
The ILO Pension Model

A Technical Guide

**Public Finance, Actuarial and Statistics Unit
Social Protection Department
International Labour Office, Geneva**

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Preface

The ILO Pension Model (ILO-PENS) is a computer-based pension projection and simulation tool developed by the Social Protection Department. It aims to assist users with the design and costing of new pension schemes and to provide information on the expected financial impact of parametric changes to existing schemes. This technical guide explains the methodology and process flow that drive ILO-PENS and also serves as a reference manual for users.

In general, our technical guides and models are made available to experts in ILO constituent countries as part of our technical cooperation and quantitative training activities. The users of ILO-PENS and the technical guide are expected to be qualified quantitative experts who have substantial experience in social protection and are conversant with standard software packages, including Excel.

ILO-PENS and the technical guide can also be used as a teaching aid for specific training in social security quantitative techniques. The textbook series Quantitative Methods in Social Protection, jointly published by the ILO and the International Social Security Association (see References for further details), complements this technical guide by outlining the methodological concepts underlying ILO-PENS.

Our tools are subject to constant development and improvement. Whenever there are major technical improvements, we will issue new versions of ILO-PENS and the supporting technical guide. These updates will be issued via our web page indicated on the copyright page.

For any requests for further information as well as to provide user feedback, please feel free to contact us at socpro@ilo.org.

Geneva, March 2018

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The ILO Pension Model: Summary

1. Scope

The ILO Pension Model (ILO-PENS) is a projection model used for the actuarial valuation of pension schemes. It provides actuarial estimates of future expenditure and required contributions, with reference to the various associated financing systems. ILO-PENS constitutes a component of the ILO family of quantitative financial analysis models and tools, which have the objective of providing comprehensive support for the compilation, integrity-checking and processing of source data. The models and tools further aid the actuarial valuation and costing simulation of national social security programmes in a consistent manner under various national economic circumstances.

The valuation outputs of ILO-PENS contribute to fiscal planning by national governments with respect to their social security obligations and the selection of appropriate financing mechanisms.

2. Main features

Methodology

ILO-PENS estimates the future cost of financing pension benefits on the basis of the cohort decomposition method. It projects, on a year-by-year basis, the evolving statuses that a participating member can attain (active contribution, death, invalidity, withdrawal, retirement, etc.) and their probabilities, as well as the associated pension profile values (i.e. average salary, average pension). The assumptions and probabilities that support these projections are informed by the scheme-specific demographic and financial profile. To the extent possible, distributions are considered for crucial variables such as accrued credit and income levels of the scheme members. ILO-PENS has the capacity to be adjusted to unique national and/or scheme-specific contexts, thus yielding tailored projection outputs.

Software

ILO-PENS operates in Windows Excel. The core projection engine of the model is written in Visual Basic for Applications (VBA).

File structure

The Excel file structure consists of:

- Input files and input-making files;
- Projection files;
- Output files and base files;
- Long-term account files.

3. Data requirements

Base data

These include:

- Statistical and economic structure of the pensioner and contributor populations in the base year;
- Observation of evolving scheme experience with respect to benefit amounts, insurable earnings and biometric data.

Demographic and economic assumptions

These include:

- Outputs of relevant ILO models (population model, labour-force model, economic model, wage-distribution model) or equivalent data;
- Estimation of the insured population based on labour market forecasts.

4. Results

Key outputs

These include:

- Total amount of insurable earnings and number of contributors;
- Total amount of benefit expenditure and number of pensioners;
- Projected income/expenditure statements;
- Contribution rates based on alternative financing systems.

Detailed outputs

These results are disaggregated by:

- Group (sex, category);
- Age;
- Categories of benefits (newly awarded or total in payment).

Part I. Introduction

1. Actuarial valuations and models

The financial management of a pension scheme on the basis of a sound long-term financial perspective is crucial for ensuring its ongoing sustainability. Periodic actuarial valuations and the assessment of the expected impact of proposed pension reforms are means of providing such a long-term financial perspective for pension scheme managers and planners.

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 by using models.

The ILO pension model (ILO-PENS) has been developed to support actuarial reviews or studies of statutory social security pension schemes. It helps to provide a quantitative basis for making policy decisions with respect to social security pension schemes. ILO-PENS also enables:

- (i) projections of future benefit expenditure and the contributions base through year-by-year simulations;
- (ii) determination of future contribution rates under alternative financing methods;
- (iii) simulation of the development of the reserves of the scheme;
- (iv) assessment of the financial impact of reforms of the pension scheme;
- (v) identification of the factors to be considered when creating the required fiscal space.

The ILO has developed and applied computer-based pension models since the early 1970s. While these models have evolved over this period, their underlying mathematical frame has changed only marginally. With the advent of more powerful PCs and associated data-management software, there have been major technical improvements in the dynamism and robustness of pension models.

Technological and methodological improvement

As a result of these technological advancements, ILO-PENS has become more robust and user-friendly. The projection model has been structured in a modularized form in order to provide maximum transparency of the process flow. The calculation procedures are automated to assist the user in accomplishing the modelling outcomes. Local experts are now better able to use ILO-PENS independently and to apply it to various scenarios to inform pension-scheme benefit-design and financing options.

By introducing the distribution of past credits and income levels, the degree of disaggregation of the simulation has been extended considerably. The execution time of the programme model has also improved, allowing for faster generation of valuation outcomes. In addition, there are more possibilities for integration and dynamic linking with different applications. It must be noted, however, that the ultimate responsibility for results and the quality of data lies with the user.

2. The ILO actuarial model family

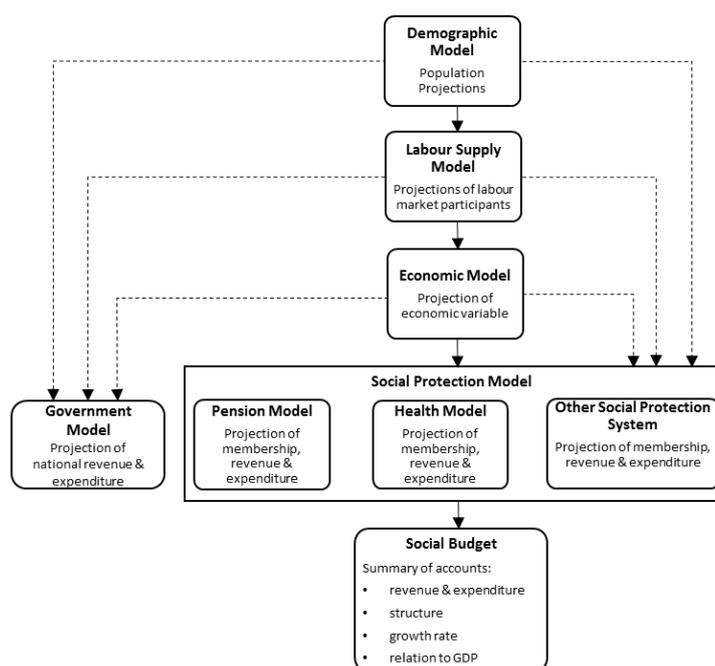
A social security pension scheme constitutes a part of each country’s socio-economic and political system and functions within a national economic environment; it is therefore dependent on the national demographic and economic context. ILO-PENS, as a part of the ILO actuarial model family, aims to provide an integrated and comprehensive set of quantitative tools to forecast national social security pension expenditure and financing requirements.

The ILO actuarial model family consists of three major structural elements: a social budget model, a pension model and a health-care model. Each element can be applied either as a stand-alone model or as part of an interconnected modelling network. The social budget model projects and simulates the expenditure and income of comprehensive national social protection systems (ILO-SOCBUD), while the pension (ILO-PENS) and health-care (ILO-HEALTH) models project the income and expenditure of individual social protection subsystems. There are also ancillary models which generate alternative wage (ILO-DIST) and national population (ILO-POP) distributions, which can be used to provide inputs to the structural models.

The ILO-SOCBUD structural element consists of four submodels. The labour force submodel (ILO-LAB) and the economic submodel (ILO-ECO) generate employment and earnings data projections. The employment and earnings data is then utilized by the social expenditure submodel ILO-SOC to project major social protection expenditures (pensions, health, etc.). The ILO-GOV submodel subsequently aggregates the functional social protection expenditures into the government and institutional accounts of the social security system.

