widow pension benefits.
- If the sum of all values in a row is greater than or equal to 1, a death at that age will create at least one spouse survivor (possible in cases of polygamy).

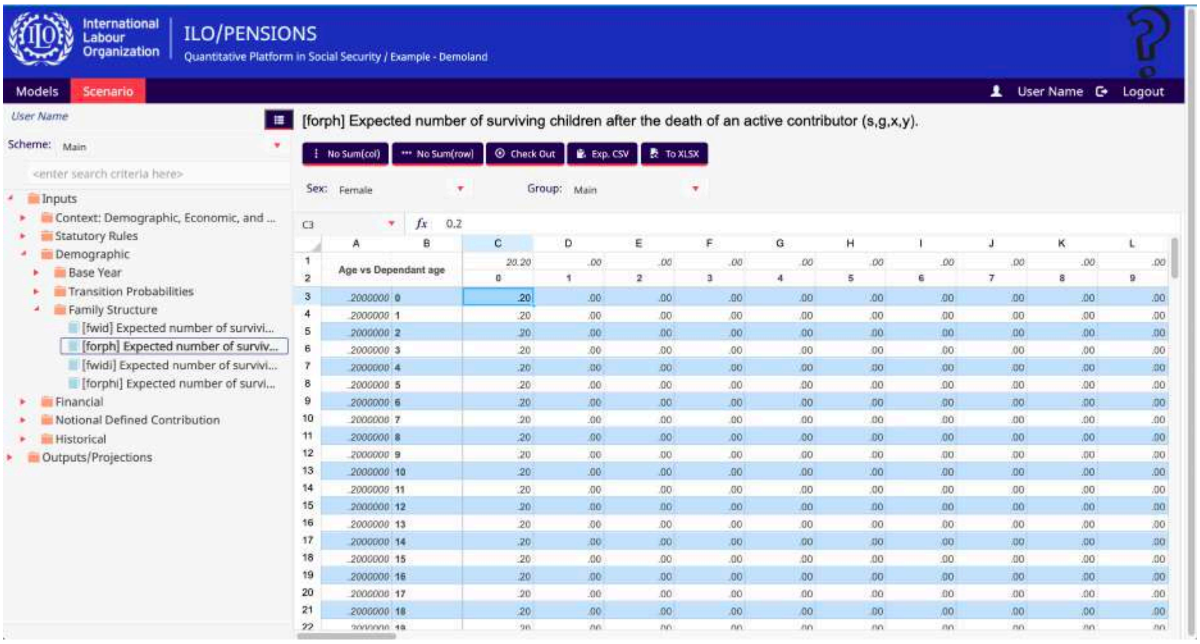
The matrix [fwidi] exhibits the same relationship as [fwid] only for inactive contributors and pensioners.

For orphans, the matrices [forph] and [forphi] show the relationship between contributors and expected eligible orphans. For example, in many countries, surviving adult children of the deceased are ineligible for the benefit.

For the purpose of this exercise, the same widow(er) and orphan matrices for active and inactive contributors, male and female, will be used. To make a simple orphan matrix, the idea is that every deceased contributor has a 20 per cent probability (0.2) of having a surviving child of age 0 and no more.[47] For spouses, every deceased contributor has a 40 per cent probability (0.4) of having a spouse of the same age and no more.[48]

- ➔ To fill in the [forph] and [forphi] matrices, check out, and enter 0.2 in the first cell. Select the Copy command (or Ctrl+C), copy the row to the end, check that all rows and columns have been filled in by looking at Row 1 and Column A. All responses should be identical. Check in.

- ➔ Do this process for both males and females. (A quick way to do this is to fill in one matrix, e.g. [forph], export it as a csv file, and use the Import .CSV functionality to copy it to all the remaining matrices.)

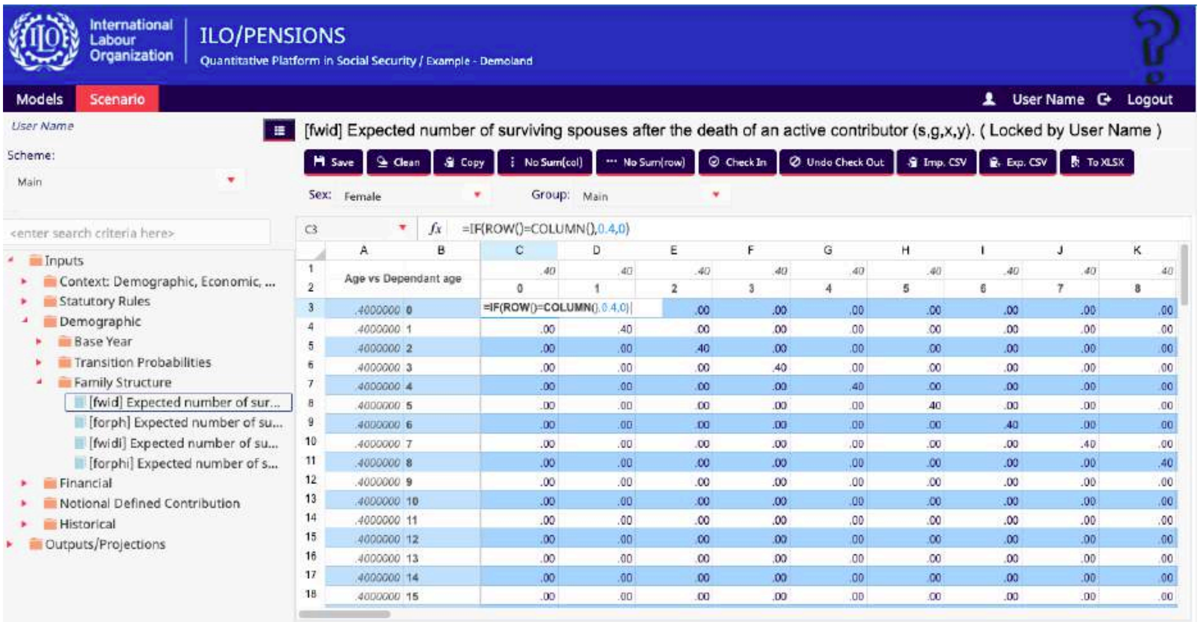


- ➔ To fill in the [fwid] and [fwidi]: check out the matrix. In the first cell, enter the formula =IF(ROW()=COLUMN(),0.4,0) and copy it to all cells that have a 0, until a diagonal matrix appears with 0.4.

(Note: Copy functions do not work for formulas in ILO/PENSIONS, so it is advised to export them as csv files. Complete this process on one Excel sheet and import the same csv to fill in the rest.) Again, do this process for both males and females. Users should check that they have copied everything correctly by ensuring that all entries in Row 1 and Column A read “0.40”.

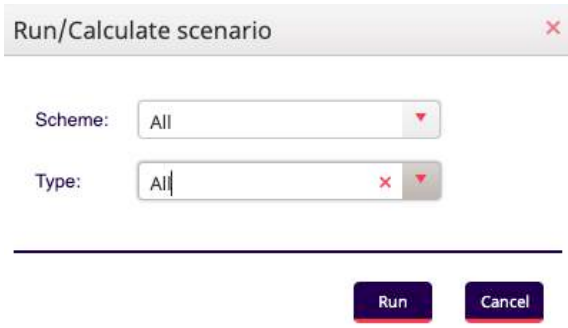
[47] By default, the surviving orphans are 50 per cent male and 50 per cent female.
[48] This family structure is a placeholder that does not actually occur. The correct way to fill in the matrix with national statistics on family structure, most likely found in a census or household survey.

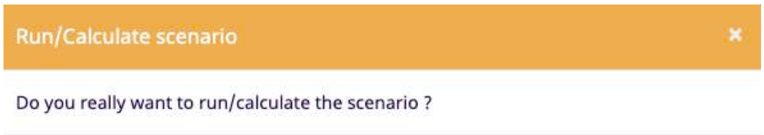
➔ Check the Completion brief.



6.3. Running a scenario

Now that the required matrices are complete, users should choose Scenario in the main menu, select the scenario with their name and select Run. Once users confirm that they want to run the scenario, they can work on other projects, as they will receive an email notification when the scenario is calculated. Users should avoid opening the scenario while they explore as this can affect calculations.



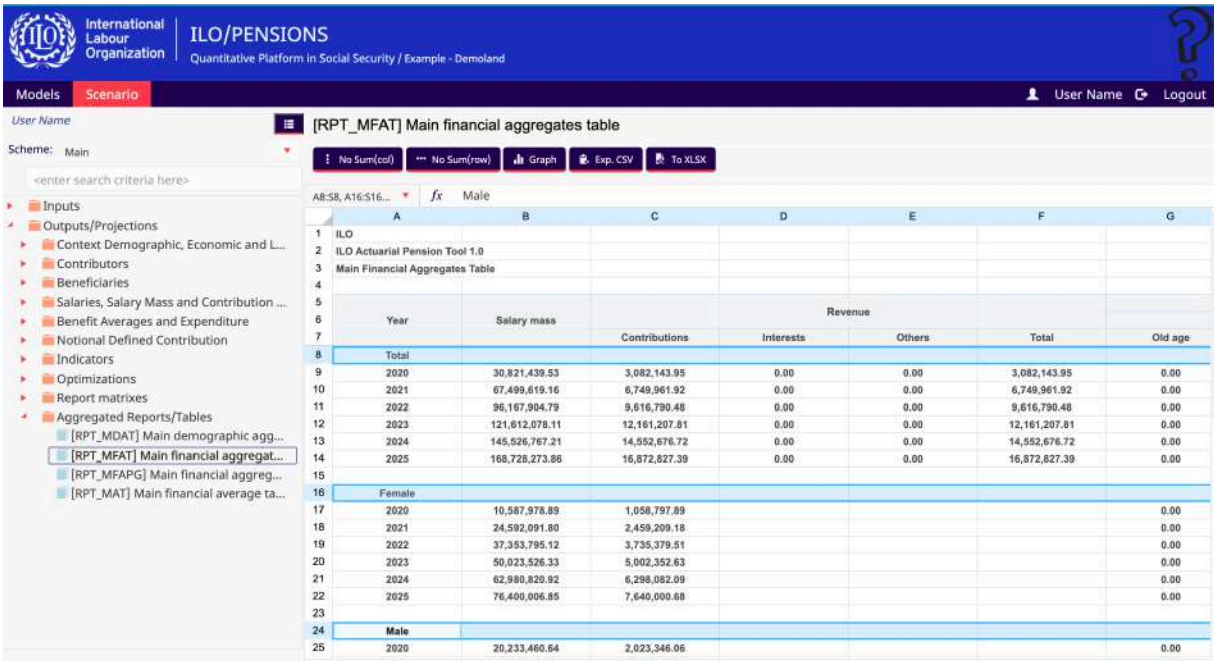


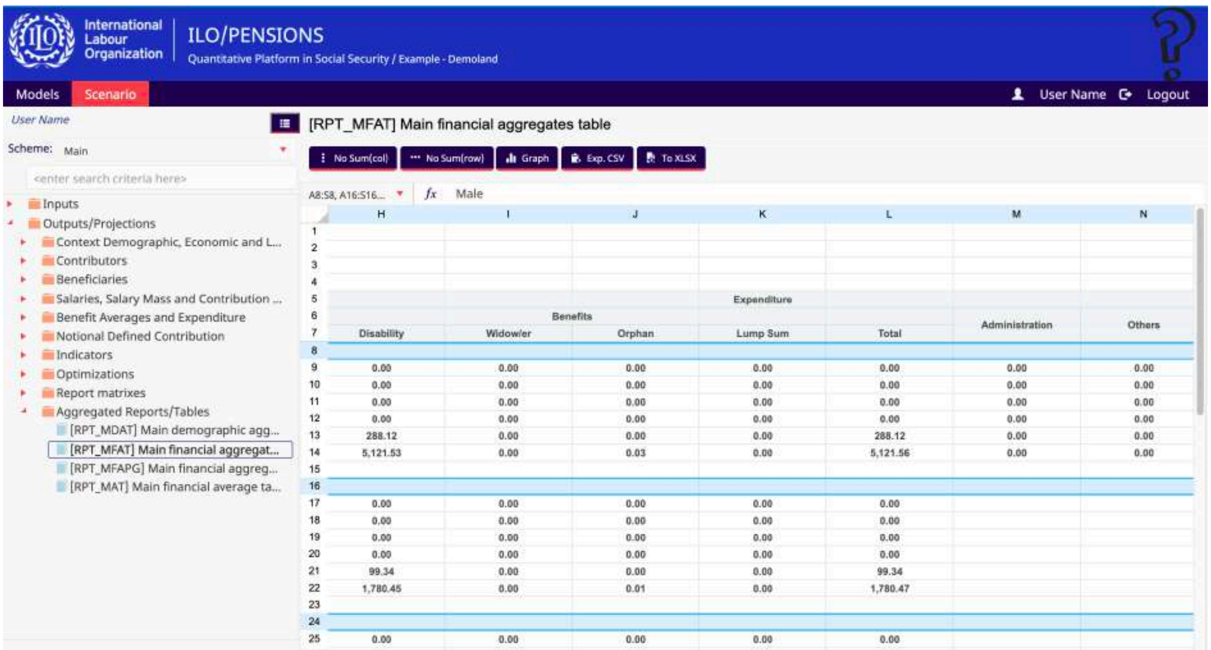
6.4. Exploring the basic output matrices

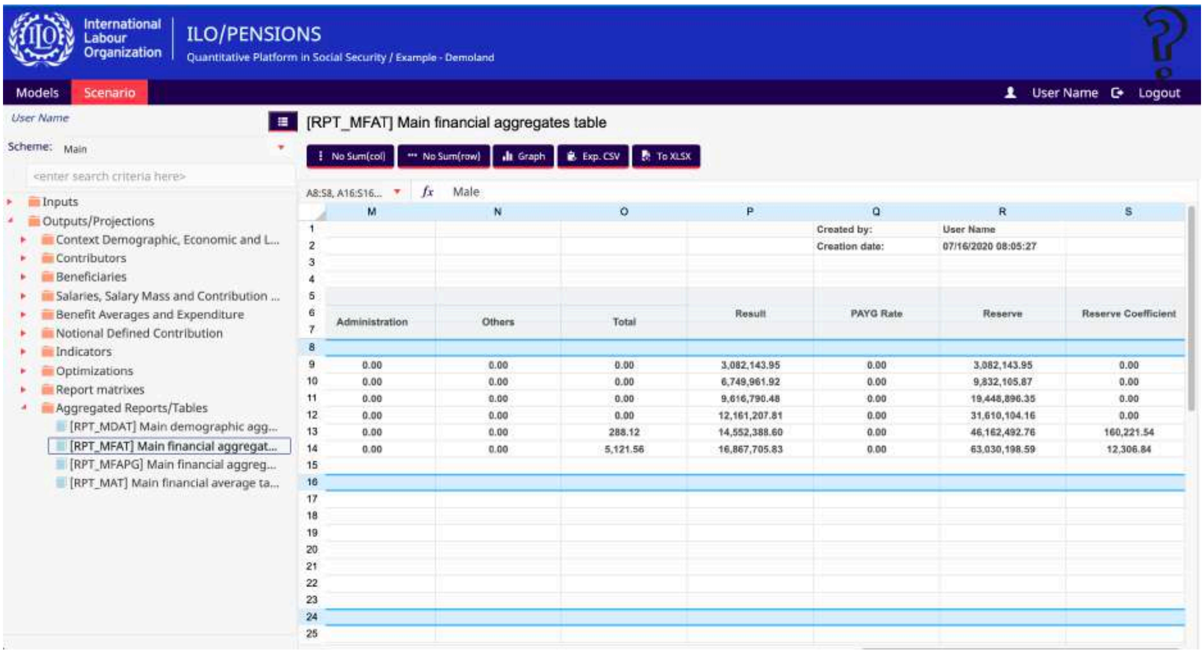
Once the scenario is run, users can explore the newly completed output matrices. **This section describes the main information available in the main output matrices and potential uses for that information.** Generally, the section moves from the more general to the more specific matrices, and from those that will be used in most actuarial exercises to those that will be accessed only for detailed calculations. It is advisable to begin by examining the simpler matrices (those that are a column with a time dimension) that can be plotted as a line or bar chart. Users can then move to matrices with age (in rows) and time (in columns) that can be plotted as areas or line charts to perform comparisons by year.

6.4.1. Financial report matrices

Users normally first look at the Main Financial Aggregates Table [RPT_MFAT]. This table is where users can identify the main financial projections of the scheme crucial to scheme sustainability. It is found in: Outputs/Projections > Aggregated Reports/Tables > RPT_MFAT.







The table has three main parts: Male, Female and Total. The first two sections show the aggregates related to female and male contributors or beneficiaries for each year of the projection. Salary Mass, Contributions and Benefits can be disaggregated by sex; other financial aggregates depend on values of other aggregates that cannot be disaggregated by sex.

Of the three parts, the most important is the total. It contains three sections: Income, Expenditure and Results.

In the Income section, the first column is the Salary mass, showing the level of potential insurable earnings. The second column shows the Contributions (calculated over the Salary mass), followed by Interest income and Other Income. The final column of the section is Total income (the sum of Contributions, Interest and Other income).

The Expenditure section has a Benefits subsection, which lists the Value of Pensions for Old-Age, Disability, Widow(er)s and Orphans, a total of all Lump sums and a total of all Benefit expenditures. Besides benefits, the section has Administrative expenditures, Other expenditures and a Total of all expenditures (total of benefit, administrative and other expenditures).

The Results section sheds light on the relationships between the aggregates of other sections. The first result corresponds to the difference between income and expenditure. Next is the PAYG rate, which lists the ratio between Expenditures and Salary Mass. This is followed by Reserve, the expected value of the fund's reserve. Finally, the Reserve coefficient demonstrates the number of times reserve covers annual expenditures.