ILO-PENS and ILO-HEALTH require inputs from the labour force and economic submodels of ILO-SOCBUD and the ancillary models ILO-POP and ILO-DIST or equivalent data from other sources. The interrelationship between the models is shown in I.2.1. With this set of models, it is possible to create a comprehensive view of multiple future scenarios that takes into account the expected evolution of the national population, forecasts of the labour market and macroeconomic indicators in order to generate income and expenditure projections of social security pension and health-care schemes. These pension and health-care projection results can then be aggregated with the cost estimates for other social protection branches to generate an expected national social protection budget account.

Figure I.2.1. Interrelationship of the ILO actuarial model family



3. Main features of the model

The development of the current version of ILO-PENS was motivated by a variety of considerations, including:

- integration of multiple ILO models to provide a comprehensive tool to assess the impact and evolution of social protection schemes within the national economy;
- improvement of projection methodology;
- provision of portable and readily accessible software;
- easier user interface.

Software

The ILO-PENS model operates in the Windows Excel environment. The model uses both Excel spreadsheets and Visual Basic for Applications (VBA) capabilities. The main projection component of the model has been programmed in VBA and integrated into an Excel workbook module. A good knowledge and experience of using Excel is therefore required. Users are expected to have a solid quantitative background, preferably some experience in the financial management of social security schemes and sound programming knowledge.

4. Dissemination of the model

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The copyright of all ILO actuarial models rests with the Public Finance, Actuarial and Statistics (PFACTS) Unit of the Social Protection Department of the ILO. The ILO does not accept any responsibility for projection results which are produced with the help of its software programmes by users who are not ILO staff or ILO experts. Should any requests for further information or software updates arise, users can contact the PFACTS team. The contact details are listed on the copyright page.

Part II. General model structure

Part II of this guide focuses on the methods and model structure of ILO-PENS, while technical details on their application follows in part III.

1. Methods

This chapter explains the mathematical methods underlying the actuarial valuation engine of ILO-PENS. Generally, the actuarial valuation is undertaken in two steps. The first step is to estimate the future expenditure and contribution base of the social protection scheme; the second step is to establish the adequacy of the contribution base and the long-term sustainability of the scheme. Where the scheme is found to be financially unsustainable, the model will yield the recommended contribution rate(s) to bring the scheme to a fully funded state, based on the financial system adopted by the scheme.

1.1. Methods of cost estimation

1.1.1. General

The year-by-year simulation method is generally used to estimate future costs. The basic idea of this method (see figure II.1.1) is to first record the current profile or status of the scheme membership (active persons, inactive persons, pensioners, etc.) and the associated benefit expenditure experience. The evolution of the membership profile is then projected forward on a year-by-year basis by using actuarially assumed transition probabilities (mortality rate, retirement rate, withdrawal rate, rate and profile of new entries, salary increment rate, etc.), against which benefit eligibility conditions and applicable pension formulae are applied to generate annual future expected expenditure. This cycle is repeated until the end of the projection period. By summarizing age-specific results, global future costs are obtained. The basic calculation can be symbolically explained as follows:

$$\begin{aligned} \text{Annual benefit expenditure} &= \text{cost}(\text{death benefits}) + \text{cost}(\text{withdrawal benefits}) \\ &+ \text{cost}(\text{retirement benefits}) + \text{cost}(\text{invalidity benefits}) \end{aligned}$$

For the costing of future benefit expenditure on a year-by-year basis, survival and adjustment factors (derived from the scheme profile) are applied to the current year's expenditure. The total benefit cost of newly awarded pensions (in the current year) are also added to this outcome:

$$\begin{aligned} \text{Next Year's Expenditure} &= (\text{current year's expenditure})(\text{survival rate})(\text{adjustment factor}) \\ &+ (\text{cost of new pensions projected for award next year}) \end{aligned}$$

On the income side, the expected contributions (contribution base) are calculated by multiplying the assumed number of active contributors by the projected average insurable earnings and the scheme contribution collection rate (contribution factor):

$$\text{Contribution base} = (\#\text{contributors}) (\text{average insurable earnings}) (\text{collection factor})$$

The general methodology is explained in more detail in the following sections.

1.1.2. Estimating the covered population

(i) Definitions

The following definitions introduce the various population types applicable to the ILO-PENS model.

Reg(x,t)

The **Registered population** in year t is defined as the persons who are registered in the scheme and have made at least one contribution at any period in the past (contributions are usually made on a monthly basis). Those who have already withdrawn, died or become pensioners are *excluded*.

Act(x,t)

The **Active population** in year t is defined as the persons who have made at least one contribution during the current year t .

Inact(x,t)

The **Inactive population** in year t is defined as the persons who are registered in the scheme but have made no contribution during the current year t .

$$Reg(x,t) = Act(x,t) + Inact(x,t)$$

Cont(x,t)

Contributors in year t is defined as the average number of persons who made full contributions at each contribution period during year t . Generally, the size of the active population will exceed the number of contributors as not all workers will contribute for the entire year t . Thus, we define the “density factor” (commonly referred to as contribution density) as the percentage of the contributors to the active population.

$$Dens(x,t) = Cont(x,t) / Act(x,t)$$

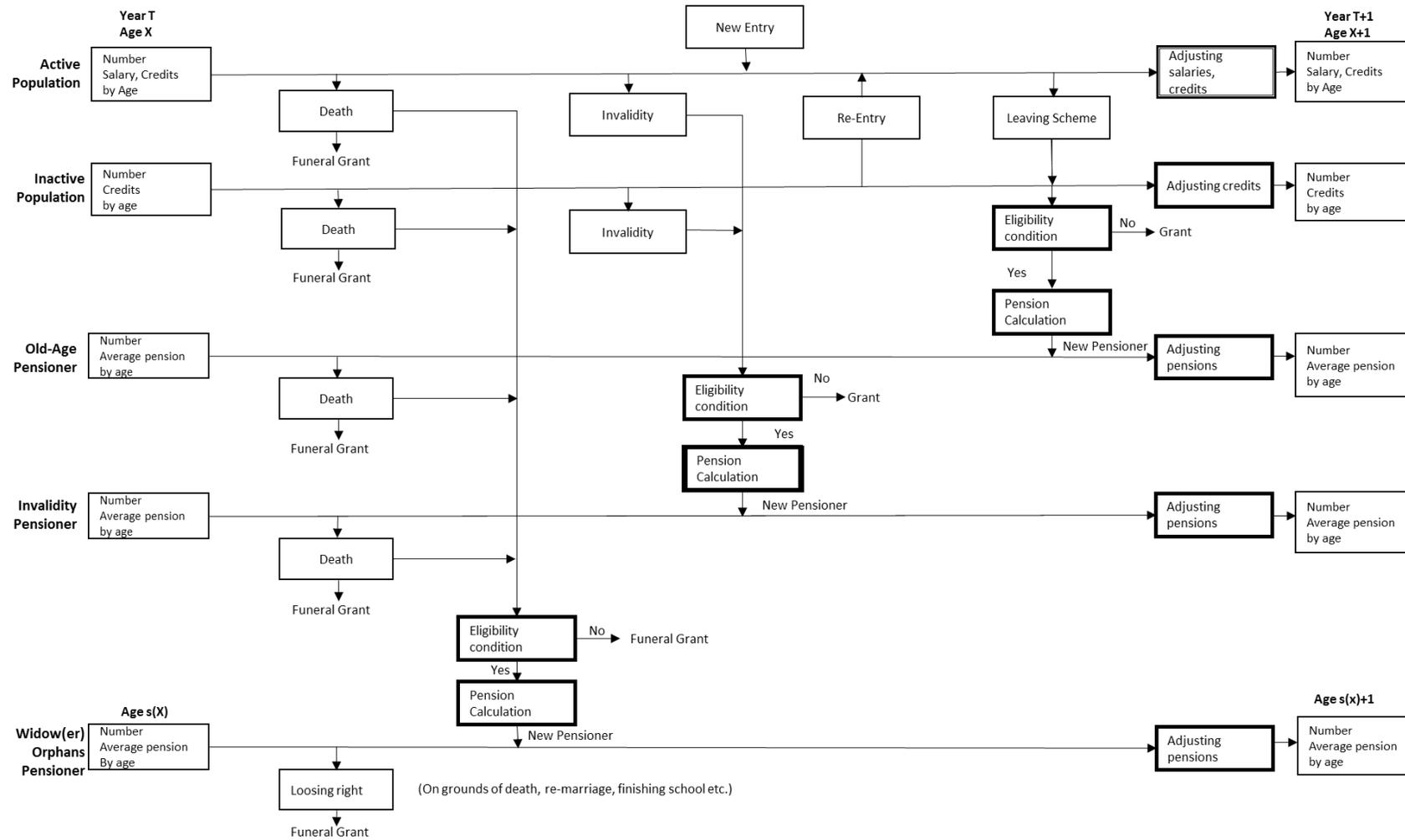
Nent(x,t)

New entrants in year t is defined as the persons who have become newly registered during year t and have also made at least one contribution during the same period.

Rent(x,t)

Re-entrants in year t is defined as the persons who belonged to the inactive population in year $t-1$, as they did not make any contributions during the $t-1$ period, but have since transitioned to the active population in year t , by making at least one contribution during this period t .

Figure II.1.1. Simulation of the pension scheme (conceptual)



(ii) Estimation

The number of the active population [$Act(x,t)$] can be estimated by multiplying the projected base population [$Pop(x,t)$] by the coverage rate [$Covrate(x,t)$]. The coverage rate assumptions are developed by taking into account the forecast of the labour force participation rate, the unemployment rate and the observed scheme past experiences. The projected base population can be based on the national population, the labour force population or the employed population, depending on the mandated cover of the social security scheme.¹ Therefore, the estimation of $Act(x,t)$ is given by:

$$Act(x, t) = Covrate(x, t) \cdot Pop(x,t)$$

Where:

$Pop(x,t)$ is the base population in year t

$Covrate(x,t)$ is the coverage rate in year t

To monitor the year-by-year evolution of the membership profile of the social security scheme, we introduce two new definitions, namely $S[Act(x,t)]$ and $D(x+1,t+1)$.

$S[Act(x,t)]$ is defined as the members of $Act(x,t)$ who continue to remain in active population in the following year $t+1$.

Then, $D(x+1,t+1)$ is defined as the difference between the total active population in year $t+1$ and $S[Act(x,t)]$. Typically, $D(x+1,t+1)$ is composed of new entrants and or re-entrants.

$$D(x+1,t+1) = Act(x+1,t+1) - S[Act(x,t)]$$

As shown in figure II.1.2, one of the following two cases (case (a) and case (b)) may occur.

Case (a): $D(x+1,t+1) \geq 0$

This is usually the case when the scheme is relatively young and therefore has a growing active population. In this case, the difference is made up of either new entrants or re-entrants. We therefore introduce a new variable $NR(x,t)$, which is the percentage of new entrants into the scheme.

The number of new entrants at year $t+1$ is therefore calculated as follows:

$$Nent(x+1,t+1) = NR(x+1,t+1) \cdot D(x+1,t+1)$$

The number of re-entrants at year $t+1$ is calculated as follows:

$$Rent(x+1,t+1) = [1-NR(x+1,t+1)] \cdot D(x+1,t+1)$$

To ensure the continued validity of the formula above, there is a need to reference it against the evidenced number of inactive persons. In case there are not enough inactive persons to become re-entrants, i.e. $S[Inact(x,t)] < Rent(x+1,t+1)$, then $Act(x+1,t+1)$ would need to be adjusted (reduced) so that it allows for the maximum possible number of re-entrants against evidenced data.

¹ The current version of ILO-PENS projects the number of active contributors by using a cohort approach in a stand-alone worksheet.

Where $S[Inact(x,t)]$ is defined as the number of $Inact(x,t)$ who continue to remain in the inactive population in the following year $t+1$.

At the same time, $[Act(k,t+1); k < x+1]$ would need to be readjusted so that the total number of active population remains the same, consistent with evidenced data.

Case (b): $D(x+1,t+1) < 0$

Usually, this occurs in more mature social security schemes, where the rate of new entrants is minimal. In this case, $D(x+1,t+1)$ is regarded as the inactive population.

Thus, we can estimate the number of active population, new entrants and re-entrants of the following year. The registered population, inactive population and contributors are estimated as follows:

$$Reg(x+1,t+1) = S[Reg(x,t)] + Nent(x+1,t+1)$$

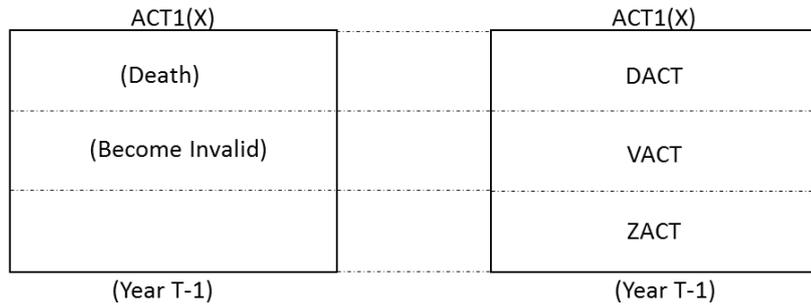
$$Inact(x+1,t+1) = Reg(x+1,t+1) - Act(x+1,t+1)$$

$$Cont(x+1,t+1) = Act(x+1,t+1) \cdot Dens(x+1,t+1)$$

Where $S[Reg(x,t)]$ is defined as the number of $Reg(x,t)$ who continue to remain part of the registered population in the following year $t+1$.

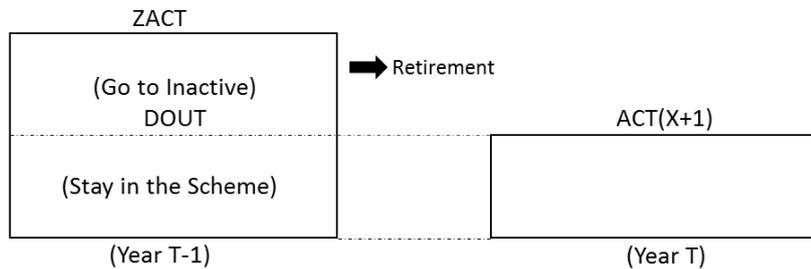
Figure II.1.2. Transition of active and inactive population

STEP 1: (module: Projection())

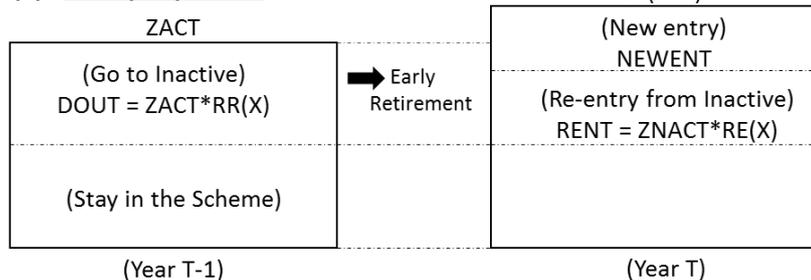


STEP 2: (module: InsIns())

(a) If $ACT(X+1) < ZACT$



(b) If $ACT(X+1) > ZACT$



1.1.3. Transition from active to pensioners (demographic part)

With reference to figure II.1.2, the transition from active (or inactive) to pensioners is simulated by using transition probabilities:

Where VACT is defined as the number of persons who become invalid during year t .

$$VACT = Act(x,t) \cdot Invrate(x,t)$$

Where DACT is defined as the number of persons who become deceased during year t .

$$DACT = Act(x,t) \cdot Mort(x,t)$$

Where DOUT is defined as the number of persons who become inactive during year t .

$$DOUT = Act(x,t) \cdot Inactiverate(x,t)$$

Where RACT is defined as the number of persons who retire during year t .²

$$RACT = Act(x,t) \cdot Retrate(x,t)$$

ZACT is defined as $S[Act(x,t)]$, which is the members of $Act(x,t)$ who continue to remain in the active population in the following year $t+1$. Therefore:

$$ZACT = S[Act(x,t)] = Act(x,t) - VACT - DACT - RACT$$

Then, $Npens\#(x+1,t+1)$ is defined as the number of new pensioners at $t+1$ and is calculated as:

$$NPens\#(x+1,t+1) = NINV\#(x+1,t+1) + NRET\#(x+1,t+1) + NSURV\#(s(x),t+1)$$

Where:

$$NINV\#(x+1,t+1) = VACT,$$

$$NRET\#(x+1,t+1) = RACT, \text{ and}$$

$NSURV\#(s(x),t+1)$ is the number of survivor pensioners (note that survivors also occur on the death of pensioners). This is calculated by a subroutine in ILO-PENS.