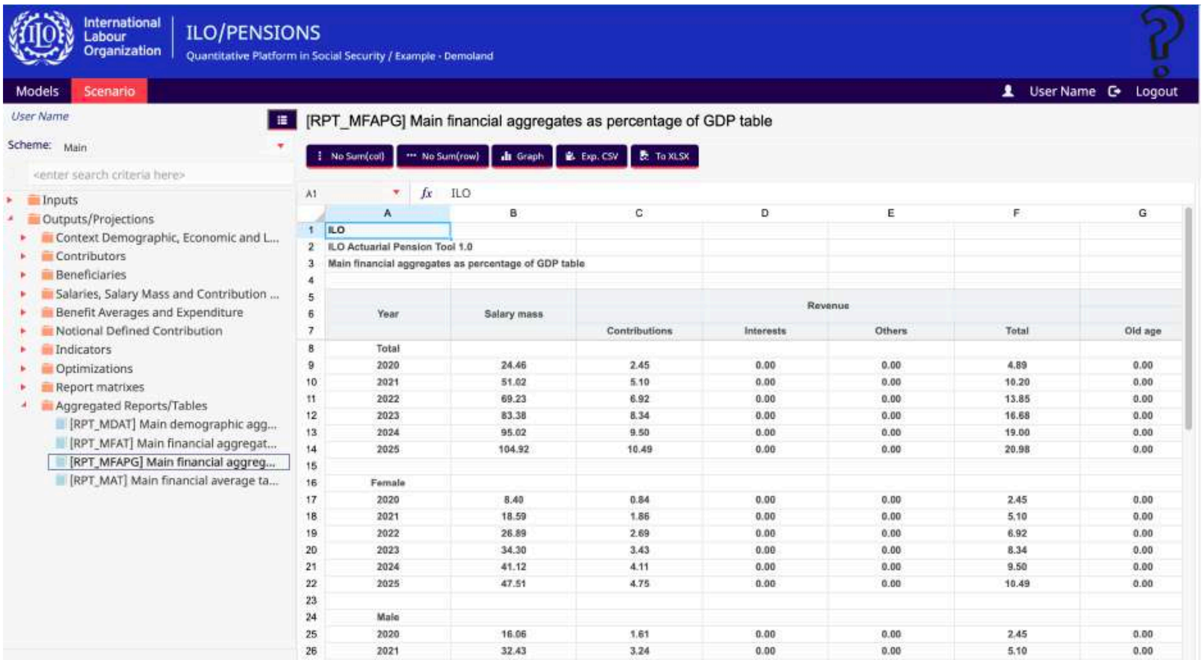
The Reserve column shows for two critical points: the year when the reserve falls below zero for the first time and the first year the reserve decreases. The column result (below zero) shows an additional critical point the first time the result is negative.

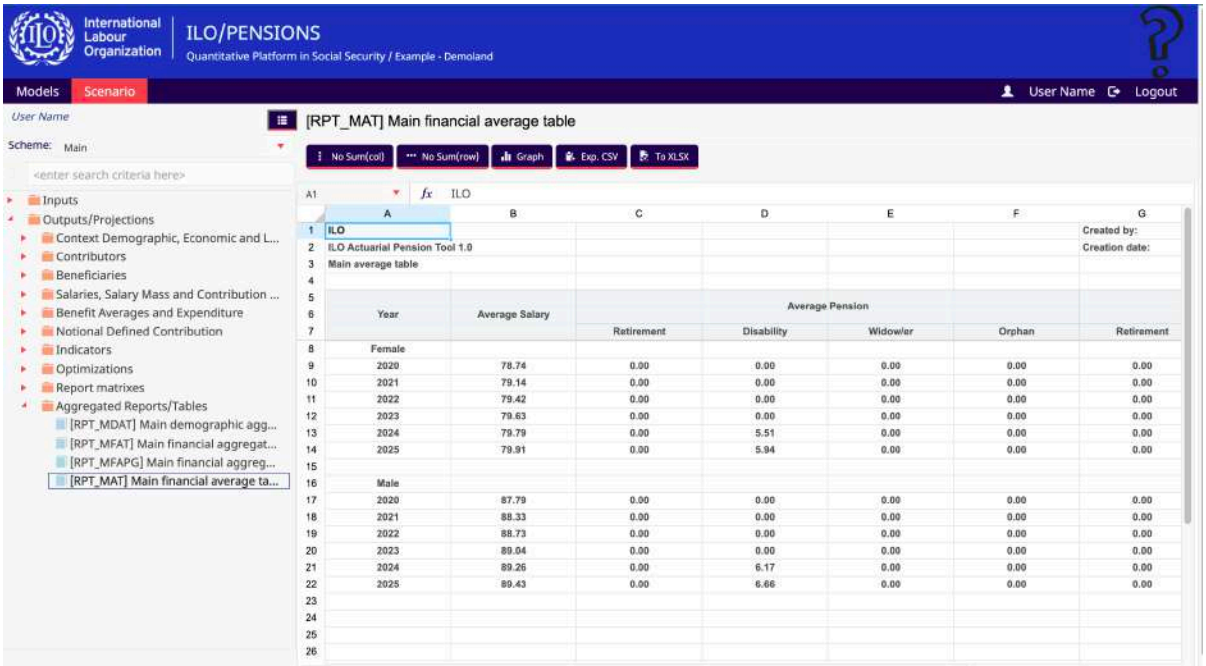
Users are invited to export the matrix to an Excel file to prepare some basic charts for interpretation:

- PAYG rate line chart;
- reserve area or bar chart;
- line chart with total income, total expenditure and results;
- stacked column chart with different types of income; and
- stacked column chart with different types of expenditures (a one-line series with total income can be added).

In addition to [RPT_MFAT], the financial report is complemented by:

- The Main Financial Aggregates as a Percentage of GDP [RPT_MFAPG]. This shows the full set of information with everything expressed as a percentage of GDP. This allows users to view income and expenditures in relation to the size of the economy and to potentially assess the magnitude of the potential impact of the scheme(s).
- The Main Average Table [RPT_MAT]. This shows the values of average salaries and benefits such as pensions and lump sums by sex. This is useful a preliminary assessment of the adequacy of benefits over time.



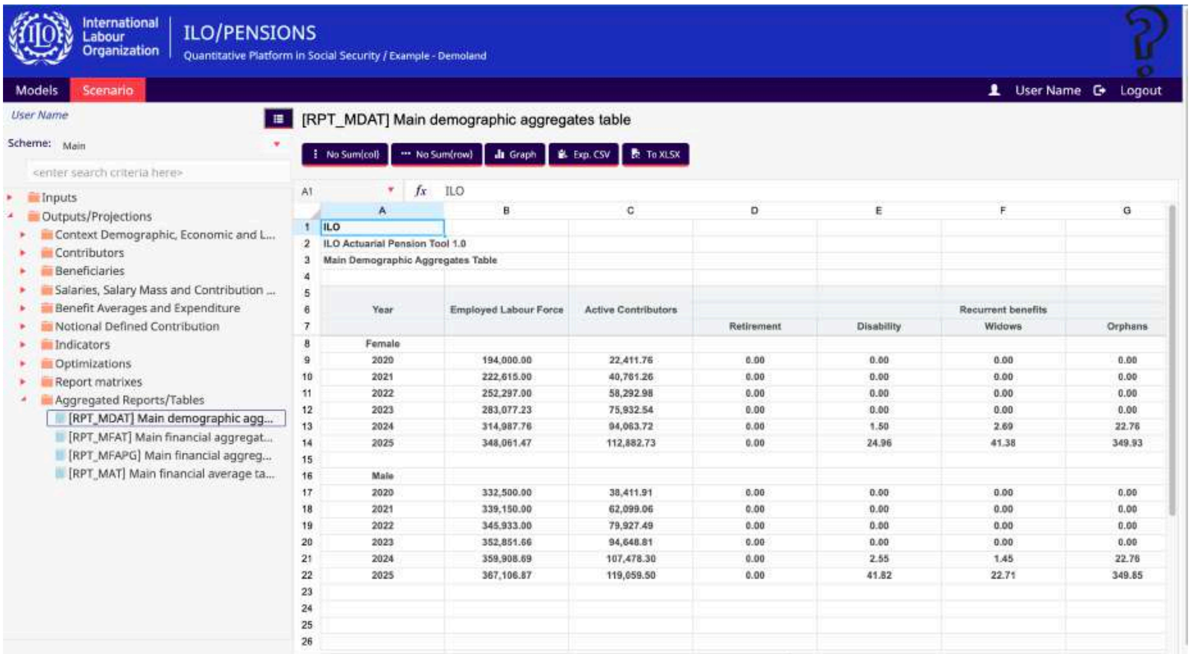


6.4.2. Demographic report matrices

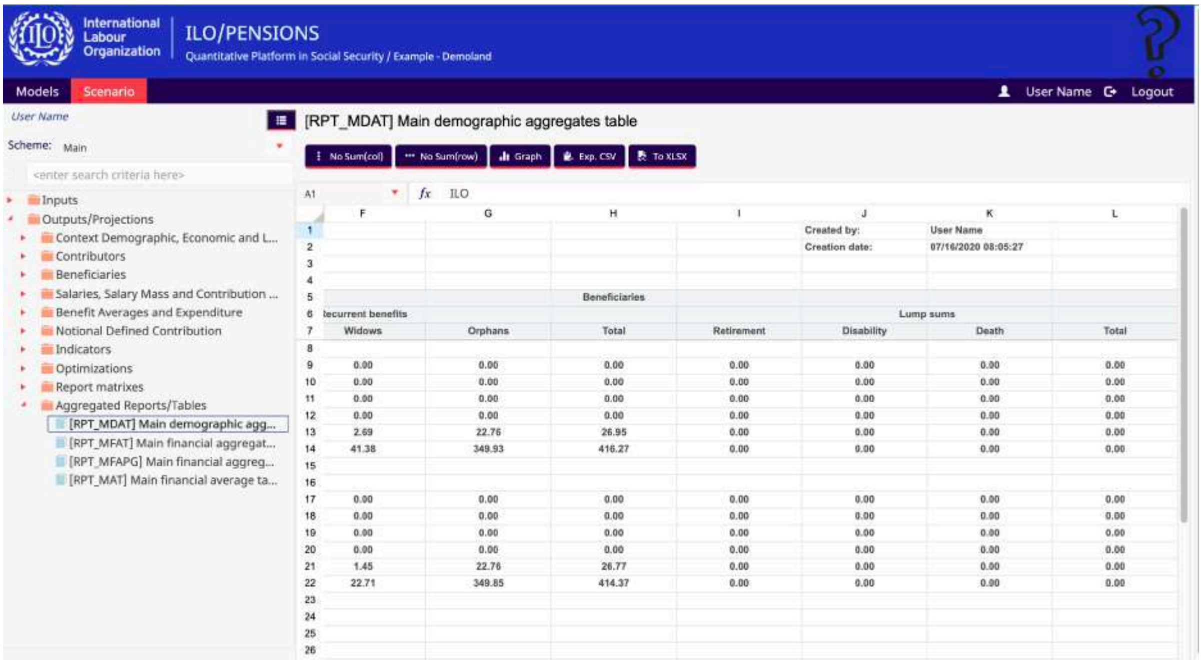
The three financial reports are accompanied by the Main Demographic Aggregates Table [RPT_MDAT]. This table lists the sizes of key demographic aggregates. This report has Total, Female and Male sections with annual information. It is found in: Outputs/Projections > Aggregated Reports/Tables > RPT_MDAT.

The columns have two main sections: First, the contributors-related section with information on the labour force and total active contributors. Second, the beneficiary-related section with information on the number of beneficiaries of ongoing benefits (pensions) and lump sums, according to the contingency.

Users can study trends by viewing each time series independently or by analysing the demographic composition of the beneficiaries over time.



	A	B	C	D	E	F	G
1	ILO						
2	ILO Actuarial Pension Tool 1.0						
3	Main Demographic Aggregates Table						
4							
5							
6	Year	Employed Labour Force	Active Contributors			Recurrent benefits	
7				Retirement	Disability	Widows	Orphans
8	Female						
9	2020	194,000.00	22,411.76	0.00	0.00	0.00	0.00
10	2021	222,615.00	40,761.26	0.00	0.00	0.00	0.00
11	2022	252,297.00	58,292.98	0.00	0.00	0.00	0.00
12	2023	283,077.23	75,932.54	0.00	0.00	0.00	0.00
13	2024	314,987.76	94,063.72	0.00	1.50	2.69	22.76
14	2025	348,061.47	112,882.73	0.00	24.96	41.38	349.93
15							
16	Male						
17	2020	332,500.00	38,411.91	0.00	0.00	0.00	0.00
18	2021	339,150.00	62,099.06	0.00	0.00	0.00	0.00
19	2022	345,933.00	79,927.49	0.00	0.00	0.00	0.00
20	2023	352,851.66	94,648.81	0.00	0.00	0.00	0.00
21	2024	359,908.69	107,478.30	0.00	2.55	1.45	22.76
22	2025	367,106.87	119,059.50	0.00	41.82	22.71	349.85
23							
24							
25							
26							



	F	G	H	I	J	K	L
1					Created by:	User Name	
2					Creation date:	07/16/2020 08:05:27	
3							
4							
5			Beneficiaries				
6	tecurrent benefits				Lump sums		
7	Widows	Orphans	Total	Retirement	Disability	Death	Total
8							
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	2.69	22.76	26.95	0.00	0.00	0.00	0.00
14	41.38	349.93	416.27	0.00	0.00	0.00	0.00
15							
16							
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	1.45	22.76	26.77	0.00	0.00	0.00	0.00
22	22.71	349.85	414.37	0.00	0.00	0.00	0.00
23							
24							
25							
26							

6.4.3. Financial indicators

Indicators correspond to a data series used to highlight certain aspects of a projection. They are the results of comparisons between projection results and are therefore replicable. ILO/PENSIONS automatically calculates these as they are common requests in many actuarial valuations.

There are three types of indicators in ILO/PENSIONS:

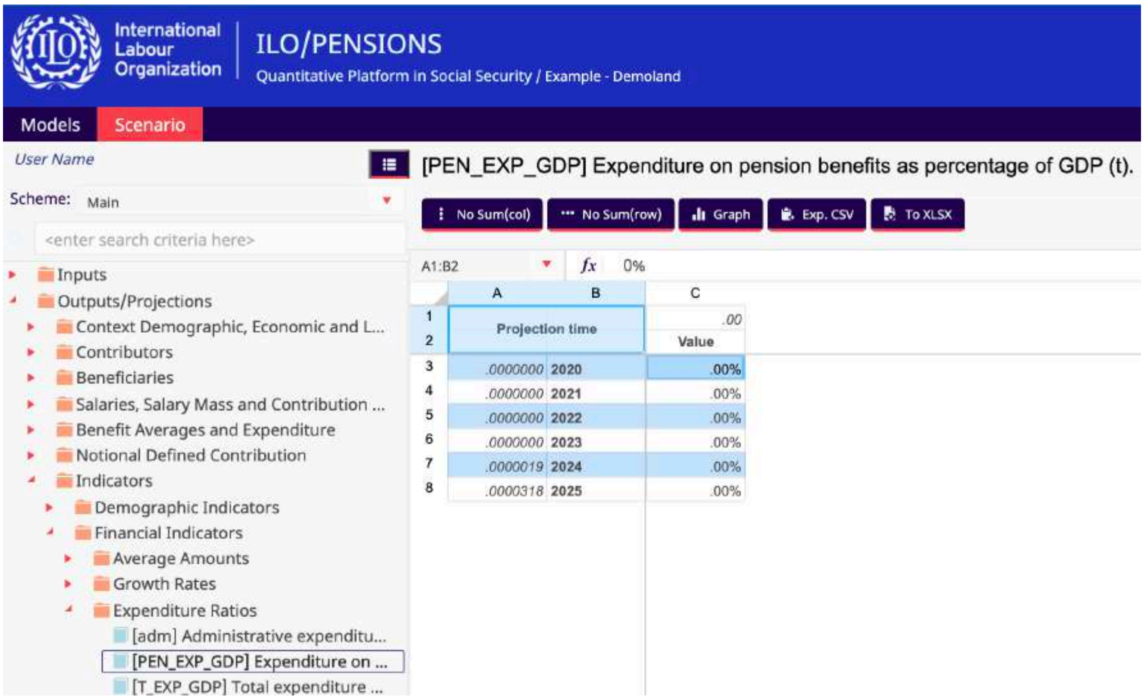
6.4.3.1. *Financial results*

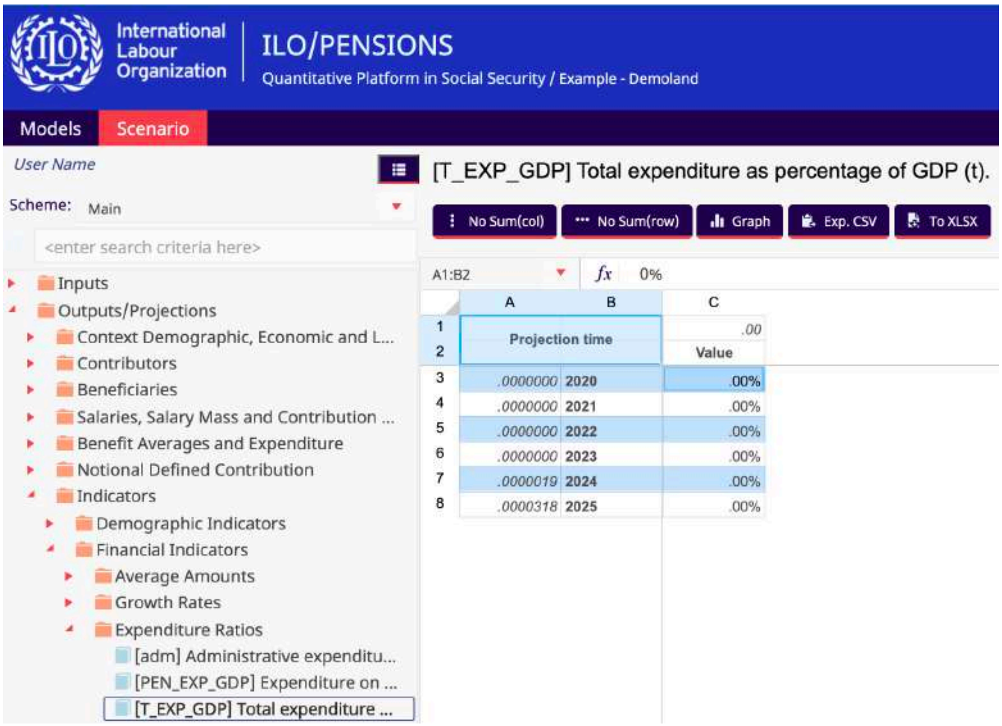
They are extractions of financial results of the projection placed under a single matrix to facilitate the work for users. The three financial results are:

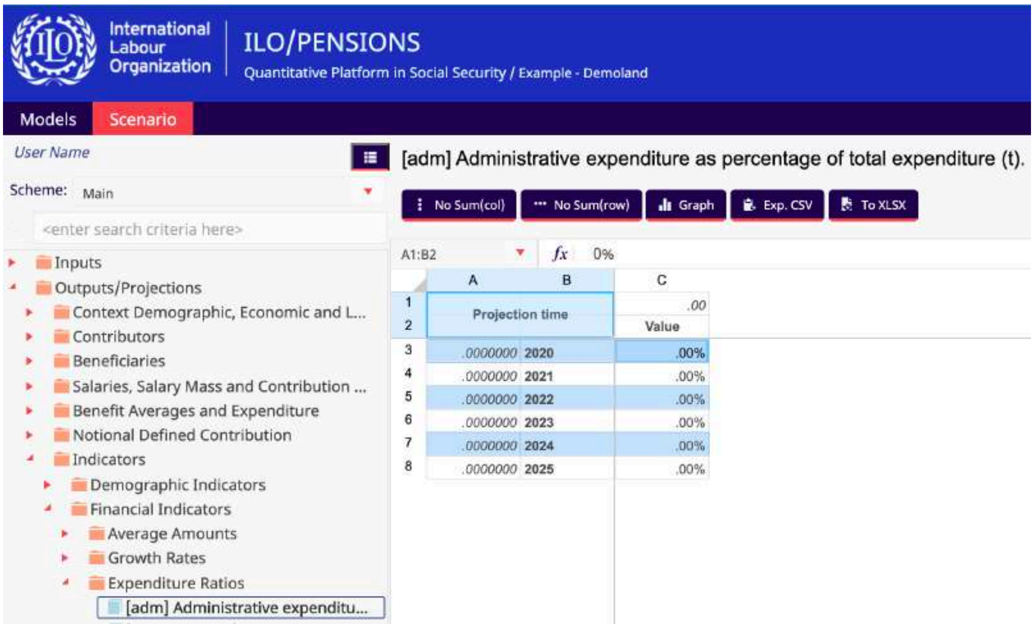
- [RES] Reserve with the projected value of the scheme's reserve per year of projection.
- [RES_RT] Reserve ratio, which compares the reserve with the scheme's expenditure. This is an indication of the expected level of robustness of the reserve. The higher the ratio, the higher the level of financial threat the scheme can endure while maintaining some level of sustainability.
- [GAP] General average premium, which is the contribution rate needed to keep the scheme running with positive reserves for the full projection period. If the current statutory contribution rate over the period is lower than the GAP, the scheme will exhaust all reserves before the end of the projection period. If it is higher, the scheme will complete the projection period with some reserves.

6.4.3.2. *Expenditure ratios*

These indicators are comparisons of certain expenditure items or total expenditures with other aggregates. They assess the magnitude of these expenditures with respect to the economy in the case of [PEN_EXP_GDP] Expenditure on Pension Benefits as percentage of GDP and [T_EXP_GDP] Total expenditure as a percentage of GDP. They may also assess the relative efficiency of expenditures as in the case of [adm] administrative expenditures as a percentage of total expenditures.

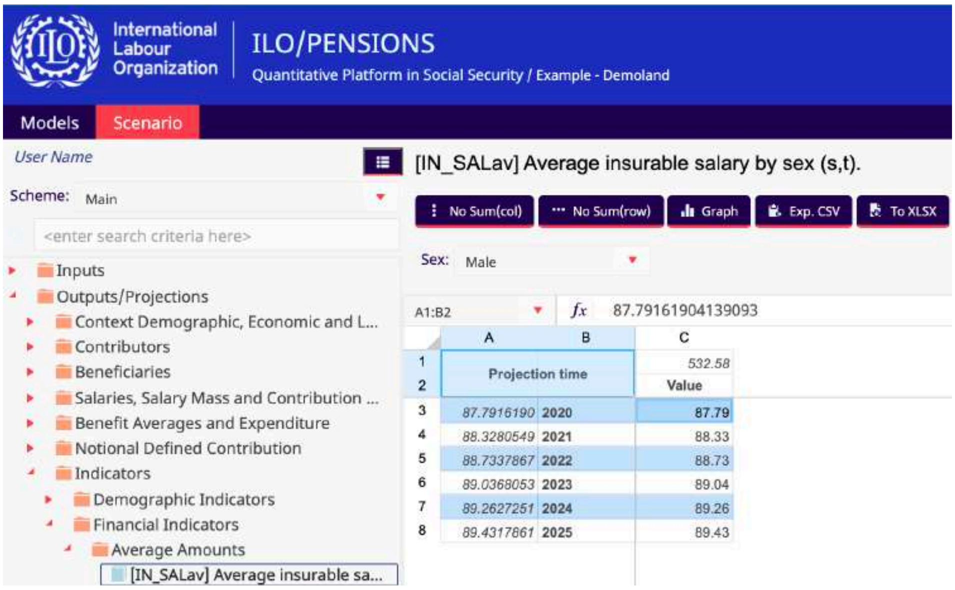

International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
[PEN_EXP_GDP] Expenditure on pension benefits as percentage of GDP (t).
Scheme: Main
No Sum(col)
No Sum(row)
Graph
Exp. CSV
To XLSX
<enter search criteria here>
A1:B2
0%
Projection time
Value
Inputs
Outputs/Projections
Context Demographic, Economic and L...
Contributors
Beneficiaries
Salaries, Salary Mass and Contribution ...
Benefit Averages and Expenditure
Notional Defined Contribution
Indicators
Demographic Indicators
Financial Indicators
Average Amounts
Growth Rates
Expenditure Ratios
[adm] Administrative expenditu...
[PEN_EXP_GDP] Expenditure on ...
[T_EXP_GDP] Total expenditure ...

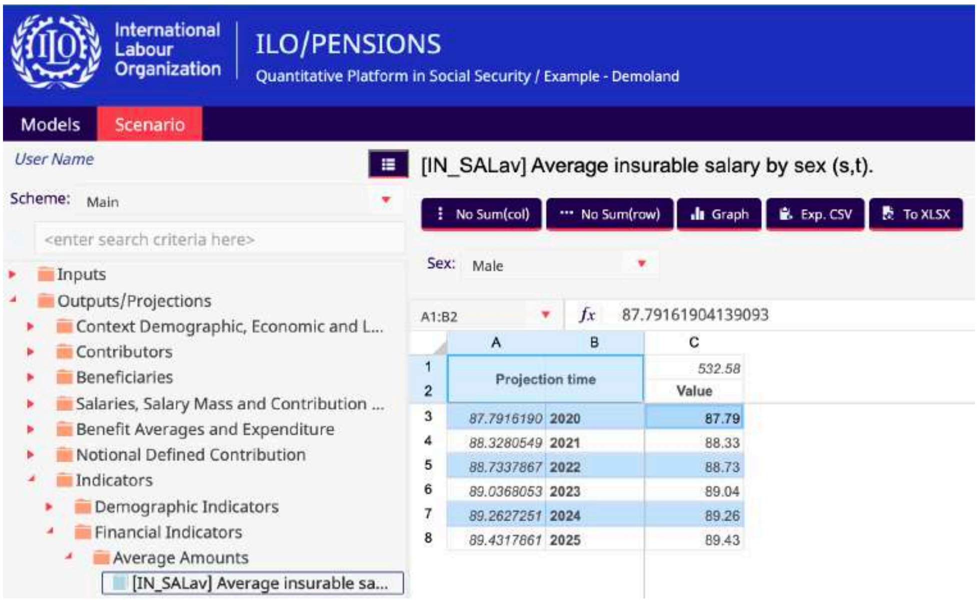

International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
[T_EXP_GDP] Total expenditure as percentage of GDP (t).
Scheme: Main
No Sum(col)
No Sum(row)
Graph
Exp. CSV
To XLSX
<enter search criteria here>
A1:B2
0%
Projection time
Value
Inputs
Outputs/Projections
Context Demographic, Economic and L...
Contributors
Beneficiaries
Salaries, Salary Mass and Contribution ...
Benefit Averages and Expenditure
Notional Defined Contribution
Indicators
Demographic Indicators
Financial Indicators
Average Amounts
Growth Rates
Expenditure Ratios
[adm] Administrative expenditu...
[PEN_EXP_GDP] Expenditure on ...
[T_EXP_GDP] Total expenditure ...

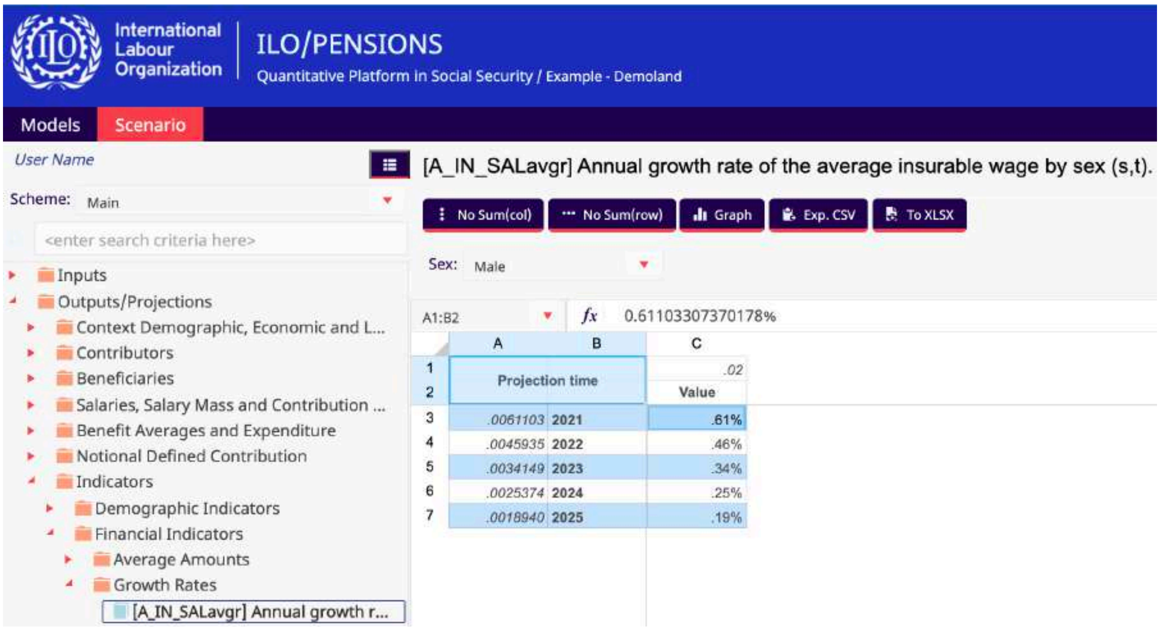


6.4.3.3. *Average amounts and growth rates*

The other two groups of indicators correspond to annual projections of the average value for individual salary or benefit and the expected growth in this value, by sex. These values provide information on the adequacy of the scheme's benefits, especially in the short term. Average amounts and growth rates are found in: Outputs/Projections > Indicators > Financial Indicators > Average Amounts or Growth Rates, respectively.





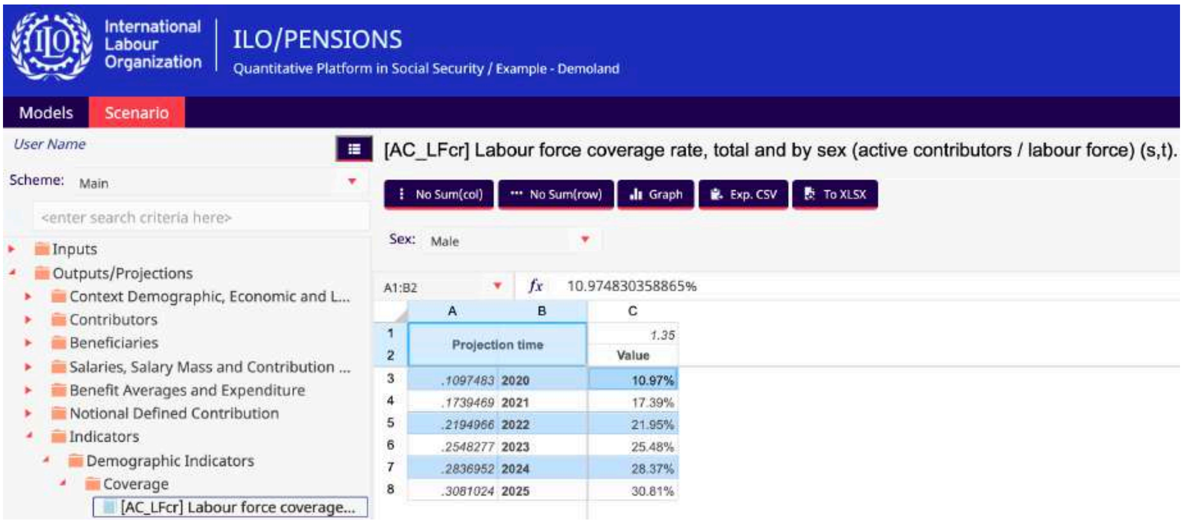


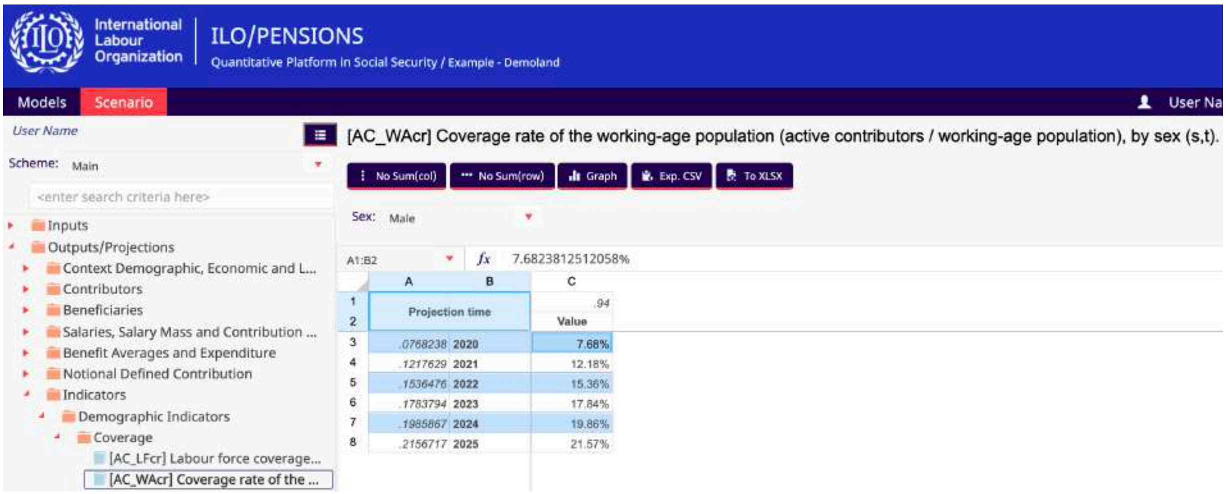
6.4.4. Demographic indicators

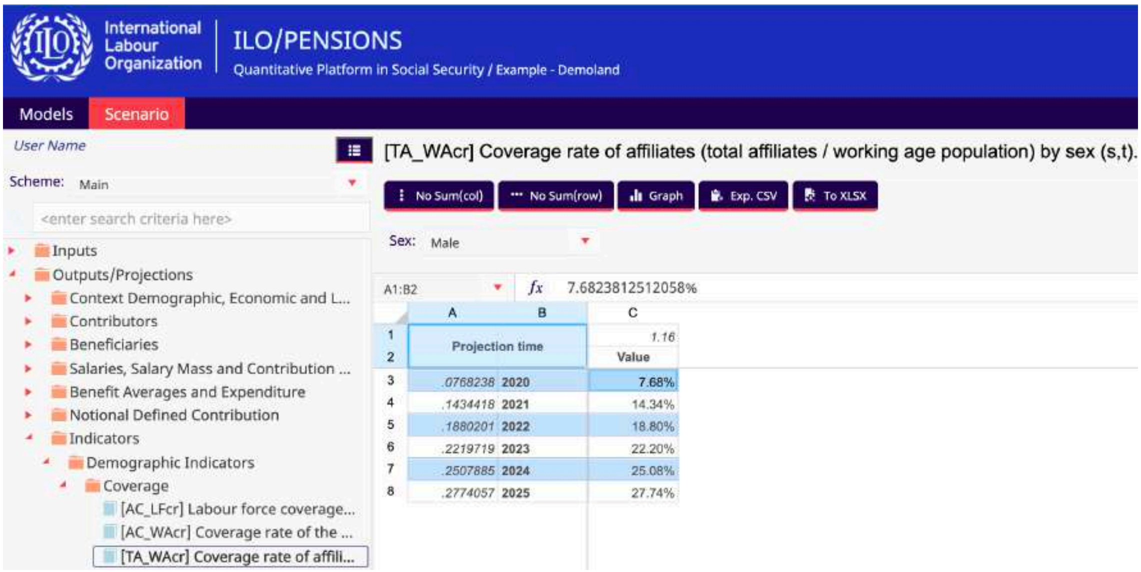
In addition to financial indicators, ILO/PENSIONS provides a set of demographic indicators. These are found in: Outputs/Projections > Indicators > Demographic Indicators and are of two types:

6.4.4.1. *Coverage rates*

Ratios between demographic aggregates help users analyse how the schemes affect their target population. There are three kinds of coverage: Active coverage that compares the active contributors over time with the labour force [AC_LFcr] or with the working age population [AC_WAcr]; affiliate coverage, which compares the total number of affiliated members to the working age population [TA_WAcr]; and beneficiary coverage, which compares the number of beneficiaries over a certain age (60 or 65) to the national population over the same age [PEN_RAP60cr] and [PEN_RAP65cr]. The higher the coverage, the higher the progress in making the scheme universal. These are found in: Outputs/Projections > Indicators > Demographic Indicators > Coverage.