1.1.4. Transition from active to pensioners (financial part)

In a defined-benefit social security scheme, the pension benefits for new pensioners are calculated by using the acquired credit and assumed past salary. The newly awarded pensions are estimated by applying the pension eligibility conditions and associated transition probabilities and the applicable pension formula to all subgroups of the active and inactive population by credit and salary (as well as their correlation).

The active and inactive populations can also be classified by accrued past credits and by income level. In the ILO-PENS simulation, the credit distribution is constructed by taking account of the inflow of contributions paid in that year by the active members $ZACT\$(x+1,t+1)$, as well as the outflow of benefits paid out in that year to pensioners

² In the practical application of ILO-PENS, the retirement rates are programmed as a subset of those who transition to become inactive, i.e. $RACT = DOUT \cdot Retrate(x,t)$.

$NRET\$(x+1,t+1)$, invalidity beneficiaries $NINV\$(x+1,t+1)$ and survivor pensions $NSURV\$(x+1,t+1)$.

$ZACT\$(x+1,t+1)$ Inflow of contributions from active members

$NRET\$(x+1,t+1)$ Amount of retirement benefit expenditure outflows

$NINV\$(x+1,t+1)$ Amount of invalidity retirement benefit expenditure outflows

$NSURV\$(x+1,t+1)$ Amount of survivor retirement benefit expenditure outflows

At the same time, the credit which has been translated into benefits should be deducted from the active person's cumulated past credits.

1.1.5. Transition from active to active

If an active worker stays active one year, then the accrued credit will increase by the contributed period.

For defined-benefit schemes, the credit is calculated as follows:

$$Cred(x+1,t+1) = Cred(x,t) + Dens(x,t)$$

Where:

$$Cred(x,t) = \text{average acquired credit}$$

For defined-contribution schemes, the credit is calculated as follows:

$$Bal(x+1,t+1) = Bal(x,t) \cdot [1 + Int(t)] + Contrate(t) \cdot Sal(x,t) \cdot Dens(x,t) \cdot Int(t)/2$$

Where:

$Bal(x,t)$ = Average balance of individual savings accounts (this is used for the valuation of defined-contribution schemes)

$Int(t)$ = Interest rate

$Contrate(t)$ = Contribution rate

$Sal(x,t)$ = Average insurable salary

1.1.6. Transition from pensioners to pensioners

This transition can be simulated as follows:

$$Pens\#(x+1,t+1) = Pens\#(x,t) \cdot [1 - q(x,t)] + NPens\#(x+1,t+1)$$

$$Pens\$(x+1,t+1) = Pens\$(x,t) \cdot [1 - q(x,t)] \cdot [1 + adj(t)] + NPens\$(x+1,t+1)$$

Where:

$Pens\#(x,t)$ = Number of pensioners

$Pens\$(x,t)$ = Amount of pension benefits

$NPens_{(x+1,t+1)}$ = Amount of pension benefits in respect of new pensioners

$q(x,t)$ = probability of death

$adj(t)$ = pension benefit adjustment factor

1.2. Performance indicators and methods of setting long-term contribution rates

1.2.1. Basic equation of the financing model

To determine the long-term contribution rates required to maintain a sustainable social protection system, there is a need to project the future benefit expenditure as well as the contribution base on a year-by-year basis, as well as to assess the continued adequacy thereof.

Let:

F_t : Reserve at the end of year t

I_t : Annual total income in year t (including interest income)

P_t : Annual contribution income in year t (excluding interest income)

R_t : Annual interest income in year t

S_t : Annual expenditure in year t

G_t : Total insurable earnings in year t

p_t : Contribution rate in year t

i_t : Interest rate in year t

Then, the following accounting identities hold:

$$I_t = P_t + R_t$$

$$R_t = (\sqrt{1+i_t} - 1)(P_t - S_t) + i_t F_{t-1}$$

$$F_t = F_{t-1} + I_t - S_t$$

$$P_t = p_t G_t$$

By using the above equations, the fund reserves are simulated on a year-by-year basis.

From these equations, it follows that:

$$F_t = (1+i_t) F_{t-1} + \sqrt{1+i_t} \times (p G_t - S_t)$$

Or:

$$v_t F_t = F_{t-1} + v_t^{1/2} \times (p G_t - S_t)$$

Where:

$$v_t = (1 + i_t)^{-1}$$

This is a recursion formula with respect to F_t ; it describes the evolution of the fund in each year.

It follows that:

$$\bar{G}_t = \sum_{k=1}^t G_k W_k \quad \bar{S}_t = \sum_{k=1}^t S_k W_k$$

and:

$$V_t F_t = V_{n-1} F_{n-1} + p(\bar{G}_t - \bar{G}_{n-1}) - (\bar{S}_t - \bar{S}_{n-1}).$$

Where:

$$V_t = \prod_{k=1}^t v_k \quad W_t = V_{t-1} \times v_t^{1/2}$$

1.2.2. Major financial systems

As previously stated, the continued funding adequacy of the social protection system should be referenced against the pertinent financing/financial system and the applicable contribution rate within that system. This section looks at the different financing systems and the embedded contribution rates.³

(1) Pay-as-you-go

The pay-as-you-go contribution rate is given by:

$$C_t^{PAYG} = \frac{S_t}{G_t}$$

This contribution rate may be expressed as a product of two factors:

$$C_t^{PAYG} = d_t \times r_t$$

Where:

$$d_t = (\text{number of pensioners in year } t) / (\text{number of active contributors in year } t)$$

and d_t is referred to as the “system demographic dependency ratio”

$$r_t = (\text{average pension in year } t) / (\text{average insurable earnings in year } t)$$

and r_t is referred to as the “system replacement ratio”

³ For further details pertinent to this section, see K. Hirose: Topics in quantitative analysis of social protection systems, *Issues in Social Protection Discussion, Paper 6* (Geneva, ILO, 1999).

(2) Level contribution rate

The level contribution rate (or discounted average premium) for the period $[n, m]$ is given:

$$C^{Level}_{[n,m]} = \frac{\bar{S}_m - \bar{S}_{n-1} - \bar{F}_{n-1} V_{n-1}}{G_m - G_{n-1}}$$

To obtain the general average premiums for a specified period, m is adjusted to the end of that period.

(3) Contribution rate keeping target reserve ratio

The contribution rate can be set with respect to expenditure in order to enable the building up of reserves to meet a specified target. This target, referred to as “the reserve ratio” is expressed as:

$$a_t = F_{t-1} / S_t$$

The reserve ratio measures the reserve in terms of annual expenditure. Where the target value of the reserve ratio is given (a_0), the contribution rate under which the reserve ratio attains the target value at the end of the period $[n, m]$ is given by:

$$C(a = a_0; n, m) = \frac{a_0 V_{m-1} S_m - V_{n-1} F_{n-1} + (\bar{S}_{m-1} - \bar{S}_{n-1})}{G_{m-1} - G_{n-1}}$$

If we substitute $a_0=0$ in the above equation, we obtain the formula of the Level Premium over the period $[n, m-1]$.

(4) Contribution rate keeping target balance ratio

The contribution rate can also be set to target the maintenance of the funding ratio at a specified level with respect to expenditure. This target, referred to as “the balance ratio” is expressed as:

$$b_t = (S_t - P_t) / R_t$$

This indicator measures the current funding balance of the fund. Where the target value of the balance ratio is given (b_0), the contribution rate under which the balance ratio attains the target value at the end of the period $[n, m]$ is given by:

$$C(b = b_0; n, m) = \frac{(1 + b_0(v_m^{-1/2} - 1)) \times V_m S_m + b_0(1 - v_m) \times (\bar{S}_{m-1} - \bar{S}_{n-1} - V_{n-1} F_{n-1})}{(1 + b_0(v_{msup} - 1/2 - 1)) \times V_m G_m + b_0(1 - v_m) \times (G_{m-1} - \overline{GSUbn - 1})}$$

If we substitute $b_0=1$ in the above formula, we obtain the so-called Thullen’s Scaled Premium, under which the increase in reserve is zero at the end of the period.