International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
Scheme: Main
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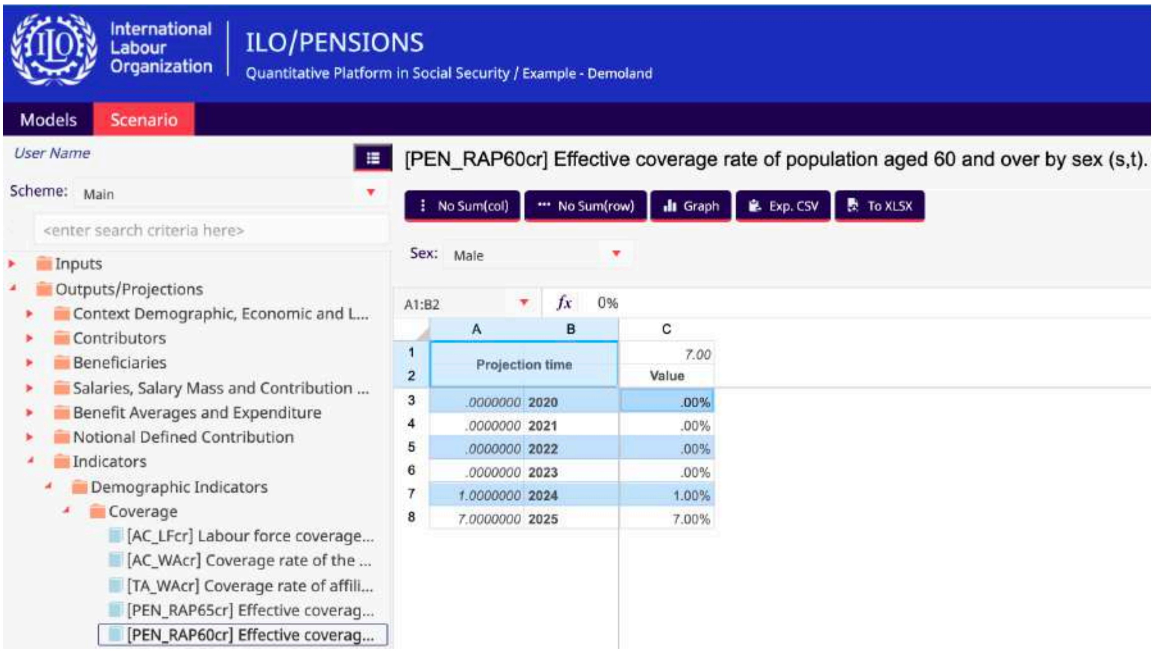
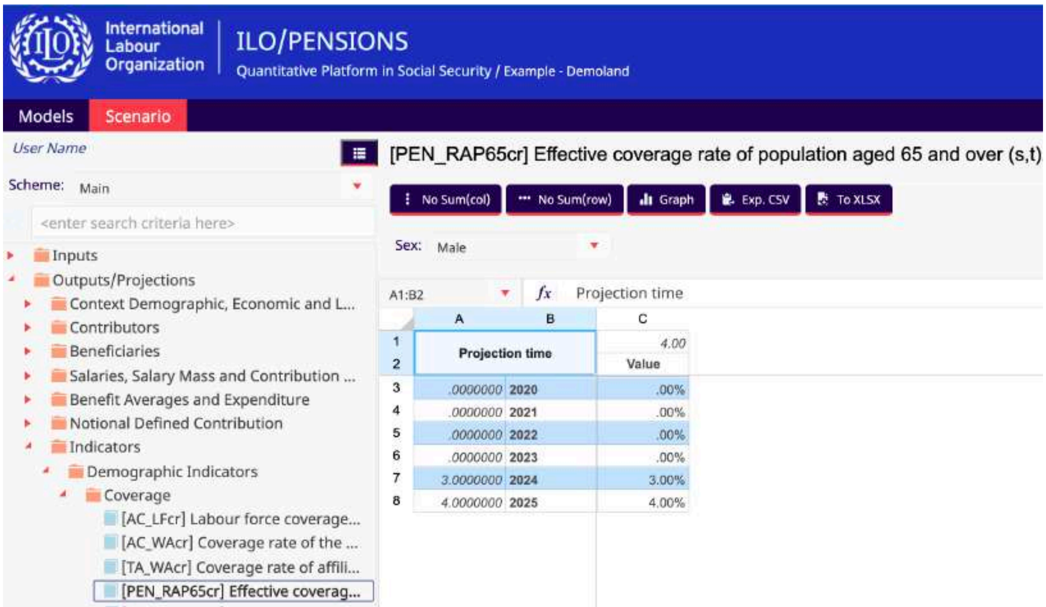
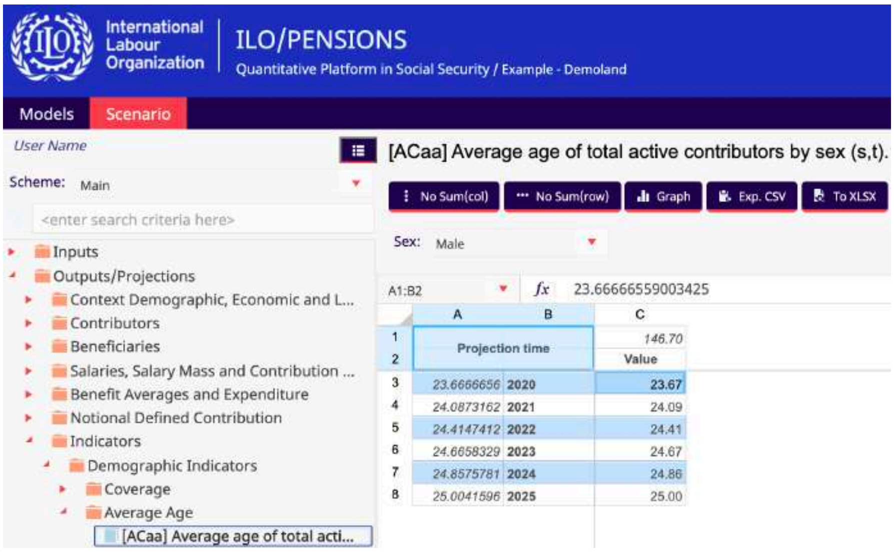
Inputs
Outputs/Projections
Context Demographic, Economic and L...
Contributors
Beneficiaries
Salaries, Salary Mass and Contribution ...
Benefit Averages and Expenditure
Notional Defined Contribution
Indicators
Demographic Indicators
Coverage
[AC_LFcr] Labour force coverage...
[AC_WAcr] Coverage rate of the ...
[TA_WAcr] Coverage rate of affili...
[TA_WAcr] Coverage rate of affiliates (total affiliates / working age population) by sex (s,t).
No Sum(col)
No Sum(row)
Graph
Exp. CSV
To XLSX
Sex: Male
A1:B2
fx 7.6823812512058%
Projection time
Value
1.16
.0768238 2020 7.68%
.1434418 2021 14.34%
.1880201 2022 18.80%
.2219719 2023 22.20%
.2507885 2024 25.08%
.2774057 2025 27.74%


International Labour Organization
ILO/PENSIONS
Quantitative Platform in Social Security / Example - Demoland
Models
Scenario
User Name
Scheme: Main
<enter search criteria here>
Inputs
Outputs/Projections
Context Demographic, Economic and L...
Contributors
Beneficiaries
Salaries, Salary Mass and Contribution ...
Benefit Averages and Expenditure
Notional Defined Contribution
Indicators
Demographic Indicators
Coverage
[AC_LFcr] Labour force coverage...
[AC_WAcr] Coverage rate of the ...
[TA_WAcr] Coverage rate of affili...
[PEN_RAP65cr] Effective coverag...
[PEN_RAP60cr] Effective coverag...
[PEN_RAP60cr] Effective coverage rate of population aged 60 and over by sex (s,t).
No Sum(col)
No Sum(row)
Graph
Exp. CSV
To XLSX
Sex: Male
A1:B2
fx 0%
Projection time
Value
7.00
.0000000 2020 .00%
.0000000 2021 .00%
.0000000 2022 .00%
.0000000 2023 .00%
1.0000000 2024 1.00%
7.0000000 2025 7.00%



6.4.4.2. *Average age*

These indicators show the average age of contributors or beneficiaries by sex over the years. These are found in: Outputs/Projections > Indicators > Demographic Indicators > Average Age. This is useful to assess the characteristics of typical beneficiaries or contributors and their changes over time (for example: ageing of the contributors, younger widow(er)s, etc.). ILO/PENSIONS has values for active contributors and pensioners, as well as for new contributors and new pensioners from different contingencies.

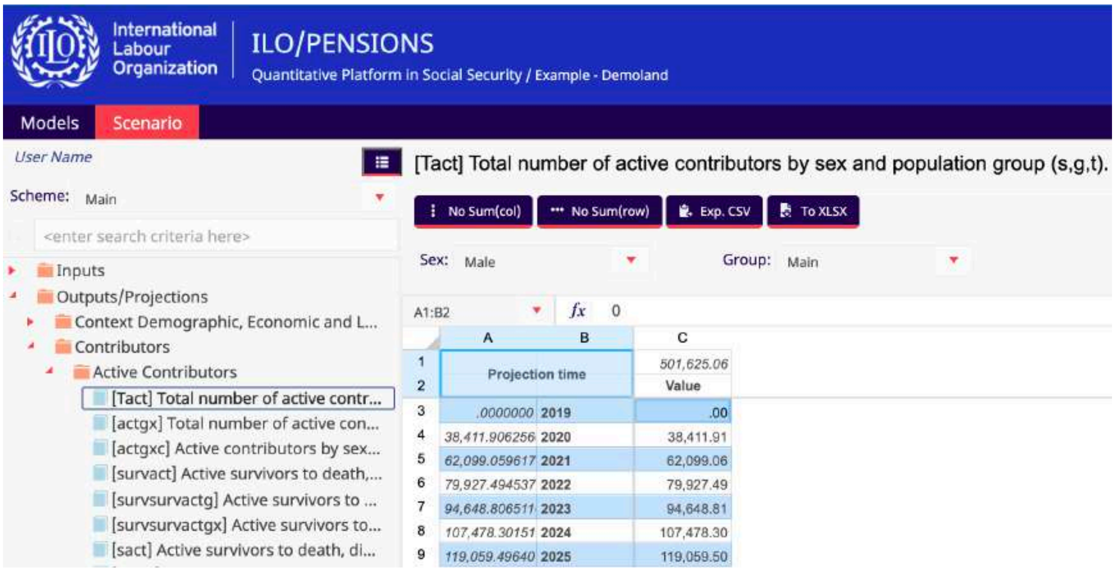


6.4.5. Contributors

The main aggregate groups for contributors are accessible in varying levels of detail for users interested in understanding the dynamics of the groups. These are found in: Outputs/Projections > Contributors and contain active contributors, inactive contributors and entries to contributors.

6.4.5.1. *Yearly aggregates per sex and group*

This is the simplest level of detail possible: A time series per sex that shows the total number of individuals of a group without age details. This level of detail is available for total number of active contributors of a group [Tact], total entries in a group [entg], total new entries [nent] in a group[49] and active contributors from the previous year that did not die, or experience disability, other exits or retirement [sursurvactg].



6.4.5.2. *Year and age crosstabs*

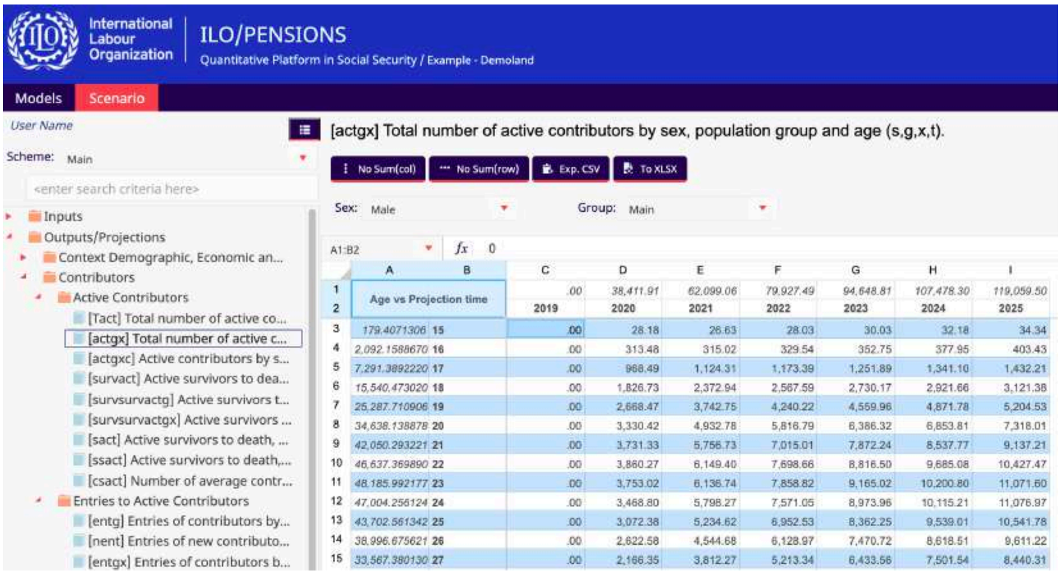
These tables show the years in the columns and the age in the rows. This level of detail enables users to view demographic transitions (the "diagonal" ageing of cohorts). These tables are available for the following main groups: Active contributors [actgx], Entries, New entries, Re-entries ([entgx], [nentx] and [rent]) and Inactive contributors [inactx]. Other groups shown with this detail are residual groups of contingencies, for example: Active contributors that survived death, disability

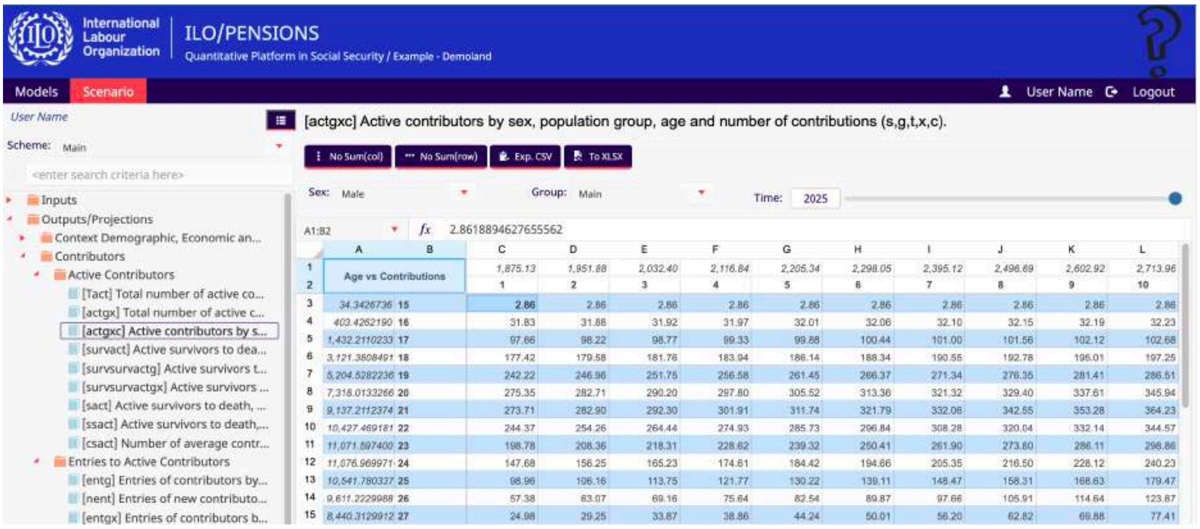
[49] There is no total annual aggregate for inactive contributors. Users can locate the numbers in the total column of the age distribution. In many cases, users will need to indirectly calculate some values. This is not a complicated process and avoids unnecessarily increasing the size of scenarios.

and other exits [survact], Active contributors from the past year that did not die, experience disability, other exits or retirement [sursurvactgx], inactive contributors that did not die, experience disability or other exits [survinact], and inactive contributors from the previous year that did not die, experience disability, other exits or retirement [sursurvinact]. Finally, this level of detail is available for the total number of monthly contributions from active survivors and entries ([csact] and [cent]).

6.4.5.3. *Year, age and contributions crosstabs*

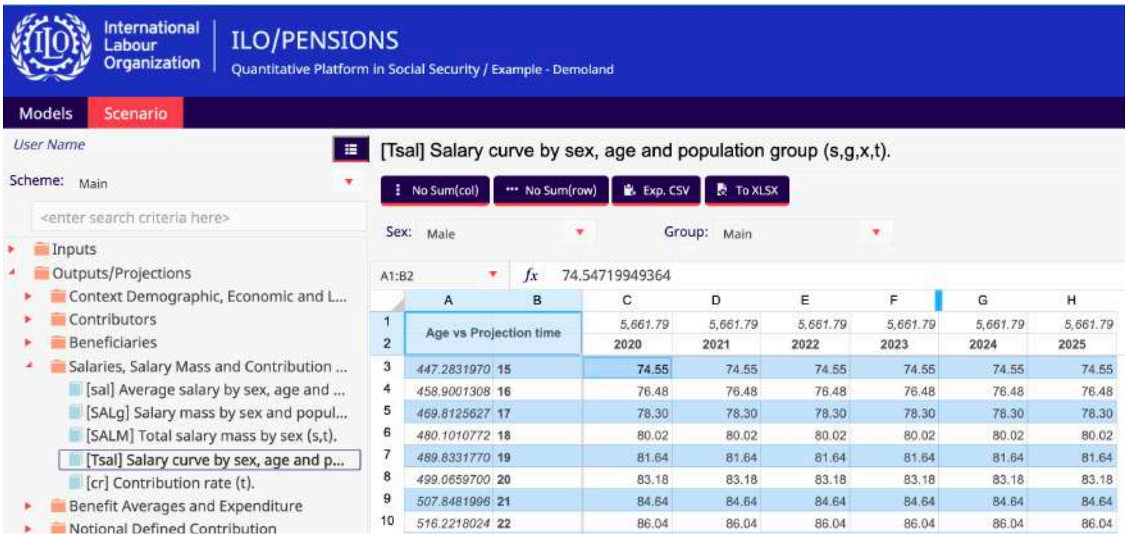
The highest level of detail for any group consists of annual matrices showing the combination of age in the rows and contributions in the columns. The matrices are useful for assessing the accumulation of rights through contributions over time.