2. Model structure

File structure

ILO-PENS consists of the following set of Excel files.

2.1. Input files

Two types of input files need to be prepared. The first type is the economic-demographic file (EconDem.xls), which contains the economic factors and mortality rates. This is a standard file that can be applied to various schemes and their respective populations.

The second type is the N-th group data file (GroupN.xls), which contains the statistical data of a specific group of the covered population. A unique file has to be prepared for each different population.

2.2. Input-making files

If there is insufficient data, the following additional files have been developed to facilitate the preparation of the input data: Covpop.xls, Famstr.xls, Penpop.xls and Credist.xls.

2.3. Projection programme file

The projection programme file is the engine of ILO-PENS. It is the platform on which the long-term cost-estimate projections are conducted.

2.4. Base files

For converting the output text files (.txt) into Excel files (.xls), three framework files have been prepared: RbaseT.xls, RbaseX.xls, RbaseTC.xls.

2.5. Output files (results files)

(i) *Text files*

As direct outputs of the projection programme, four kinds of text results files are generated for each group.

(ii) *Excel files by group*

Next, each text file is converted into an Excel file by using the base files mentioned above.

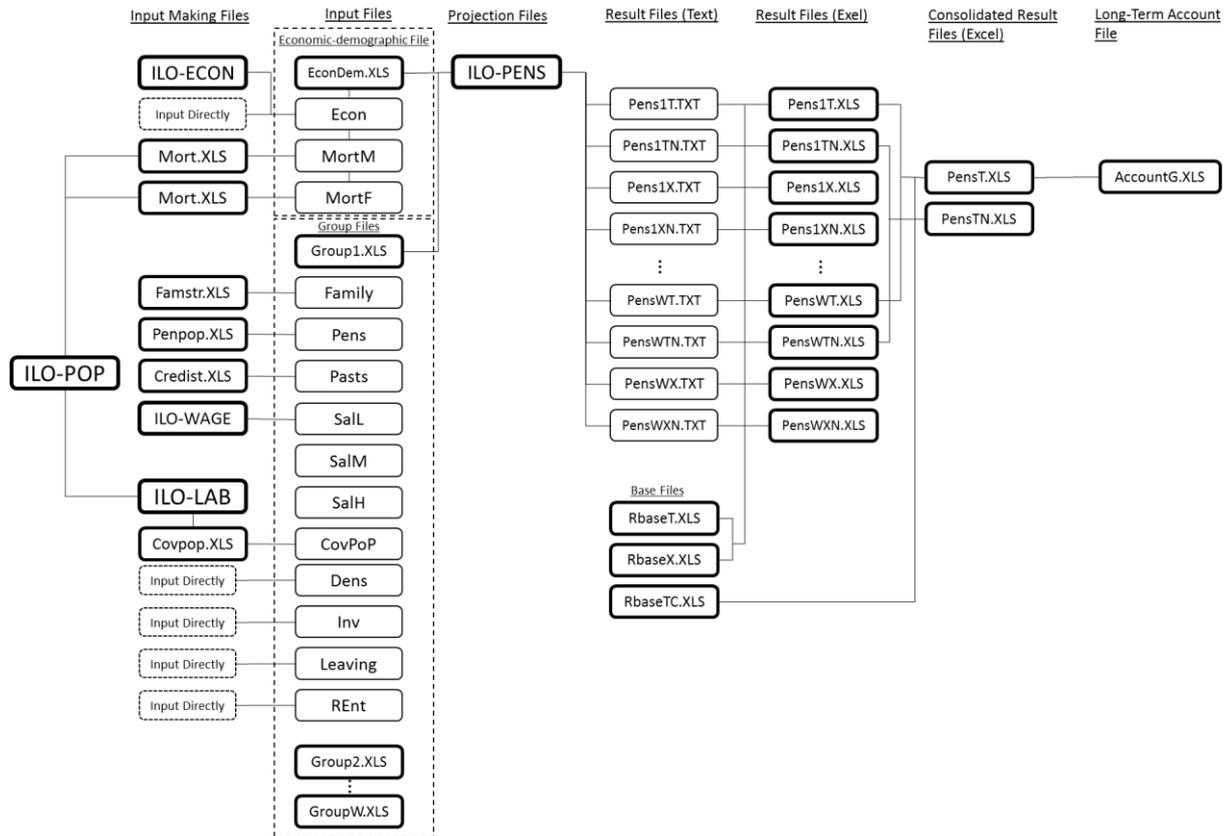
(iii) *Excel file of the total group*

Finally, a single reporting file is created by consolidating all group Excel files.

2.6. Long-term account file

Once the long-term cost-estimate projections are generated (i.e. values of the expenditures and the insurable base), the long-term account file (AccountG.xls) is used to make long-term accounting calculations and to determine the requisite future contribution rate. The interrelationship between these files is shown in figure II.2.1.

Figure II.2.1. General file flow of ILO-PENS



Part III. Technical application

Introductory remarks

Part III of this guide focuses on the technical application of ILO-PENS model. Section 1 (Data requirements) deals with the collection of the required data.

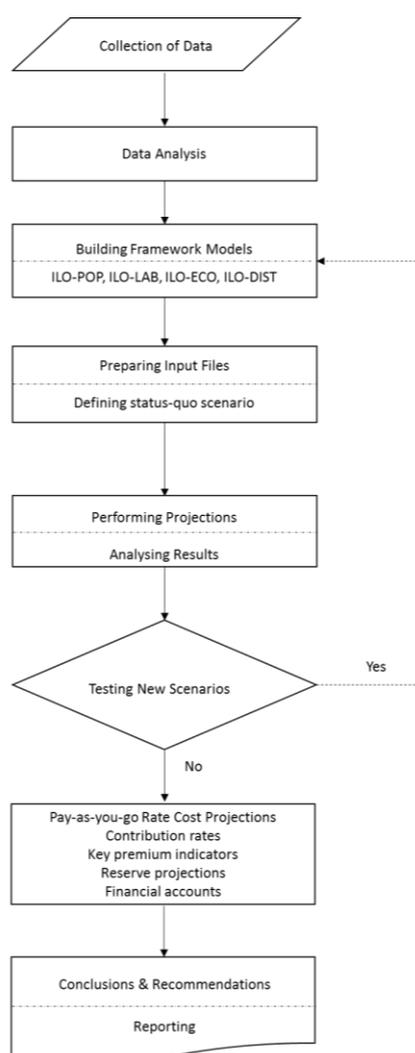
Section 2 (Input preparation) provides guidance on how to analyse the collected data for consistency and how to put it into a format compatible with ILO-PENS. In case of data deficiencies, support files (Covpop.xls, Famstr.xls, Penpop.xls and Credist.xls) can be applied to facilitate the preparation of standardized data.

Section 3 (Projections) explains how to define and generate the parameters of the desired actuarial projections. This section describes the main modules of the projection programme (written in VBA), how to run the projection programme(s) and how modifications can be introduced to consider the impact of various scheme-design and financing scenarios.

Section 4 (Results) deals with the technical aspects of generating output files, while section 5 (Analysis and conclusion) outlines the methodology of results analysis and reporting.

The general workflow of the actuarial valuation using the ILO actuarial model family is shown in figure II.2.2.

Figure II.2.2. General workflow of actuarial valuations



1. Data requirements

The actuarial projections by ILO-PENS require a considerable amount of data input. Data collection is therefore a crucial part of the actuarial valuation exercise. This section presents the statistical and financial data required for the actuarial projections.

1.1. General statistics

There are multiple data sources that can be utilized to provide the required data for ILO-PENS. General population and labour statistics can usually be sourced from national statistical offices. Where the data is not available, is incomplete or is of questionable quality, additional data can be sourced from internationally available general statistical publications. The data sets that can be obtained from such general statistical publications are listed under subheadings (i) to (v) below.