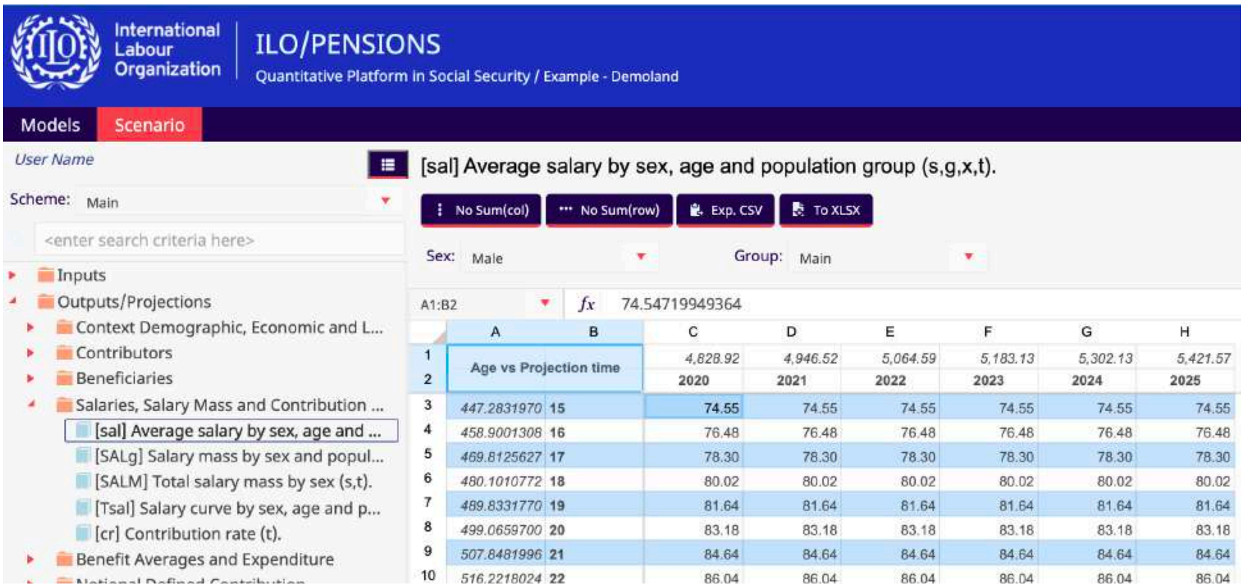


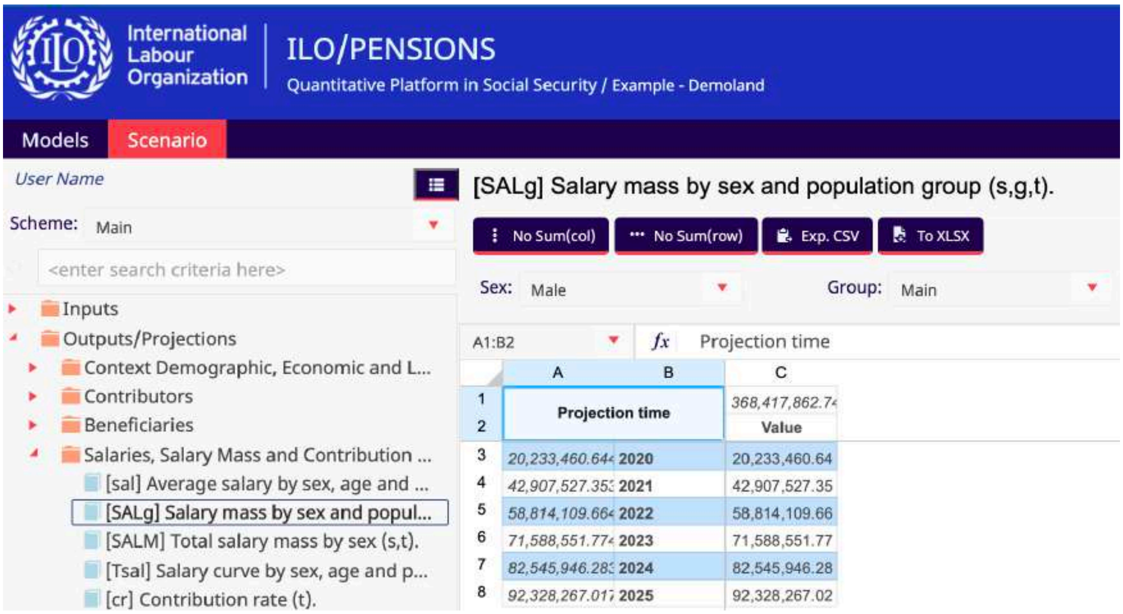


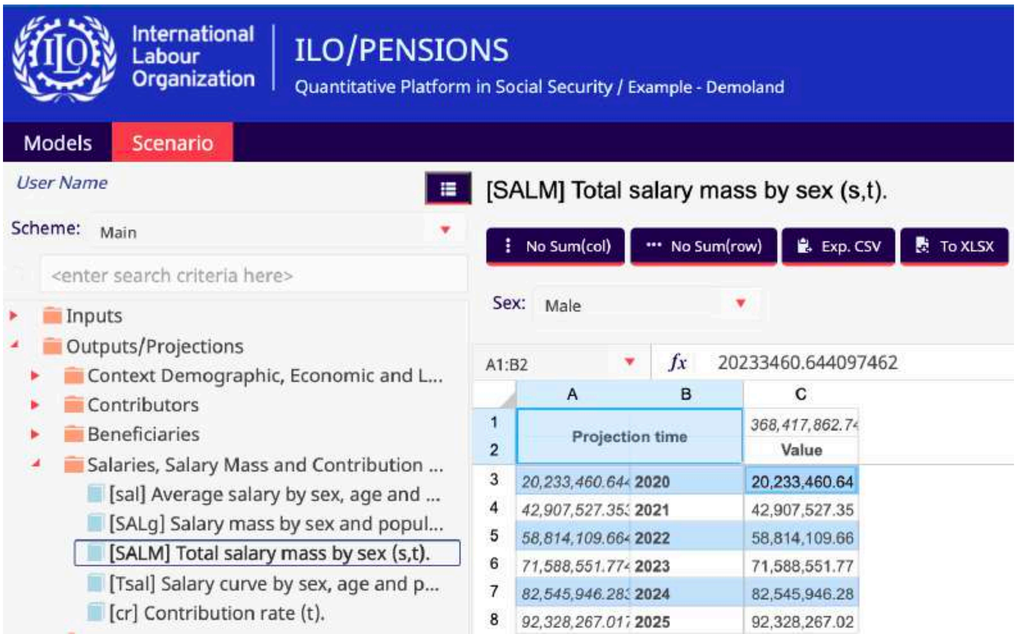
6.4.6. Salary matrices

Similarly, the salary matrices relate income with age for active contributors. There are four salary matrices: [Tsal] contains the theoretical salary and [sal] contains projected salary. Both are shown by age and sex for each group over a given year, with years shown in columns and age in rows. Additionally, the salary mass per sex and group [SALg] and total salary mass per sex [SALM] are also in this set of output matrices. These are found in: Outputs/Projections > Salaries.









Detailed expected average salary per age and sex over the projection period is used in many cases to assess the purchasing power of people over time. With certain transformations, users can also estimate the expected salary career of a given cohort.

6.4.7. Beneficiaries

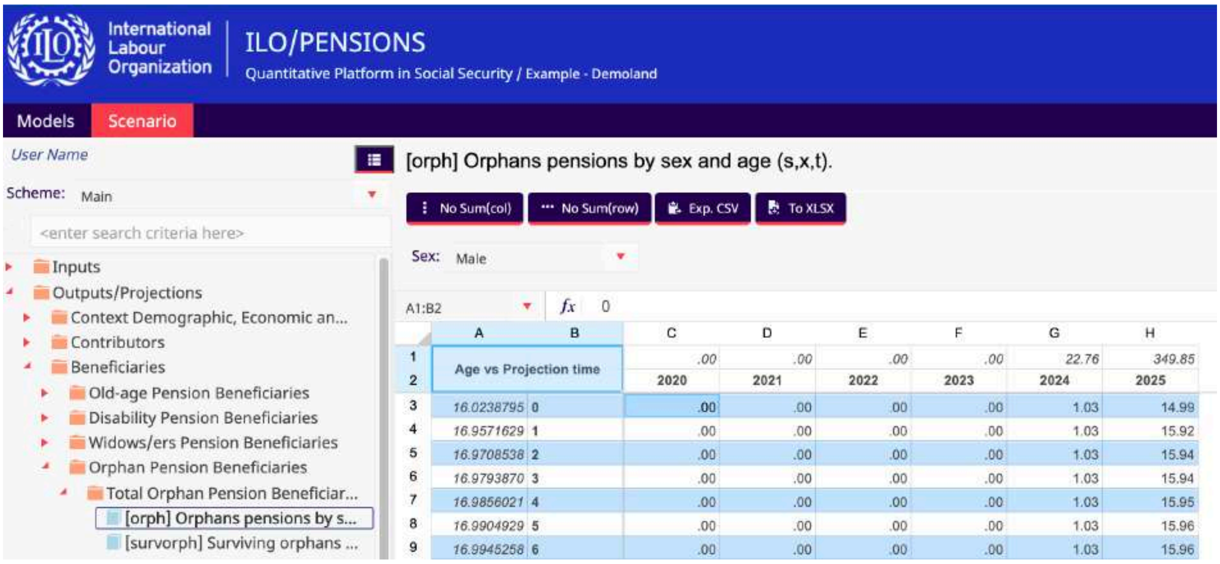
Users can access information regarding the expected number of pension beneficiaries for different contingencies and for lump sums. These are found in: Outputs/Projections > Beneficiaries.

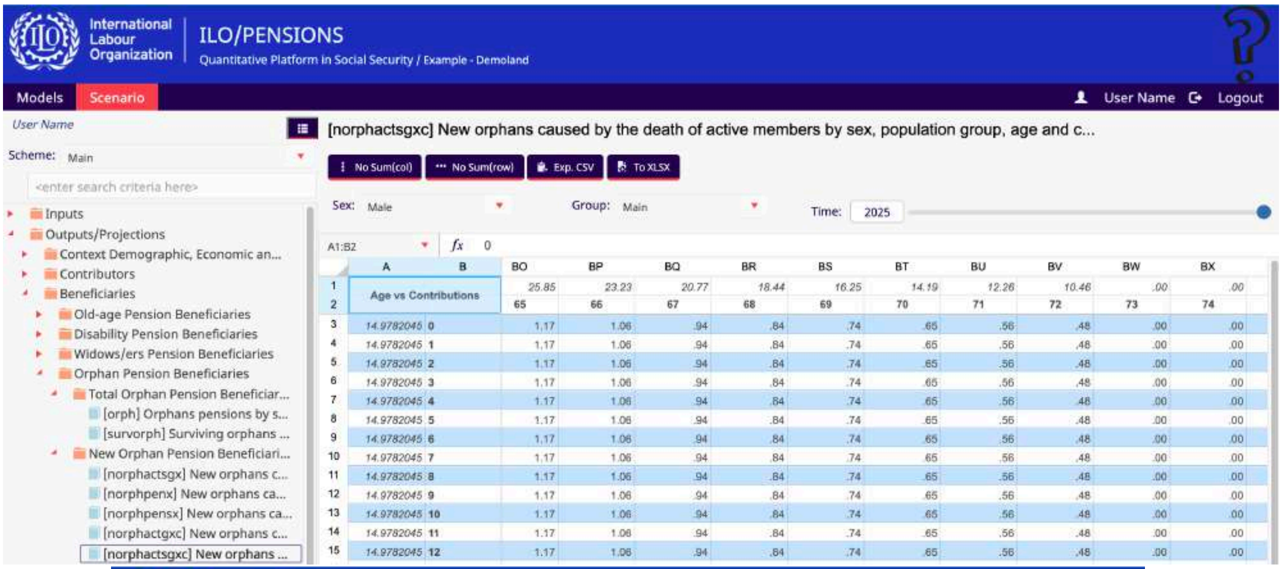
For each contingency for pensions, the tree has two branches – one specifically for new beneficiaries and the other for total beneficiaries.

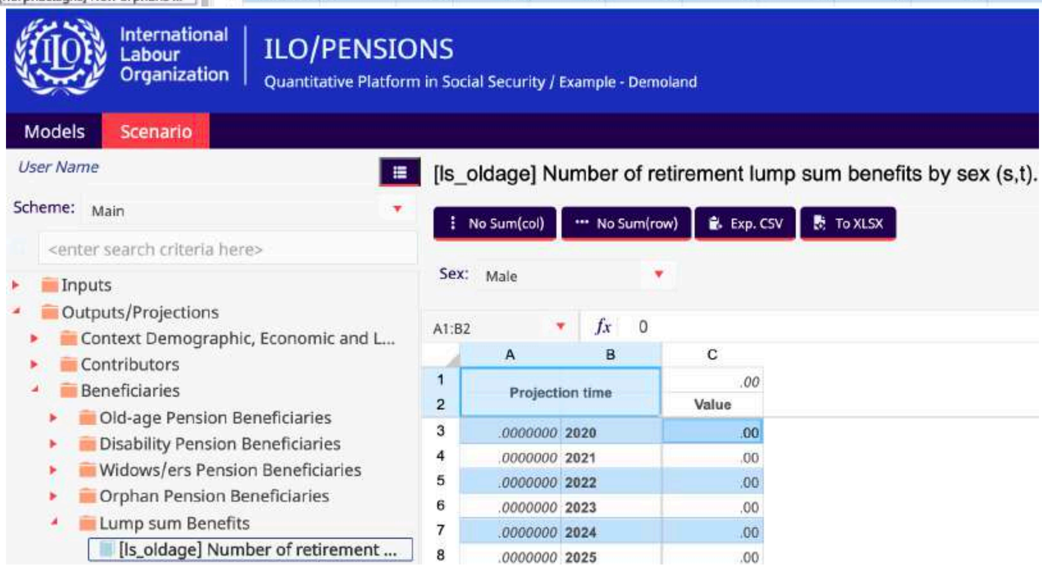
The total beneficiary information is always shown in terms of sex, age (in rows) and years (in columns). Two kinds of matrices exist: one listing the total number of recipients of pensioners of a given contingency, and the other listing the pensioners of the contingency that are expected to survive from the previous year.

The new beneficiary information is more detailed and is useful for calculating new pensions. It has information on the origin of the beneficiary, for example: from active contributors, from pensioners, from death of active contributors or from death of pensioners, the age of the beneficiary and the number of contributions accrued.

In terms of lump sums, the information covers the number of old-age lump sums, and in the event of disability or death, the number of lump sums and the age of the beneficiary.







6.4.8. Benefit matrices

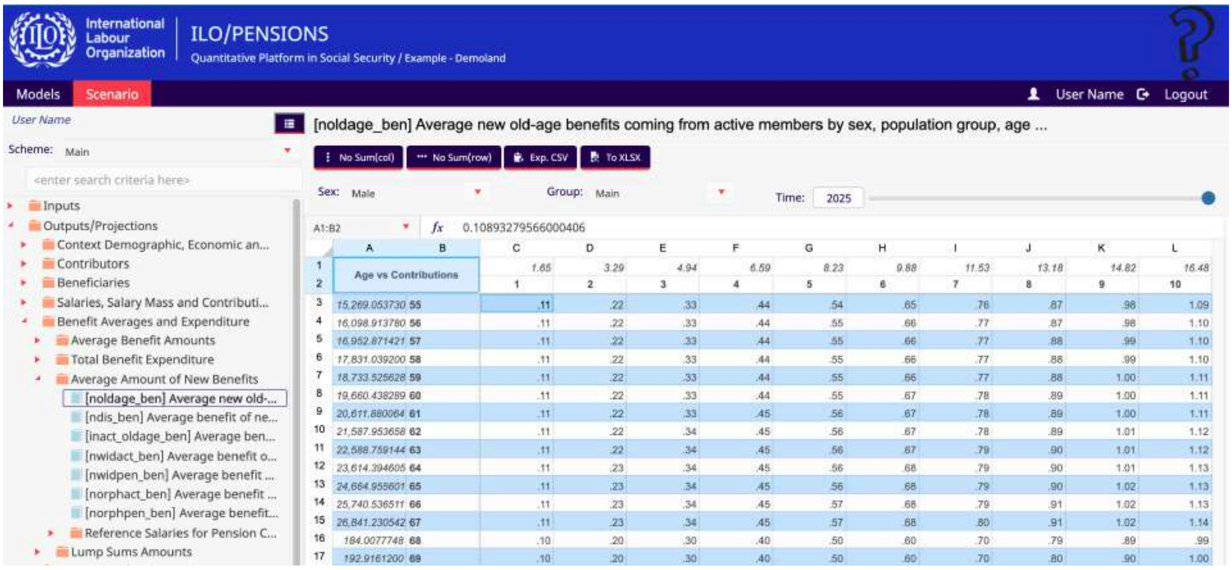
To complement the information related to beneficiaries, the model has a set of matrices to relate the demographic data to a financial dimension. These are found in: Outputs/Projections > Benefit Averages and Expenditure.

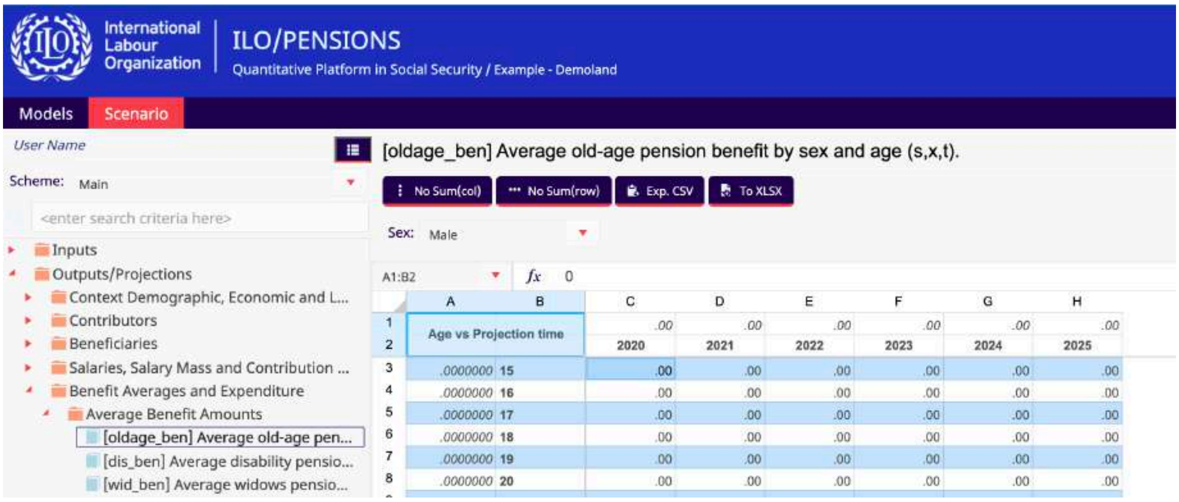
Information on benefits has three dimensions: average new benefits, average benefits and total expenditures.

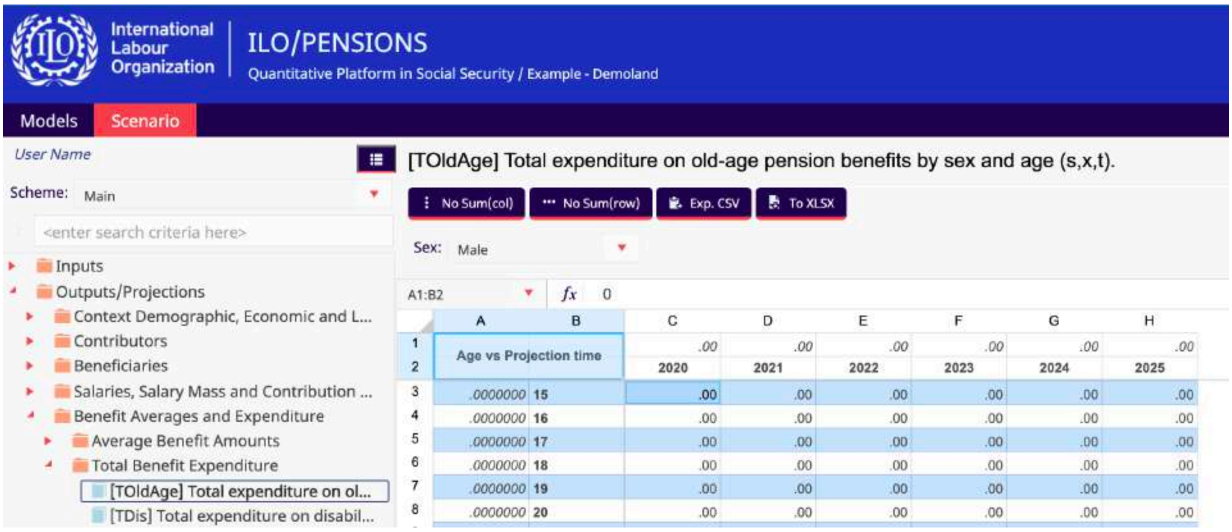
The information on new benefits shows the level per age and sex of the new benefits of each contingency according to the reason for the benefit (for example, due to the death of a pensioner). The same folder of the new benefits contains matrices for calculating reference salaries, which is not discussed here. Additionally, there is a folder for lump sums with information on their total cost per age and contingency.

The average benefit amount relates the average new benefit amount and the adjusted previous benefits for survivors. The information is shown for each contingency and by age and sex.

Combining demographic information with the average benefit amount provides the total expenditure per contingency, by sex, year and age.

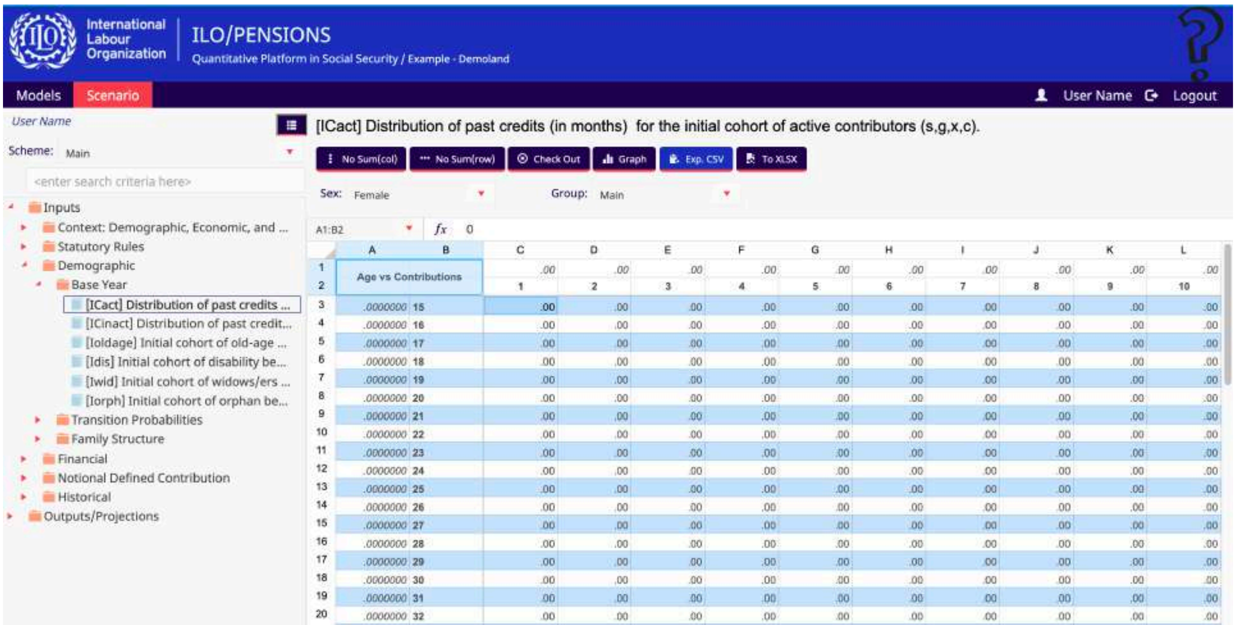


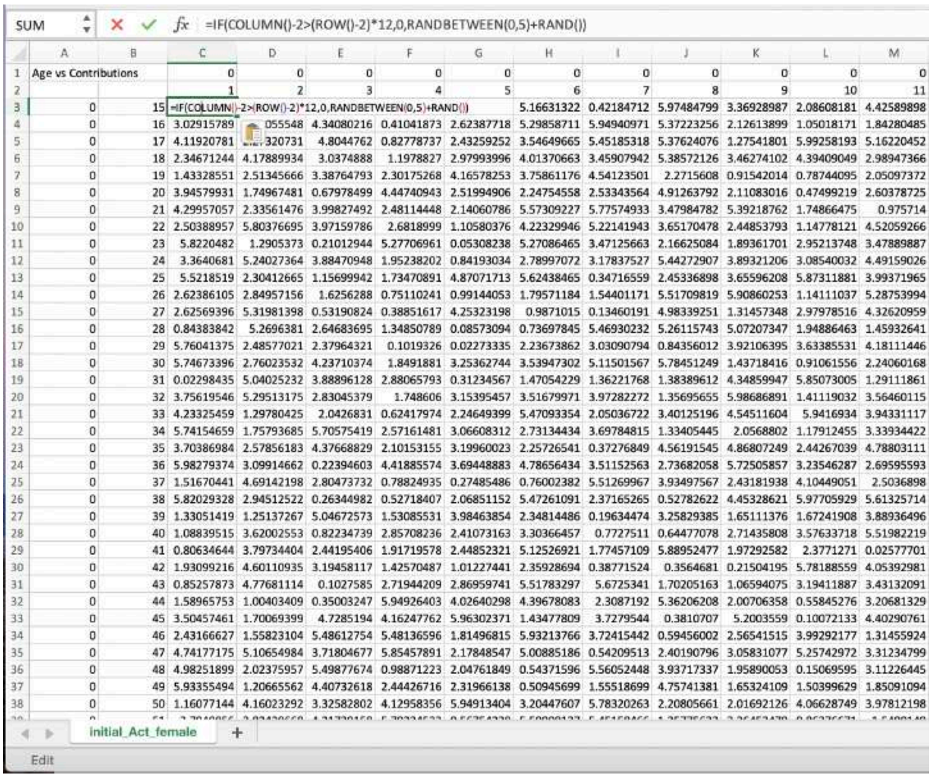


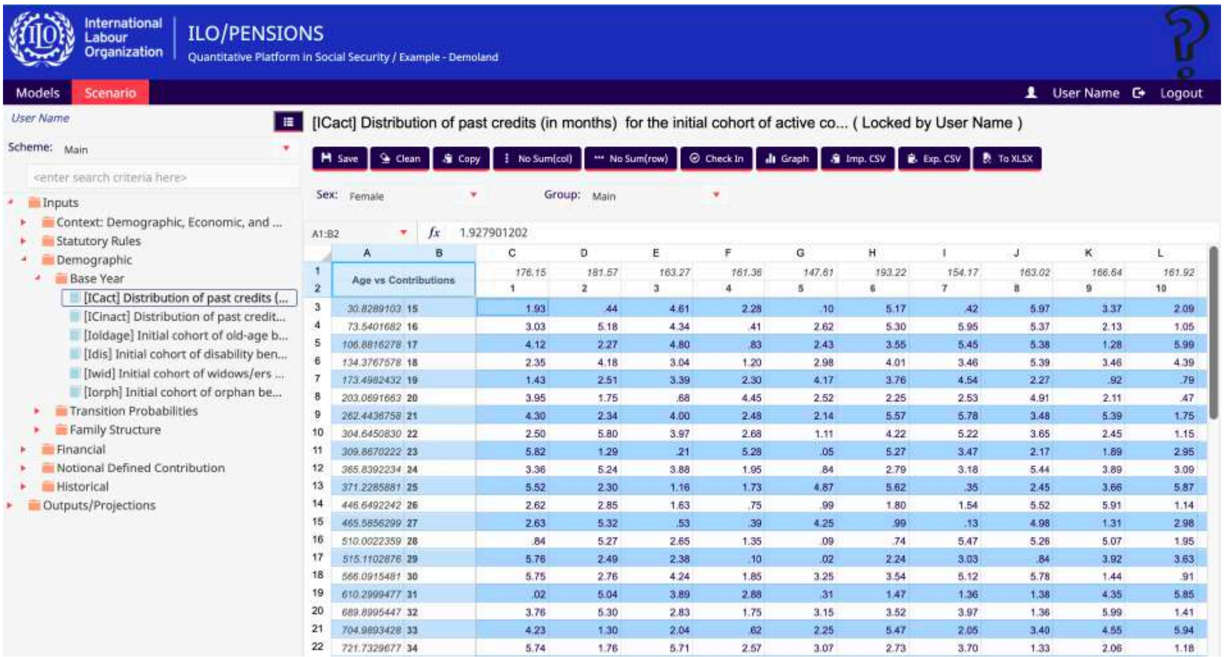


6.5. Creating a copy for an alternative scenario

Once users have explored the model, they can prepare an alternative scenario. For variety, initial active population can be added in the model. Users can add a randomly generated initial active population. To do this, they should export the [ICact] as csv, save it as initial_Act_male.csv, and write and copy the following formula in the whole range =IF(COLUMN()-2>(ROW()-2)*12,0,RANDBETWEEN(0,5)+RAND()), save, import and do the same for the female population (this will produce different random values).







Fill in the [Isal] matrices with the same values as [ITsal] and run the model. Study the new outputs.

6.6. ILO/PENSIONS cheat sheet

The table below summarizes the commands available to users in ILO/PENSIONS, how to use them and what they can be used for.

Function Name	Purpose	Method
Check Out	Enables user to make changes to a given matrix (worksheet?)	Check Out
Check In	Saves changes to the worksheet, enables other users to make changes to the matrix	Check In
Undo Check Out	Sign out of a matrix without saving any changes	Undo Check Out. Available until users select Save.
Save	Saves all changes made to a checked-out matrix	Save
Hide/Show Sums	To hide or show a row or column that displays the sum of values in that row/column	Hide/Show accordingly (purely aesthetic; does not remove the row/column)
Copy using menu	Copy values of a given row or column to a set number of rows or columns that follow, or to the end of the respective row/column	Use the menu to copy a row or column. Select "Number of copies" to specify how many times to duplicate the value. Check the "Copy to the end" box to copy to the end.
Copy using Ctrl+C	Allows users to copy information from a cell/row/column to another one of exactly the same size	Ctrl+C (Cmd+C on Mac)
Paste	Allows user to copy information from a cell/row/column to another one of exactly the same size	Ctrl+V (Cmd+V on Mac)
Clean	Erase all information written in a matrix	Clean
Export as CSV/XLS	Export matrix as csv/xls file	Exp. CSV/XLS
Import as CSV	Imports a csv file into a given matrix	Imp. CSV and select the desired file to upload from the file browser. Imported file dimensions must match the matrix dimensions, and the imported file must be in csv.
"+" sign on right bottom corner of a cell	Allows users to copy information from a given cell to the next row/column (one at a time).	Hover over the cell until the + sign appears on the bottom right corner. Hold and drag down or to the right to copy information. This can be used for a numeric value or a formula.

7. Consistency review

This section is for:

- *Practitioners/Users of ILO/PENSIONS, especially those consulting results, conducting consistency reviews and writing reports*

In this section, users will learn:

- *How to carry out a consistency review of demographic projections*
- *How to carry out a consistency review of financial projections*

Users are advised to use tools for graphing indicators to better analyse trends according to different dimensions: sex, age, type of risk pension, salaries, pension amounts and relative structures, among others.

7.1. Review of demographic results

7.1.1. Projection of active and inactive contributors according to labour force size:

a) Verify that the number of active and inactive contributors by sex and the total are consistent with the projections of the labour force by year and sex. It is advisable to use the country's official population projection. Remember that the active contributors are residents of a country that belong to the labour force. Some sectors of inactive contributors may migrate, meaning that in some cases, contributors can exceed the country population for certain ages. When this happens for certain age groups, proof that migration has caused the excess is required.

b) Check for consistency with historical trends: compare the growth trend for the projection period with the one of the previous years and justify any significant changes. Be careful to first classify the last years of historical data as: average for the scheme or otherwise, over- or underperforming in terms of affiliation. Especially in overperforming periods, do not assume a lasting overperforming trend for the projection.

7.1.2. Projection of pension beneficiaries:

a) **By sex, type of pension and total.** This is expected to show a smooth upward trend; otherwise, the analysis should explain deviations from the trend. Some explanations include effects of significant affiliation increases in the past, transitional generations between pension reforms or scheme maturity.

b) **Relative distribution of new pensioners by sex, type of pension (risk) and total.** It is normal that as a pension system matures and the affiliated population ages, the proportion of new old-age pensioners to new disability pensioners and new surviving pensioners gradually increases. Some possible exceptions occur when extremely stringent requirements are established for retirement and many people try to retire through disability.

c) **Relative distribution of pensioners by sex, type of pension (risk) and total.** It is expected that as the proportion of new old-age pensioners relative to other pension types increases, the proportion of total old-age pensioners will also increase in relation to disability pensioners and survivors. If this expected situation does not occur and the proportion of pensioners in relation to other pensioners remains relatively constant over time, it is likely that a relatively stable demographic state has been reached, or that the pension scheme being assesses is already mature.

d) **Demographic dependency ratio (number of contributors/pensioners) by sex and year.** It is expected that if the pension system is maturing, this indicator will gradually decrease and, as it approaches a stable demographic state, will tend to stabilize.

e) **Change in average past credit (average number of accumulated contributions) by sex, age and total.** This must be consistent with the conditions of contribution density in the pension scheme.

7.1.3. Check changes in the following indicators, which should be consistent with the assumptions by population group, sex and year of projection:

a) Labour force coverage rate, total and by sex: active contributors/labour force ratio.

b) Coverage rate of the working age population by sex: ratio of active contributors to the working age population.

c) Rate of coverage of contributors by sex: total ratio of contributors/working age population.

d) Effective coverage rate of the population aged 65 and over: pensioners aged 65 and over as a percentage of the population aged 65 and over, total and by sex.

e) Effective coverage rate of the population aged 60 and over: pensioners aged 60 and over, as a percentage of the population aged 60 and over, total and by sex.

f) Average age of total active contributors, by sex.

g) Average age of total elderly pensioners, by sex.

h) Average age of new contributors, by sex.

i) Average age of new old-age pensioners, by sex.

j) Average age of new disabled pensioners by sex.

k) Average age of new widow(er) pensioners by sex.

l) Average age of orphan pensioners by sex.

7.2. Review of financial results

7.2.1. PAYG Rate (benefit cost as a percentage of insurable earnings)

a) The PAYG rate by sex, type of pension and total is expected to show a smooth upward trend; otherwise, the analysis should explain the reasons for the trend.[50]

b) Verify that the PAYG rate tends to stabilize over the long term. The point at which it stabilizes must be consistent with the demographic projection, whose structure by age and sex also stabilizes in the long term.

7.2.2. GDP growth, wages and pension amounts

There must be consistency over time between the assumptions on GDP growth, the rate of wage increase (which is theoretically linked to long-term labour productivity trends), the rate of adjustment of pension amounts and the inflation rate.

7.2.3. Replacement rate (average pension/average salary)

This is a crucial indicator as it represents a measure of benefit adequacy. Replacement rates can be measured in different ways: by sex, by type of pension (risk), for new pensioners/all pensioners, etc. Three basic metrics that should be considered are:

a) Ratio of average amount of pension/average insurable earnings;

b) Average pension amount of new pensioners/reference wage for pension calculation (as defined by national regulations); and

c) Average pension of new pensioners/average insurable earnings.

7.2.4. Check changes the following indicators, which should be consistent with the assumptions by sex and year of projection:

a) Average insurable earnings, total and by sex.

b) Annual growth rate of the average insurable earnings, total and by sex.

c) Average amount of old-age pension by sex.

d) Average amount of the disability pension by sex.

e) Average amount of widow(er) pension by sex.

[50] For this and all other indicators, when an unexpected behaviour occurs, users should attempt to analyse the indicator and isolate the sources of the inconsistencies. For example, an increase in the PAYG rate, a year for which the PAYG rate is higher than both the previous and following years may be result of an increase in the total cost for that year, a sudden decrease in the salary in the same year or both. Determining whether the reason is cost or salary related can save time in the consistency check.

f) Average amount of orphan pension by sex.

g) Average rate of growth of old-age pension amounts by sex.

h) Average rate of growth of disability pension amounts, by sex.

i) Average rate of growth of widow(er) pension amounts, by sex.

j) Average growth rate of orphan pension amounts, by sex.

k) Annual administrative expenditure as a percentage of annual expenditure on pension benefits.

l) Expenditure on pension benefits as a percentage of GDP.

m) Total scheme expenditure as a percentage of GDP.

n) Reserve ratio (accumulated reserve / previous year's expenditure).

o) General average premium.