Population and labour statistics data sets are also required for the other models in the ILO actuarial model family, in particular ILO-POP, ILO-LAB and ILO-ECO, which can serve as ancillary inputs to ILO-PENS. When collecting data from general statistical publications, it is recommended to source data in a timed series (past five years or longer); in case no general statistical publication sources are available, other reference publications may be cited.

(i) **Demographic data**

- National population (by sex and age)
- Life table (mortality table, by sex)
- Life expectancy (by sex)
- Total fertility rates (by age group)
- Migration statistics

Reference publications

- United Nations: *World Population Prospects* (biennial)
- United Nations: *The sex and age distribution of world populations* (biennial)
- United Nations: Model Life Tables for Developing Countries (applicable to target population)

(ii) **Labour statistics**

- Economically active population (by sex and age; by sector, if necessary)
- Employed population (by sex and age; by sector, if necessary)
- Unemployment rate (by sex and age)
- Average wage (by sex and age)
- Legal minimum wage

Reference publications

- ILO / World Bank: *Key labor market indicators: Analysis with household survey data*

(iii) Macroeconomic and financial statistics

- Gross domestic product (GDP) and its growth rate (real and nominal)
- Rate of inflation
- Rate of interest
- Government expenditure on social security programmes

Reference publications

- World Bank: *World Development Report* (annual)
- United Nations Development Programme: *Human Development Report* (annual)

(iv) Household/family statistics

- Proportion of the population who are married
- Age difference between husbands and wives
- Average number of children per family
- Age difference between children and parents
- Distribution of income

Reference publications

- National population census and statistical reports (as available)

(v) Forecasts

- Population projections
- Labour force forecast
- Forecast or outlook of macroeconomic indicators
- National development plan (if it exists)

Reference publications

- United Nations: *World Population Prospects* (biennial)
- United Nations: *The sex and age distribution of world populations* (biennial)
- ILO / World Bank: *Key labor market indicators: Analysis with household survey data*

1.2. Scheme-specific data and information

In addition to general national statistics, scheme-specific data and information reflective of the benefit design framework is also necessary. A synopsis of the information required to provide a profile of scheme characteristics is provided under subheadings (i) and (ii) below. This information can be sourced from the legal instruments that guide the operations and benefit entitlements of the scheme, whether in the form of national legislation or scheme rules, via the relevant national institutions and scheme administrators.

(i) Information on legislation

- Pension formula (benefit rate)
- Contribution rate
- Eligibility condition
- Minimum and maximum insurable earnings
- Funeral grant
- Adjustment factor (e.g. in line with wage or consumer price index (CPI))

Reference publications

- United States Social Security Administration: *Social security programs throughout the world* (biennial)

(ii) Data on the scheme

Registered population (total insured population)

- ***Reg(x,t)***: The registered population in year t is defined as the persons who are registered in the scheme and have made at least one contribution at any period in the past (contributions are usually on a monthly basis). Those who have already withdrawn, died or become pensioners are excluded.
- Analysis by category, sex and age, as well as past credits for each subgroup. If possible, the distribution of past credits for each subgroup should also be analysed.

Newly registered persons

- ***Nent(x,t)***: New entrants in year t is defined as the persons who have become newly registered during year t and have also made at least one contribution during the same period.
- Analysis by category, sex and age, as well as average insurable earnings for each subgroup. If possible, the distribution of average insurable earnings for each subgroup should also be analysed.

Active population (current insured population)

- ***Act(x,t)***: The active population in year t is defined as the persons who have made at least one contribution during year t .

-
- Analysis by category, sex and age, as well as average insurable earnings and past credits for each subgroup. If possible, the distribution of average insurable earnings and past credits for each subgroup should also be analysed.

Inactive population (latent insured population)

- ***Inact(x,t)***: The inactive population in year t is defined as the persons who are registered in the scheme but have made no contribution during the current year t .
- Analysis by category, sex and age, as well as past credits for each subgroup. If possible, the distribution of past credits for each subgroup should also be analysed.

Contributors

- ***Cont(x,t)***: Contributors in year t is defined as the average number of the persons who made full contributions at each contribution period during year t .
- Analysis by category, sex and age, as well as average insurable earnings and past credits for each subgroup. If possible, the distributions of average insurable earnings and past credits for each subgroup should also be analysed.

Existing pensioners: (Old-age, invalidity and survivors)

- ***Pens#(x,t)***: The existing pensioners in year t is defined as the persons who have received at least one pension payment during year t , as well as in any prior period.
- Analysis by category, sex and age, as well as average pension amounts for each subgroup. If possible, the distribution of average pension amounts for each subgroup should also be analysed.

Newly awarded pensioners (Old-age, invalidity and survivors)

- ***NPens#(x,t)***: The new pensioners in year t is defined as the persons who have received at least one pension payment during year t , but not in any prior period.
- Analysis by category, sex and age, as well as average pension amounts, average credit and reference salary for each subgroup. If possible, the distribution of average pension amounts, average credit and reference salary for each subgroup should also be analysed.

Financial statements, including the revenue and expenditure statement, and the balance sheet

- Analysis of revenue and expenditure statements, as well as the balance sheets of the scheme for the overall scheme and for each subgroup.

Portfolio of the invested asset

- Analysis by date of investment type, interest rate and duration.

2. Input preparation

In this section, the methods of creating the input files needed for the projection programme are explained.

2.1. Input data

The input data comprises the financial and demographic base data and the assumptions for future developments. The base data comprises the statistics of the base year of projection, including the age and contribution structure of the covered population and the age and payment structure of the pensioner population. This data is sourced from the scheme and relevant national sources.

The assumptions of future developments with respect to macroeconomic factors (e.g. GDP, CPI, salary increase), future coverage and actuarial assumptions (e.g. mortality rates, entry rates into invalidity) are based on external sources or derived from the results of the other models of the ILO actuarial model family. To support long-term projections, ILO-PENS requires assumptions that exceed 75 years. The limitation in this regard is that economic/financial forecasts do not generally exceed five or six years, in which case the best judgement of future developments beyond the forecast period is required. To develop such long-term assumptions, it is vital that related factors are developed in a coherent manner. Advice can be sought from the relevant economic and labour authorities. The Actuarial Standard of Practice as well as the ILO-International Social Security Association (ISSA) guidelines also provide useful guidance in this regard.

Reference publications

- International Actuarial Association: *Final IAA guidelines of actuarial practice for social security programs* (Ottawa, 2002).
- ILO/ISSA: *Guidelines on actuarial work for social security* (Geneva, 2016).

2.2. Input data files

Input data should be prepared in a specified format. For the projection programme, two kinds of input files need to be prepared:

- the economic-demographic file (**EconDem.xls**);
- the group file(s) (**GroupN.xls**).

The total covered population is usually composed of several groups that have different characteristics (e.g. male/female, public/private sector). Where legislation or scheme rules provide for different treatment of participant groups with respect to benefit eligibility and entitlement (e.g. normal retirement age, pension formula, eligibility condition, assumptions), a unique group file is prepared for each group. ILO-PENS has the capacity to accommodate ten unique group files.

Conversely, the economic-demographic file contains information that is in common to all groups. The contents of these input files are shown in figure III.2.1.