Annex 1: List of variables in ILO/PENSIONS

Category	Reference	Description
Inputs		
Context: Demographic, Economic, and Labour Market		
Demographic and Labour Market		
1	NATPOP	National population (s,t).
2	POP65OVER	Population aged 65 and over (s,t).
3	POP60OVER	Population aged 60 and over (s,t).
4	Partr	Labour force participation rate (s,t).
5	POPACT	
6	unemrate	Unemployment rate (s,t).
7	cov	Coverage rate as a percentage of the employed labour force (s,g,t).
Economic		
8	IGDP	Gross Domestic Product for the initial year (t).
9	gdp	GDP growth rate (t).
10	gex	Government expenditure as a percentage of GDP (t).
11	inf	Inflation rate past and future (t).
12	i_rate	Interest rate (t).
Statutory Rules		
Contribution Rate		
13	crg	Contribution rate (g,t).
Eligibility Conditions		
Retirement Conditions		
14	xminret	Minimum possible age to be entitled to an old-age pension (s,t).
15	cret	Number of contributions a person aged x needs to be entitled to an old-age pension (s,x,t).
16	clsret	Minimum number of contributions to be entitled to a retirement lump sum benefit (s,t).
Disability Conditions		
17	cdis	Minimum number of contributions to be entitled to a disability pension (s,t).
18	clsdis	Minimum number of contributions to be entitled to a disability lump sum benefit (s,t).
Survivors Conditions		

Category	Reference	Description
19	cdeath	Minimum number of contributions to be entitled to a survivor's pension (s,t).
20	clsdeath	Minimum number of contributions to be entitled to a survivor's lump sum benefit (s,t).
Benefit Formulas		
Old-age pension formula		
21	crefret	Number of periods (months) used as reference for old-age pension calculation (t).
22	maxretpen	Maximum old-age pension amount (t).
23	minretpen	Minimum old-age pension amount (t).
24	flatret	Flat amount component of the old-age benefit (t).
25	aret	Basic replacement rate for old-age pension as a percentage of the reference salary (t).
26	bret	Accrual rate old-age pension, additional replacement rate per contribution period (t).
27	ctret	Threshold of contributions for additional replacement rate for old-age pension (t).
Disability pension formula		
28	crefdis	Number of periods (Months) used as a reference for the disability pension calculation (t).
29	maxdispen	Maximum disability pension amount (t).
30	mindispen	Minimum disability pension amount (t).
31	flatdis	Flat amount component of the disability pension benefit (t).
32	adis	Basic replacement rate for disability pension, as a percentage of the reference salary (t).
33	bdis	Accrual rate disability pension, additional replacement rate per contribution period for disability (t).
34	ctdis	Threshold of contributions for the additional replacement rate for disability pension (t).
Survivors' Pension Formula		
35	crefdeath	Number of periods (months) used as a reference for the survivor`s pension calculation (t).
36	maxsurvpen	Maximum survivorship pension amount (t).
37	minsurvpen	Minimum survivorship pension amount (t).
38	flatsurv	Flat amount component of the survivors' benefit (t).

Category	Reference	Description
39	asurv	Basic replacement rate for survivorship, as a percentage of reference salary (t).
40	bsurv	Accrual rate survivorship pension. Additional replacement rate per contribution period for survivorship (t).
41	ctsurv	Threshold of contributions for additional replacement rate for survivorship (t).
42	widp	Proportion of total survivor pension allocated to the widow(er) (t).
43	orphp	Proportion of total survivor pension allocated to each orphan (t).
	Lump sum benefits formulas	
44	zret	Lump sum benefit per contribution period as a percentage of the reference salary for old age (t).
45	zdis	Lump sum benefit per contribution period as a percentage of the reference salary for disability (t).
46	zsurv	Lump sum benefit per contribution period as a percentage of the reference salary for survivorship (t).
	Demographic	
	Base Year	
47	ICact	Distribution of past credits (in months) for the initial cohort of active contributors (s,g,x,c).
48	ICinact	Distribution of past credits (in months) for the initial cohort of inactive contributors (s,x,c).
49	Ioldage	Initial cohort of old-age beneficiaries (s,x).
50	Idis	Initial cohort of disability beneficiaries (s,x).
51	Iwid	Initial cohort of widow/er beneficiaries (s,x).
52	Iorph	Initial cohort of orphan beneficiaries (s,x).
	Transition Probabilities	
53	q	Probability of death for active members (s,g,x,t).
54	qd	Probability of death for a disability pensioner (s,x,t).
55	qi	Probability of death for an inactive contributor or an old-age pensioner (s,x,t).
56	qw	Probability of death (including other reasons for exit such as marriage) for a widow(er) (s,x,t).
57	qo	Probability of death (including other reasons for exit such as reaching the age of majority, usually 18) for an orphan (s,x,t).
58	ir	Probability of incapacitating disability (s,g,x,t).
59	er	Probability of leaving the active contributing population for any reason but death, retirement or disability (s,g,x,t).
60	rp	Probability that a given entry in a group has a past history of contributions (s,g,x,t).

Category	Reference	Description
61	f	Distribution of the total entries per age (s,g,x,t).
62	ret	Probability of taking retirement once active contributors meet retirement conditions (s,g,x,t).
63	reti	Probability of taking retirement once inactive contributors meet retirement conditions (s,x,t).
	Family Structure	
64	fwid	Expected number of surviving spouses after the death of an active contributor (s,g,x,y).
65	forph	Expected number of surviving children after the death of an active contributor (s,g,x,y).
66	fwidi	Expected number of surviving spouses after the death of an inactive member (s,x,y).
67	forphi	Expected number of surviving children after the death of an inactive contributor (s,x,y).
	Financial	
	Base Year	
68	IRES	Pension fund reserve in the initial year (t).
69	Isal	Average salary of initial contributors (s,g,x).
70	ITsal	Initial theoretical salary curve (s,g,x).
71	Ioldage_b en	Average pension benefit for the initial cohort of old-age pension beneficiaries (s,x).
72	Idis_ben	Average pension benefit for the initial cohort of disability pension beneficiaries (s,x).
73	Iwid_ben	Average pensions benefit for the initial cohort of widow(er) pension beneficiaries (s,x).
74	Iorph_ben	Average pensions benefit for the initial cohort of orphan pension beneficiaries (s,x).
	Financial Assumptions	
75	asg	Salary growth rate assumption (g,t).
76	adjben	Benefit adjustment rate (t).
77	Admt	Administrative expenditure as a percentage of the total benefit expenditure (t).
78	OI	Other revenue (t).
79	OE	Other expenditure (t).
	Notional Defined Contributions	
80	IBIA	Initial balance of individual account for active contributors (s,g,x,c).
81	IBIAI	Initial balance of individual account for inactive contributors (s,x,c).
82	r	Notional rate of return (t).

Category	Reference	Description
83	qndc	Official mortality table for NDC scheme (s,x,t).
84	i	Notional rate of discount for annuities (t).
	Historical	
	Historical Demographic	
85	HTP	Total national population (s,t).
86	HWEP	Working age population (s,t).
87	HLF	Employed labour force (s,t).
88	HRAP60	Population aged 60 and over (s,t).
89	HRAP65	Population aged 65 and over (s,t).
90	HAC	Total active contributors (t).
91	HActCont _0A65ra	Ratio of active contributors/retired people aged 65 and over(t).
92	HOAP	Old-age pensioners by sex (s,t).
93	HDISP	Disability pensioners by sex (s,t).
94	HWP	Widow(er) pensioners by sex (s,t).
95	HORP	Orphan pensioners by sex (s,t).
	Historical Financial	
96	HMS	Historical minimum salary (t).
97	HIN_SAL av	Average insured earnings/total average salary by sex (s,t).
98	HOAEXP	Expenditure on old age by sex (s,t).
99	HDISEXP	Expenditure on disability by sex (s,t).
100	HWIEXP	Expenditure on widow(er)s by sex (s,t).
101	HOREXP	Expenditure on orphans by sex (s,t).
102	HOA_Pav	Average old-age pension by sex (s,t).
103	HDIS_Pav	Average disability pension by sex (s,t).
104	HWI_Pav	Average widow(er) pension by sex (s,t).
105	HOR_Pav	Average orphan pension by sex(s,t).
106	HAdm	Administrative expenses (t).
107	HTRev	Total revenue (t).
108	HContRev	Total contributions revenue (t).
109	HIntRev	Interest revenue (t).
110	HRev_Go vTrans	Revenue from government transfers (t).
111	HOI	Other revenue (t).

Category	Reference	Description
112	HOE	Other expenses (t).
113	BS_ContExp	Balance sheet on contributions and expenditures: revenue minus expenditures on contributions (t).
114	TBS_RevExp	Total balance sheet: total revenue minus total expenditures (t).
	Outputs/Projections	
	Context Demographic, Economic and Labour Market	
115	LF	Labour force by sex (s,t).
116	PGDP	Gross Domestic Product (t).
117	PGEX	Government Expenditure (t).
	Contributors	
	Active Contributors	
118	Tact	Total number of active contributors by sex and population group (s,g,t).
119	actgx	Total number of active contributors by sex, population group and age (s,g,x,t).
120	actgxc	Active contributors by sex, population group, age and number of contributions (s,g,t,x,c).
121	survact	Active survivors to death, disability and other exits by sex, population group and age (s,g,x,t).
122	survsurvactg	Active survivors to death, disability and retirement by population group (s,g,t).
123	survsurvactgx	Active survivors to death, disability, exit and retirement by age (s,g,x,t).
124	sact	Active survivors to death, disability and other exits by sex, population group, age and contributions (s,g,t,x,c).
125	ssact	Active survivors to death, disability, other exits and retirement by sex, population group, age and contributions (s,g,t,x,c).
126	csact	Number of average contributions from active members by sex, population group and age (s,g,x,t).
	Entries to Active Contributors	
127	entg	Entries of contributors by sex and population group (s,g,t).
128	nent	Entries of new contributors without past periods of contribution by sex and population group (s,g,t).
129	entgx	Entries of contributors by sex, population group and age (s,g,x,t).
130	rent	Re-entries of contributors with past contribution periods by sex, population group and age (s,g,x,t).
131	nentx	Entries of new contributors without past periods of contribution by sex, population group and age (s,g,x,t).
132	cent	Number of contributions from entries by sex, population group and age (s,g,x,t).

Category	Reference	Description
	Inactive Contributors	
133	inactx	Inactive contributors by sex, and age (s,x,t).
134	inactxc	Inactive contributors by sex, age and contributions (s,t,x,c).
135	survinact	Inactive survivors to death and disability by sex and age (s,x,t).
136	survsurvinact	Inactive survivors to death, disability and retirement by sex and age (s,x,t).
137	sinact	Inactive survivors to death and disability by sex, age and contributions (s,t,x,c).
138	ssinact	Inactive survivors to death, disability and retirement by sex, age and contributions (s,t,x,c).
139	csinact	Number of contributions from inactive members by sex and age (s,x,t).
Beneficiaries		
	Old-age Pension Beneficiaries	
	Total Old-age Pension Beneficiaries	
140	oldage	Number of old-age pensioners by sex and age (s,x,t).
141	survoldage	Old-age pension survivors by sex and age (s,x,t).
	New Old-age Pension Beneficiaries	
142	nret	New old-age beneficiaries by sex (s,t).
143	nretx	New old-age beneficiaries by sex and age (s,x,t).
144	nretfact	New old-age beneficiaries coming from active by sex (s,t).
145	nretfinact	New old-age beneficiaries coming from inactive by sex (s,t).
146	nretfactx	New old-age beneficiaries coming from active by sex and age (s,x,t).
147	nretfactgx	New old-age beneficiaries coming from active by sex, population group and age (s,g,x,t).
148	nretfinactx	New old-age beneficiaries coming from inactive by sex and age (s,t,x).
149	nretfactgxc	New old-age beneficiaries coming from active by sex, population group, age and contributions (s,g,t,x,c).
150	nretfinactxc	New retirees from inactive by sex, age and contributions (s,t,x,c).
	Disability Pension Beneficiaries	
	Total Disability Pension Beneficiaries	
151	dis	Disability pensioners by sex and age (s,x,t).
152	survdis	Disability survivors by sex and age (s,x,t).
	New Disability Pension Beneficiaries	
153	ndisx	New disability pensioners by sex and age (s,x,t).

Category	Reference	Description
154	ndisgxc	New disability pensioners by sex, age, population group and contributions (s,g,t,x,c).
	Widows/ers Pension Beneficiaries	
	Total Widow(er)s Pension Beneficiaries	
155	wid	Widow(er)s pensioners by sex and age (s,x,t).
156	survwid	Widow(er)s survivors by sex and age (s,x,t).
	New Widow(er) s Pension Beneficiaries	
157	nwidactgx	New widow(er)s caused by the death of an active member by sex, age and population group (s,g,x,t)
158	nwidpenx	New widow(er)s caused by the death of pensioners by sex and age (s,x,t).
159	nwidactgx c	New widow(er)s caused by the death of active members by sex, age, population group and contributions (s,g,t,x,c).
	Orphan Pension Beneficiaries	
	Total Orphan Pension Beneficiaries	
160	orph	Orphans' pensions by sex and age (s,x,t).
161	survorph	Surviving orphans by sex and age (s,x,t).
	New Orphan Pension Beneficiaries	
162	norphacts gx	New orphans caused by the death of active members by sex, population group and age (s,g,x,t).
163	norphpen x	New orphans caused by the death of pensioners by age (x,t).
164	norphpen sx	New orphans caused by the death of pensioners by sex and age (s,x,t).
165	norphactg xc	New orphans caused by the death of active members by age, population group and contributions (g,t,x,c).
166	norphacts gxc	New orphans caused by the death of active members by sex, population group, age and contributions (s,g,t,x,c).
	Lump sum Benefits	
167	ls_oldage	Number of retirement lump sum benefits by sex (s,t).
168	ls_dis	Number of disability lump sum benefits by sex and age (s,x,t).
169	ls_death	Number of death lump sum benefits by sex and age (s,x,t).
	Salaries, Salary Mass and Contribution Rate	
170	sal	Average salary by sex, age and population group (s,g,x,t).
171	SALg	Salary mass by sex and population group (s,g,t).
172	SALM	Total salary mass by sex (s,t).
173	Tsal	Salary curve by sex, age and population group (s,g,x,t).

Category	Reference	Description
174	cr	Contribution rate (t).
	Benefit Averages and Expenditure	
	Average Benefit Amounts	
175	oldage_ben	Average old-age pension benefit by sex and age (s,x,t).
176	dis_ben	Average disability pension benefit by sex and age (s,x,t).
177	wid_ben	Average widows pension benefit by sex and age (s,x,t).
178	orph_ben	Average orphans' pension benefit by sex and age (s,x,t).
	Total Benefit Expenditure	
179	TOldAge	Total expenditure on old-age pension benefits by sex and age (s,x,t).
180	TDis	Total expenditure on disability pension benefit by sex and age (s,x,t).
181	TWid	Total expenditure on widows pension benefit by sex and age (s,x,t).
182	TOrph	Total expenditure on orphans' pension benefit by sex and age (s,x,t).
	Average Amount of New Benefits	
183	noldage_ben	Average new old-age benefits coming from active contributors by sex, population group, age and contributions (s,g,t,x,c).
184	ndis_ben	Average benefit of new disability pensions by sex, population group, age and contribution (s,g,t,x,c).
185	inact_oldage_ben	Average benefit of new old-age pensions coming from inactive contributors by sex, age and contributions (s,t,x,c).
186	nwidact_ben	Average benefit of new widow(er) pensions caused by the death of active contributors by sex, population group and age (s,g,x,t).
187	nwidpen_ben	Average benefit of new widow(er) pensions caused by the death of pensioners by sex and age (s,x,t).
188	norphact_ben	Average benefit of new orphan pensions caused by the death of active contributors by population group and age (g,x,t).
189	norphpen_ben	Average benefit of new orphans caused by the death of pensioners beneficiaries by age (x,t).
	Reference Salaries for Pension Calculations	
190	gngen	Growth rate of new generations for reference salary calculation (s,g,t).
191	crefdise	Number of past contribution periods (months) effectively used as a reference for calculating disability pensions (t,c).
192	crefdeathe	Number of past contribution periods (months) effectively used as a reference for calculating survivors' pensions (t,c).
193	yrefret	Number of years of reference salary to calculate the reference salary adjusted by ex-post density for old age (s,g,t,x,c).
194	yrefdis	Number of years of reference salary to calculate the reference salary adjusted by ex-post density for disability (s,g,t,x,c).

Category	Reference	Description
195	yrefdeath	Number of years of reference salary to calculate the reference salary adjusted by ex-post density for survivors' pensions (s,g,t,x,c).
196	salrefret	Reference salary for the calculation of old-age pensions (s,g,t,x,c).
197	salrefdis	Reference salary for the calculation of disability pensions (s,g,t,x,c).
198	salrefdeath	Reference salary for the calculation of survivors' pensions (s,g,t,x,c).
199	WRefpenvect	Reference benefit for pensions as a consequence of death (s,g,x,t).
	Lump Sums Amounts	
200	ls_oldage_ben	Total retirement lump sum benefit by sex (s,t).
201	ls_dis_ben	Total disability lump sum benefit by sex and age (s,x,t).
202	ls_death_ben	Total death lump sum benefit by sex and age (s,x,t).
	Notional Defined Contributions	
203	BIA	Average balance on individual account (s,g,t,x,c).
204	BIAI	Balance of individual account for inactive contributors (s,t,x,c).
205	refannact	Reference annuity for active contributors (s,g,t,x,c).
206	refanninact	Reference annuity for inactive contributors (s,g,t,x,c).
207	aa	Present value of a unit life annuity at year t (s,x,t).
208	pk	Probability of living up to age kx (s,t,x,k).
	Indicators	
	Demographic Indicators	
	Coverage	
209	AC_LFcr	Labour force coverage rate, total and by sex (active contributors / labour force) (s,t).
210	AC_WAcr	Coverage rate of the working-age population (active contributors / working-age population), by sex (s,t).
211	TA_WAcr	Coverage rate of affiliated members (total affiliated members / working age population), by sex (s,t).
212	PEN_RAP65cr	Effective coverage rate of population aged 65 and over, by sex (s,t).
213	PEN_RAP60cr	Effective coverage rate of population aged 60 and over, by sex (s,t).
	Average Age	
214	ACaa	Average age of total active contributors by sex (s,t).
215	TPaa	Average age of total pensioners by sex (s,t).

Category	Reference	Description
216	NCaa	Average age of new contributors by sex (s,t).
217	N_OAaa	Average age of new old-age pensioners by sex (s,t).
218	N_DISaa	Average age of new disability pensioners by sex (s,t).
219	N_WIaa	Average age of new widows/er pensioners by sex (s,t).
220	N_ORaa	Average age of new orphan pensions by sex (s,t).
	Financial Indicators	
	Average Amounts	
221	IN_SALav	Average insurable earnings by sex (s,t).
222	OA_Pav	Average old-age pension amount by sex (s,t).
223	DIS_Pav	Average disability pension amount by sex (s,t).
224	WI_Pav	Average widows/er pension amount by sex (s,t).
225	OR_Pav	Average orphan pension amount by sex (s,t).
	Growth Rates	
226	A_IN_SAL avgr	Annual growth rate of the average insurable earnings by sex (s,t).
227	A_OA_Pg r	Benefit growth rate of the average old-age pension by sex (s,t).
228	A_DIS_Pg r	Benefit growth rate of the average disability pension by sex (s,t).
229	A_WI_Pgr	Benefit growth rate of the average widow(er) pension by sex (s,t).
230	A_OR_Pg r	Benefit growth rate of the average orphan pension by sex (s,t).
	Expenditure Ratios	
231	adm	Administrative expenditure as a percentage of the total expenditure (t).
232	PEN_EXP _GDP	Expenditure on pension benefits as a percentage of GDP (t).
233	T_EXP_G DP	Total expenditure as a percentage of GDP (t).
	Total Expenditure	
234	BE	Total benefit expenditure (t).
235	TPB	Total pension benefit expenditure (s,t).
236	TLS	Total lump sum expenditure (s,t).
237	BEs	Total expenditure in benefits (s,t).
	Financial Results	
238	GAP	General average premium (t).
239	RES	Reserve fund balance (t).