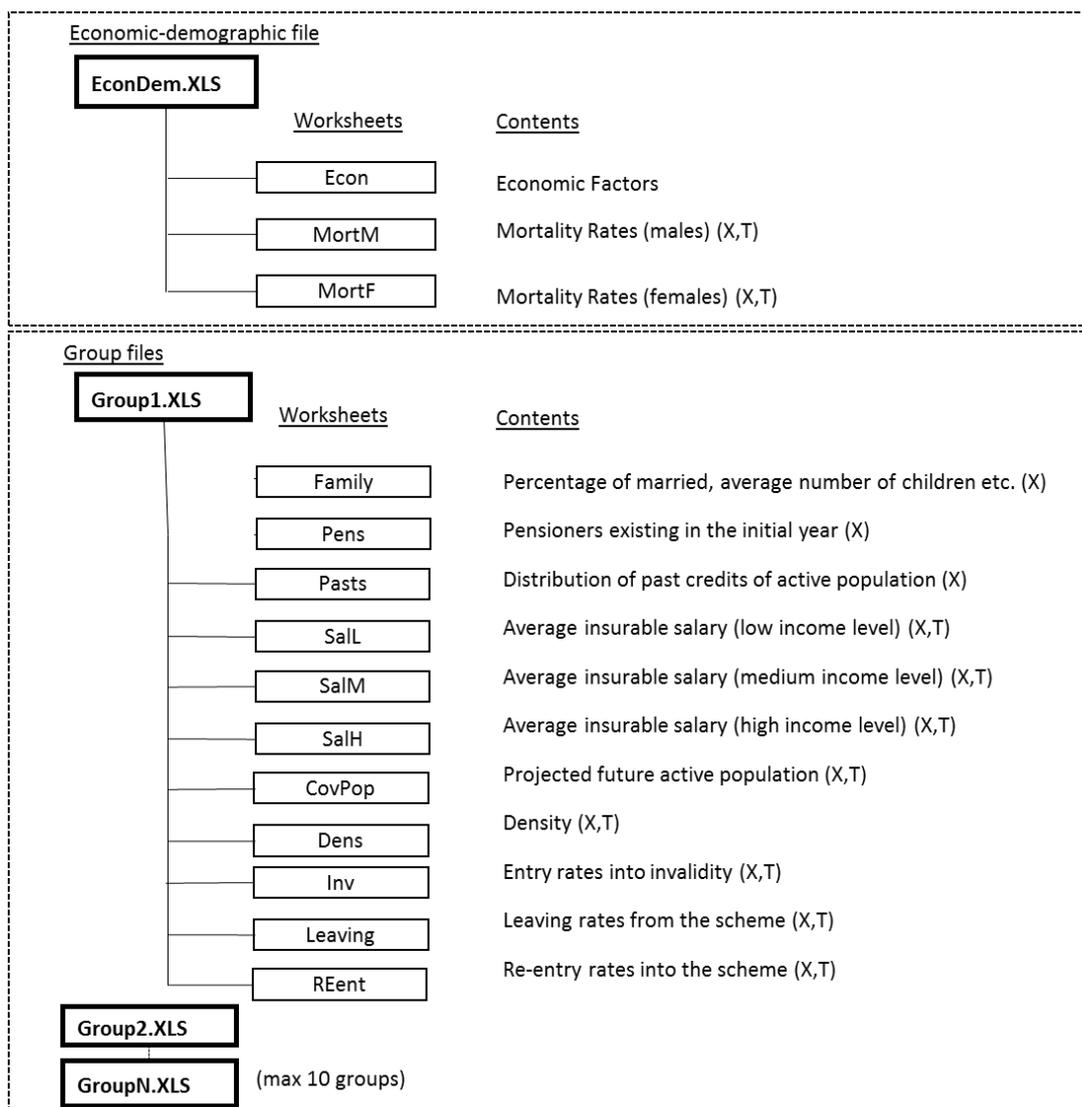
2.2.1. The economic-demographic file

The economic-demographic file, EconDem.xls, contains the following worksheets:

- Econ: economic factors;
- MortM: mortality rates for males;
- MortF: mortality rates for females.

The explanation for each worksheet is given below.

Figure III.2.1. Contents of the input files



A) Econ worksheet

The format of the Econ worksheet is shown in figure III.2.2. The following data is required for input to this worksheet (associated data descriptions are provided under subheadings (1) to (9) below):

- Annual rate of increase of average earnings;
- Annual rate of increase pensions in payment;

- Annual interest rate;
- Average legal minimum wage;
- Average minimum insurable earnings;
- Average maximum insurable earnings;
- Amount of funeral benefit;
- Contribution rate;
- Contribution collection rate.

Figure III.2.2. Format of Econ worksheet

	A	B	C	D	E	F	G	H	I	J	K	L
1		Projection year (t)										
2		-5	-4	-3	-2	-1	0	1	2	3	4	5
4												
5	Salary increase (RINFS)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
6	Benefit increase (RINFB)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
7	Interest rate (RINT)	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
8	Legal minimum wage											
9	Value	10000	10450	10920	11412	11925	12462	13023	13609	14221	14861	15530
10	Annual increase	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
11	Min Ins Earnings											
12	Value	10000	10450	10920	11412	11925	12462	13023	13609	14221	14861	15530
13	Annual increase	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
14	Max Ins Earnings											
15	Value	50000	52250	54601	57058	59626	62309	65113	68043	71105	74305	77648
16	Annual increase	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
17	Minimum Pension											
18	Value	6000	6270	6552	6847	7155	7477	7814	8165	8533	8917	9318
19	Annual increase	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
20	Funeral Benefit											
21	Value	1000	1045	1092	1141	1193	1246	1302	1361	1422	1486	1553
22	Annual increase	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
23	Contribution rate	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
24												
25	Cont. collection rate	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%

(1) Annual rate of increase of the average earnings

Data description: The annual rate of increase of average earnings in year t is the rate of increase of annual average earnings of the covered population in year t relative to the previous year $t-1$. This data is used for evaluating past salary increment trends on a year-by-year basis, leading up to the present salary levels. This trend will be subsequently applied to the assumption of future reference salaries.

- Range: From 5 years ago to the end of the projection year (max. 100).

(2) Annual rate of increase of pensions in payment

Data description: The annual rate of increase of pensions in payment in year t is the adjustment rate of the pension in payment in year t compared to the previous year $t-1$.

- Range: From 5 years ago to the end of the projection year (max 100).
- Remark: In the projection programme, the regular adjustment is assumed to occur at the beginning of the year. Modifications will be needed if the adjustment occurs at another time during the year or more than once in a year.

(3) *Annual interest rate*

Data description: The average annual rate of return on the investment of the overall reserve and/or scheme assets. The same rate is used to calculate the interest on income and benefit payments associated with the cash inflow and outflow during year t .

- Range: From 5 years ago to the end of the projection year (max 100).
- Remark: These rates are applicable from the beginning to the end of year t . Interest is calculated in proportion to the length of the period during which the principal capital is invested in that year. Modifications will be needed if interest is compounded several times in a year.

(4) *Average legal minimum wage*

Data description: The average amount of the legal minimum wage in year t . Where the minimum wage varies over the course of year t , the average is taken from the beginning to the end of year t .

- Range: From the base year to the end of the projection year (max 100).
- Remark: In the projection programme, the legal minimum wage is not explicitly used. In many cases, however, the minimum pension and the minimum and maximum limits of insurable earnings are linked to an observed ratio with respect to the legal minimum wage.

(5) *Average minimum insurable earnings*

Data description: The average amount of the minimum insurable earnings in year t . Where the minimum insurable earnings varies over the course of year t , the average is taken from the beginning to the end of year t .

- Range: From the base year to the end of the projection year (max 100).

(6) *Average maximum insurable earnings*

Data description: The average amount of the maximum insurable earnings in year t . Where the maximum insurable earnings varies over the course of year t , the average is taken from the beginning to the end of year t .

- Range: From the base year to the end of the projection year (max 100).

(7) *Amount of funeral benefit*

Data description: The annual average amount of the funeral benefit in year t . The average is taken from the beginning to the end of year t .

- Range: From the base year to the end of the projection year (max 100).

(8) *Contribution rate*

Data description: The annual average rate of contribution in year t . The average is taken from the beginning to the end of year t .

- Range: From the base year to the end of the projection year (max 100).

-
- Remark: This is used for evaluating the sustainability of defined-benefit schemes, or for calculating the accumulated amount of contributions of the defined-contribution schemes (in this case, the contribution rate is given).

(9) *Contribution collection rate*

Data description: Ratio of the amount of contributions actually collected to the amount of contributions that should be paid in year t . The amount of contributions that should be paid is given by the product of the total insurable earnings and the contribution rate in year t .

- Range: From the base year to the end of the projection year (max 100).
- Remark: This refers to actual compliance of the collection of contributions. Incidences of under-declaration of salary or of intermittent unemployment are not taken into account. (See also the descriptions of the insurable salary and density factors.)

B) **MortM and MortF worksheets**

The format of the **MortM** and **MortF** worksheets is shown in figure III.2.3. The following data is required for input to this worksheet (associated data descriptions are provided under subheadings (1) and (2) below):

- MortM: mortality rates for male population;
- MortF: mortality rates for female population.