Category	Reference	Description
240	RES_RT	Reserve ratio (t).
	Optimizations	
241	entgxXrp	Accumulate on entgx x rp (s,g,x,t).
242	SUMentgx Xrp	Accumulate on SUM(g, entgx x rp) (s,x,t).
243	tmp_42	Accumulate on equation 42 (s,g,x,t).
244	SUMtmp_ 42	Summarization of tmp_42 (s,x,t).
245	tmpasgPl usOne	Accumulate on asg (t).
246	tmpcsact_ csinact	csact + csinact (s,g,x,t).
247	tmpcsact_ csinact_c ent	csact + csinact + cent (s,g,x,t).
248	tmp56	Tmp 56 on active contributors (s,g,t,x,c).
249	tmpsact	tmp sum on sact(s,g,t,x).
	Report matrixes	
250	RPT_MD AT_B	Employed labour force (s,t)
251	RPT_MD AT_C	Active contributors (s,t)
252	RPT_MD AT_D	Beneficiaries of a retirement pension (s,t) [6]
253	RPT_MD AT_E	Beneficiaries of a invalidity pension (s,t)
254	RPT_MD AT_F	Beneficiaries of a widows pension (s,t)
255	RPT_MD AT_G	Beneficiaries of an orphans pension (s,t)
256	RPT_MD AT_H	Total pension beneficiaries (s,t)
257	RPT_MD AT_I	Lump sum beneficiaries of retirement pensions (s,t)
258	RPT_MD AT_J	Lump sum beneficiaries of disability pensions (s,t)
259	RPT_MD AT_K	Lump sum beneficiaries of death pensions (s,t)
260	RPT_MD AT_L	Lump sum beneficiaries of total pensions (s,t)

Category	Reference	Description
261	RPT_MFAT_B	Salary mass (s,t)
262	RPT_MFAT_C	Revenues contributions (s,t)
263	RPT_MFAT_D	Revenues interest (t)
264	RPT_MFAT_E	Revenues other (t)
265	RPT_MFAT_F	Revenues total (t)
266	RPT_MFAT_G	Expenditure benefits old age (s,t)
267	RPT_MFAT_H	Expenditure benefits disability (s,t)
268	RPT_MFAT_I	Expenditure benefits widow(er) (s,t)
269	RPT_MFAT_J	Expenditure benefits orphan (s,t)
270	RPT_MFAT_K	Expenditure benefits lump sum (s,t)
271	RPT_MFAT_L	Expenditure benefits total (s,t)
272	RPT_MFAT_M	Expenditure administration (t)
273	RPT_MFAT_N	Expenditure others (s,t)
274	RPT_MFAT_O	Expenditure total (t)
275	RPT_MFAT_P	Result (t)
276	RPT_MFAT_Q	PAYG rate (t)
277	RPT_MFAT_R	Reserve (t)
278	RPT_MFAT_S	Reserve coefficient (t)
279	RPT_MFAPG_B	Salary mass (s,t)
280	RPT_MFAPG_C	Revenues contributions (s,t)
281	RPT_MFAPG_D	Revenues interest (s,t)

Category	Reference	Description
282	RPT_MFAPG_E	Revenues other (s,t)
283	RPT_MFAPG_F	Revenues total (s,t)
284	RPT_MFAPG_G	Expenditure benefits old age (s,t)
285	RPT_MFAPG_H	Expenditure benefits disability (s,t)
286	RPT_MFAPG_I	Expenditure benefits widow(er) (s,t)
287	RPT_MFAPG_J	Expenditure benefits orphan (s,t)
288	RPT_MFAPG_K	Expenditure benefits lump sum (s,t)
289	RPT_MFAPG_L	Expenditure benefits total (s,t)
290	RPT_MFAPG_M	Expenditure administration (s,t)
291	RPT_MFAPG_N	Expenditure others (s,t)
292	RPT_MFAPG_O	Expenditure total (s,t)
293	RPT_MFAPG_P	Result (s,t)
294	RPT_MFAPG_R	Reserve (s,t)
295	RPT_MAT_B	Average salary (s,t)
296	RPT_MAT_C	Average pension retirement (s,t)
297	RPT_MAT_D	Average pension disability (s,t)
298	RPT_MAT_E	Average pension widow(er) (s,t)
299	RPT_MAT_F	Average pension orphan (s,t)
300	RPT_MAT_G	Average lump sum retirement (s,t)
301	RPT_MAT_H	Average lump sum disability (s,t)
302	RPT_MAT_I	Average lump sum survivors (s,t)

Category	Reference	Description
	Aggregated Reports/Tables	
303	RPT_MDAT	Main demographic aggregates table
304	RPT_MFAT	Main financial aggregates table
305	RPT_MFAPG	Main financial aggregates as a percentage of GDP table
306	RPT_MAT	Main financial averages table

Annex 2: Data request for conducting an actuarial valuation for a pension scheme

Along with the list of variables in Annex I, this document provides the data required to conduct an actuarial valuation in a sample country. All items [in brackets] can be tailored to the country context.

The document is organized into the following sections:

1. Laws, Regulations and Amendments
2. Financial Statements
3. General Data
4. Scheme-Specific Data

Note that this document sets out the initial set of data requirements based on the ILO's current knowledge and understanding of the regulations and laws in [x country]. Therefore, based on future discussions and depending on any amendments to the laws in force on the valuation date, the ILO reserves the right to request further information if necessary.

Finally, as provided for in the agreement between the ILO and [partner organization] (hereby referred to as 'the Agreement'), all information obtained by the ILO during project activities, including reports and data provided to the ILO by [national pension institution], shall be kept confidential and shall not be divulged by the ILO to any third party. The ILO will ensure that this provision of the Agreement is included in all agreements entered into with subcontractors and consultants.

1. Laws, Regulations and Amendments

1.1 For the purposes of the actuarial valuation as of [Date], the ILO will require the most recent version of the [most recent Pension Scheme Name, Year], related amendments to that law, as well as corresponding statutes, decrees and regulations.

Moreover, the ILO will require:

1.2 A copy of every draft law, if any, that is currently under review.

1.3 A summary of social security provisions.

1.4 A copy of any previous actuarial valuations performed.

1.5 Any other documentation that details the scheme or previous valuations, or that may otherwise be considered relevant.

2. Financial Statements

2.1 The ILO would like to have access to the following documents for the past 10 years:

a. Annual reports and (audited) financial statements;

b. Investment policy and guidelines;

c. Consolidated investment return achieved by pension fund;

d. Investment return achieved by different main asset class;

e. A breakdown of the invested (and non-invested) assets;

f. Target long-term investment return as per the investment policy; and

g. ALM studies or any other investment-related studies.

2.2 If the benefit expenditure and contribution income are not disaggregated in the (audited) financial statements by type of expenditure/income, the ILO would like additional details on the following expenditure/income items:

- **Expenditures**
  - Expenditure on pensions by risk: Old-age, disability and survivors;
  - Expenditure on lump sums by risk: Old-age, disability and survivors;
  - Administrative expenditure by governance level (federal, regional and local) and by main function (enrolment, collection of contributions, claims processing, others); and
  - Other expenditure categories (if any).
- **Revenues from contributions and other income**
  - Contributions from mandatory contributors separate from employers and from employees (defined benefits scheme in the case of pensions);
  - If possible: Contributions from voluntarily participants;
  - Transfers/subsidies from the government (breakdown of transfers for specific groups, if applicable);
  - Revenue from financial investments (including from the reserve fund);
  - Transfers from other national or international organizations and foreign governments, entities or individuals;
  - Penalties on late contributions; and

- Other income (if any).

3. General Data

3.1 General demographic data

Demographic data	Details
- National Population data	- Population by age and sex - Historical series for the past 20 years - Official projections for the next 20 years
- Historical information on total fertility rates (20 years)	- Total fertility rates and fertility rates by age
- Historical information on migration rates (20 years)	- Net migration rates by age and sex
- Historical information on mortality rates and life expectancy (20 years)	- Mortality rates by age and sex (infant mortality rates, under-5 mortality rates and mortality rates for other age groups) - Life expectancy by sex
- Assumptions used in population projections	- Assumptions on fertility rates, migration rates, mortality rates and life expectancy
- Any other population/housing census and statistics	

3.2 Labour force and general economic data

Labour market and economic data	Details
- Historical and projected information on labour force	- Labour force and employed population by status in employment (employees, employers and self-employed workers, by age and sex (last 10 years and projected for the next 20 years) -
- Labour force participation rates	- Labour force participation rates by age and sex (last 10 years and projected for the next 20 years)
- Historical information for the self-employed	- Self-employed population by age and sex
- Historical information on wages or income	- Average wage or average earnings by sex - Wage growth rate (real and nominal) - Wage share of GDP

- Historical information on inflation rates (10 years)	- Inflation rates: (CPI and GDP deflator rates by year)
- Historical information on GDP (10 years)	- Nominal GDP by year - Real GDP by year - Real GDP growth rate by year
- Historical information on market interest rate (10 years)	- Interest rate by year (lending rate or bank rate that usually meets the short- and medium-term financing needs of the private sector)

4. Scheme-Specific Data

4.1 Covered population (active contributors and insured population)

Active contributors and insured population	Details
- Coverage rates over the employed labour force (10 years)	- Active contributors† as a percentage of the employed labour force, by population group and sex
- Information on active contributors (10 years)*	- Number of active contributors, by population group, by sex and age
- Information on family dependants of active contributors (10 years)*	- Historical number of family dependants, by population group covered, sex and age

*Note: For non-contributory/fully subsidized schemes, provide the listed information for all registered members (with a disaggregation between the principal insured and dependants if this distinction exists in the scheme).

†Note: ‘Active contributors’ refers to those who have made at least one monthly contribution over the past 12 months. If the national definition or calculation is based on a different definition, this should be stated so that appropriate adjustments can be made.

4.2 Expenditure and revenue

Expenditure (historical)	Details
- Expenditure on pension benefits	- Expenditure on pension benefits by type of benefit (old age, disability, window/ers and orphans) and population group (10 years)
- Administrative expenses	- Administrative expenses (10 years)
- Expenditure on other cash benefits	- Expenditure on other cash benefits by population group and sex (10 years)

Revenue (historical)	Details
- Contributory salary/income*	- Average contributory salary or income by sex (10 years) If the scheme applies a standard lump sum amount for contributions (i.e., not based on salary or income), provide the amount
- Total revenue	- Total revenue by population group (10 years)
- Revenue from social contributions	- Contribution revenue from employers (10 years) - Contribution revenue from wage-earners (10 years) - Contribution revenue from other groups (10 years) such as self-employed workers, voluntary registered contributors, etc.
- Revenue from investments (10 years)	- Nominal rate of return on investments of the reserve fund of the social security scheme by type of financial instrument - Real rate of return on investments of the reserve fund of the social security scheme, by type of instrument - Revenue from investment of the reserve fund by type of financial instrument
- Government transfers/taxes	- Revenue from government transfers (10 years)
- Balance sheet on contributions	- Balance sheet on contributions and expenditure: revenue minus expenditure on contributions (10 years)
- Balance sheet total	- Total balance sheet: total revenue minus total expenditure (10 years)
- Reserve fund (if any)	- Reserve fund balance (10 years)

*Note: This information should be provided even for schemes that receive government subsidies to individual contributions based on income levels.

4.3 Data on contributors and beneficiaries

The following data on benefits for at least 60 months is required to carry out the actuarial valuation. Provide these data in an encrypted format if possible, with the same encryption method used across all files.

Employers (as applicable):

- Unique ID number (encrypted)
- Sector (according to internal classification – public, private, or other category)

Contributions (all contributions in the period):

- Month
- Year
- ID of employee (encrypted)

- ID of employer (encrypted)
- Salary / income amount
- Contribution amount
- Transfer amount from government (if applicable)

[†]The provision of pension information is crucial to this exercise. If pension information cannot be provided, this should be stated so that appropriate calculations can be made.

Contributors (active and inactive):

- ID of contributor (encrypted)
- ID of employer (encrypted)
- Sex
- Birthdate
- Marital status (optional)
- Date of employment (optional)
- Date of first contribution (optional)
- Date of latest contribution

Beneficiaries (if available. If not, please provide microdata from labour survey or census):

- ID of beneficiary (encrypted)
- ID of main contributor (encrypted)
- Birth date of beneficiary
- Sex of beneficiary
- Relation to main contributor
- Start date of the benefit (optional)

Pension benefit payments:

- Year of payment
- Month of payment
- Payment amount
- Type of pension (detailed classification)
- ID of the beneficiary (encrypted)
- ID of the cause of benefit (for survivors) (encrypted)

Family structure:

- ID of contributor and/or beneficiary (encrypted)
- ID of family member (encrypted)
- Relationship to contributor and/or beneficiary (encrypted)
- Age of family member (encrypted)

Annex 3: Notional Defined Contributions

ILO/PENSIONS allows users to model notional defined contributions (NDC) schemes as an alternative to the modelling of defined benefit schemes. This appendix explains how to set up and use ILO/PENSIONS applied to NDC schemes.

The NDC model (also referred to as the PAYG DC model) is a variant of the individual savings account model to introduce a closer link between contributions and benefits.[51] In terms of financing, the NDC model is based on the PAYG model. Resources from contributions are used to finance pension benefits to those currently retired. The main difference with the individual savings accounts schemes is that with the NDC scheme, an individual notional (virtual or unfunded) account is established for each contributor. The virtual account is typically credited without any actual funds being deposited.

Therefore, in the NDC scheme, the pension formula is constituted of an annuity applied to the virtual or notional individual account balance instead of being calculated as an explicit replacement rate over a reference salary. A NDC scheme is also different from an individual savings accounts scheme in that the individual account balance used for the calculation of the annuity is simply an accounting figure and not an actual account.

Implications of these differences are:

a) No real fund is behind the individual accounts;

b) The funding mechanism of a NDC is based on PAYG;

c) The accumulated balance of the individual accounts is capitalised using a theoretical rate of return or interest (the “notional return rate”); and

d) The annuity or pension benefit is calculated based on the theoretical balance of the individual account at the time of retirement, using a theoretical discount rate (the “notional discount rate”).

Modelling a NDC scheme in ILO/PENSIONS:

The modelling of a NDC scheme has four steps that use specific matrices for the purposes of the ILO/PENSIONS NDC module, and is linked to processes already designed for the case of defined benefits:

[51] Where PAYG DC refers to pay-as-you-go defined contributions schemes.

1. Projection of the individual account balances (theoretical or virtual ones) for active and inactive contributors: Recognition of previous balances and their notional return rate and the addition of "new funds" in the balances from current contributions;
2. Calculation of annuity factors in line with the official life expectancy table and the notional discount rate;
3. Calculation of the annuities for new pension beneficiaries; and
4. Application of maximum and minimum pension limits to the annuities to estimate the value of the new pensions.

If users select the option "Notional Defined Contributions" while defining a scheme in ILO/PENSIONS, the required inputs will change.

First, many of the matrices in the navigation tree (Inputs->Statutory Rules->Benefit Formula) will no longer need to be completed. The exceptions are all flat components, and maximum and minimum pensions.

If users select the NDC option, they must complete five new matrices (the rest of the inputs remain the same as in the case of defined benefits):

- Two matrices with the time dimension only:
  - [r] Notional rate of return that will be applied to the individual account balances; and
  - [i] Notional rate of discount for calculation of annuities.
- Two matrices with the sex dimension:
  - [IBIA] Initial balance of individual account for active contributors that requires the average balance of Individual accounts for workers of a given age and accrued number of contributions; and
  - [IBIAI] Initial balance of individual account for inactive contributors, which requires equivalent information for inactive contributors.
- The final variable has both time and sex dimensions:
  - [qndc] the official mortality table for the NDC scheme to be used in the calculation of annuities.

Six intermediate result matrices are outputs exclusively for NDC schemes:

- [pk] Survival probability;
- [aa] Annuity factor;
- [BIA] Projected balances on individual accounts for every age and accrued contribution number for the whole projection period for active contributors;

- [BIAI] Projected balances on individual accounts for every age and accrued contribution number for the whole projection period for inactive contributors;
- [refannact] Projected reference annuity for every age and accrued contribution number for the whole projection period for active contributors; and
- [refanninact] Projected reference annuity for every age and accrued contribution number for the whole projection period for inactive contributors.

All outputs from a non-NDC implementation of the model will be calculated as well, using only reference annuity values as a substitute for the result of the pension formula.

References

ILO Social Security Conventions and Recommendations

C102 – Social Security (Minimum Standards) Convention, 1952 (No. 102)

C128 – Invalidity, Old-Age and Survivors' Benefits Convention, 1967 (No. 128)

C130 – Medical Care and Sickness Benefits Convention, 1969 (No. 130)

R202 – Social Protection Floors Recommendation, 2012 (No. 202)

Publications

Cichon, M.; Scholz, W.; Van de Meerendonk, A.; Hagemejer, K.; Bertranou, F.; and Plamondon, P. 2004. *Financing Social Protection*. Quantitative Methods in Social Protection Series. ILO.

IAA (International Actuarial Association). 2002. *IAA International Standards of Actuarial Practice (ISAP) 1 and 2 – Actuarial Practice for Social Security Programs and Financial Analysis of Social Security Programs.* Adopted by Council of the International Actuarial Association (IAA), October 21, 2002 - Effective January 1, 2003.

ISSA (International Social Security Association); ILO. 2016. *Guidelines on Actuarial Work for Social Security*.

Iyer, S. 1999. *Actuarial Mathematics of Social Security Pensions*. ILO.

Plamondon, P.; Drouin, A.; Binet, G.; Cichon, M.; McGillivray, W.; Bédard, M.; and Pérez-Montas, H. 2002. *Actuarial Practice in Social Security.* ILO.