Where the size of the scheme membership is large enough and has credible mortality statistics, the mortality experience of the scheme can be applied. In most instances, scheme-specific data is not sufficient as a result of the limited scheme size, data quality and/or the duration of the observed mortality experience.

Where the scheme-specific mortality experience is deficient, the mortality experience of the general population is utilized to generate a proxy for scheme data using the ILO-POP model, subject to statistical/actuarial adjustments. National general population mortality data or United Nations assumptions on mortality rates can be used as source data for the ILO-POP model.⁴

For each group of the covered population, one of these two rates (**MortM** or **MortF**) will need to be selected in the projection programme. The mortality rates of the covered population and invalids are included in the Projection() submodule.

(1) *Mortality rates for male population*

Data description: The probability that a male of exact age x in year t will die before reaching his $x+1$ birthday.

- Range: For all ages between 0 and 99, from the base year to the end of the projection year.

⁴ Mortality data of the general population is generally not appropriate to estimate the mortality of insured persons; relevant statistical and actuarial adjustments are required to ensure the best fit.

(2) Mortality rates for female population

Data description: The probability that a female of exact age x in year t will die before reaching her $x+1$ birthday.

- Range: For all ages between 0 and 99, from the base year to the end of the projection year.

Figure III.2.3. Format of MortM and MortF worksheets

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Mortality rates												
2	Males												
5	Year	0	1	2	3	4	5	6	7	8	9	10	11
6	Age												
7	0	0.05164	0.04957	0.04758	0.04567	0.04384	0.04208	0.04039	0.03877	0.03721	0.03572	0.03428	0.03291
8	1	0.00788	0.00734	0.00684	0.00637	0.00593	0.00552	0.00515	0.00479	0.00446	0.00416	0.00387	0.00361
9	2	0.00398	0.00375	0.00354	0.00333	0.00314	0.00296	0.00279	0.00263	0.00248	0.00234	0.00221	0.00208
10	3	0.00255	0.00242	0.00230	0.00219	0.00208	0.00197	0.00188	0.00178	0.00169	0.00161	0.00153	0.00145
11	4	0.00183	0.00175	0.00167	0.00160	0.00153	0.00146	0.00139	0.00133	0.00127	0.00122	0.00116	0.00111
12	5	0.00141	0.00135	0.00129	0.00124	0.00118	0.00113	0.00108	0.00104	0.00099	0.00095	0.00091	0.00087
13	6	0.00114	0.00109	0.00104	0.00100	0.00096	0.00092	0.00088	0.00084	0.00080	0.00077	0.00074	0.00070
14	7	0.00096	0.00092	0.00088	0.00084	0.00080	0.00077	0.00074	0.00070	0.00067	0.00064	0.00062	0.00059
15	8	0.00085	0.00081	0.00078	0.00074	0.00071	0.00068	0.00065	0.00062	0.00059	0.00056	0.00054	0.00051
16	9	0.00078	0.00074	0.00071	0.00068	0.00064	0.00062	0.00059	0.00056	0.00053	0.00051	0.00048	0.00046
17	10	0.00074	0.00070	0.00067	0.00064	0.00061	0.00058	0.00055	0.00053	0.00050	0.00048	0.00045	0.00043
18	11	0.00074	0.00070	0.00067	0.00064	0.00061	0.00058	0.00055	0.00052	0.00050	0.00047	0.00045	0.00043
19	12	0.00076	0.00072	0.00069	0.00066	0.00062	0.00059	0.00057	0.00054	0.00051	0.00049	0.00046	0.00044
20	13	0.00082	0.00078	0.00074	0.00071	0.00068	0.00064	0.00061	0.00058	0.00056	0.00053	0.00051	0.00048
21	14	0.00089	0.00085	0.00081	0.00077	0.00074	0.00070	0.00067	0.00064	0.00061	0.00058	0.00056	0.00053
22	15	0.00097	0.00093	0.00089	0.00085	0.00082	0.00078	0.00075	0.00072	0.00068	0.00066	0.00063	0.00060
23	16	0.00106	0.00102	0.00097	0.00093	0.00090	0.00086	0.00082	0.00079	0.00076	0.00072	0.00069	0.00067
24	17	0.00116	0.00111	0.00107	0.00102	0.00098	0.00094	0.00091	0.00087	0.00083	0.00080	0.00077	0.00074
25	18	0.00126	0.00121	0.00116	0.00112	0.00107	0.00103	0.00099	0.00095	0.00091	0.00087	0.00084	0.00081
26	19	0.00136	0.00131	0.00126	0.00121	0.00116	0.00111	0.00107	0.00103	0.00099	0.00095	0.00091	0.00088
27	20	0.00145	0.00139	0.00134	0.00129	0.00124	0.00119	0.00114	0.00110	0.00105	0.00101	0.00097	0.00094
28	21	0.00154	0.00148	0.00142	0.00137	0.00132	0.00127	0.00122	0.00117	0.00112	0.00108	0.00104	0.00100
29	22	0.00162	0.00156	0.00150	0.00144	0.00139	0.00134	0.00129	0.00124	0.00119	0.00114	0.00110	0.00106

2.2.2. The group file

The group file, **GroupN.xls**, contains the following worksheets:

- CovPop: Covered population;
- Dens: Density factor;
- SalL: Insurable earnings (low income level);
- SalM: Insurable earnings (medium income level);
- SalH: Insurable earnings (high income level);
- Family: Family structure;
- Pasts: Past credits;
- Pens: Pensioners existing in the base year;
- Inv: Entry rates into invalidity;
- Inact: Inactive population by past credits;
- ReEnt: Re-entrance rates;
- Leaving: Leaving rates.

The explanation for each worksheet and associated data descriptions are provided under subheadings (1) to (10) below.

(1) Covered population (CovPop) worksheet

The format of the Covered population (**CovPop**) worksheet is shown in figure III.2.4; data on the projected number of the covered population by age is required for input to this worksheet.

Data description: The number of persons, at each age group, who are covered by the scheme (i.e. active) in year t .

- Range: For the insurable ages (min: 15; max: 69), from the base year to the end of the projection year;
- Remark: See also the explanation of the Density factor (**Dens**) submodule provided below.

Figure III.2.4. Format of Covered population worksheet

(2) Density factor (Dens) worksheet

The format of the Density factor (**Dens**) worksheet is shown in figure III.2.5; data on the assumed rates of density factors by age is required for input to this worksheet.

Data description: The ratio of the number of contributors [$Cont(x,t)$] in year t (i.e. number of persons eligible to make full contributions in year t), with reference to the active population [$Act(x,t)$] (i.e. number of persons who have made at least one contribution in year t (**CovPop**)).

- Range: For the insurable ages (min: 15; max: 69), from the base year to the end of the projection year;
- Remark: The density factor refers to the average completeness of the working time (for a full-time worker the density is 100 per cent, while for a part-time worker or a worker who has an intermittent unemployment period the density is less than 100 per cent). This does not take into account the compliance of the contribution collection or the

under-declaration of insurable earnings. See also the description of the contribution collection rate and the insurable earnings.

Figure III.2.5. Format of Density factor worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Density												
3	Year	0	1	2	3	4	5	6	7	8	9	10	11
4	Age												
5	15	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
6	16	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
7	17	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
8	18	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
9	19	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
10	20	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
11	21	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
12	22	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
13	23	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
14	24	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
15	25	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
16	26	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
17	27	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
18	28	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
19	29	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
20	30	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
21	31	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
22	32	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
23	33	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
24	34	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
25	35	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
26	36	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
27	37	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721
28	38	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721	0.721

(3) Insurable earnings (SalL, SalM, SalH) worksheets

The format of the Insurable earnings (SalL, SalM, SalH) worksheets is shown in figure III.2.6; data on the projected average insurable earnings, by income group and by age, is required for input to this worksheet.

Data description: The average insurable earnings of those aged x in year t is defined as the annual average insurable earnings of the covered population aged x in year t , subject to minimum and maximum limits.

Annual average insurable earnings are calculated by income level. For each year and each age, average insurable earnings are calculated for three percentile groups:

- the low income level (**SalL**) is the average of the lowest 30 percentile values of the distribution of insurable earnings;
- the high income level (**SalH**) is the average of the highest 30 percentile values of the distribution of insurable earnings;
- the medium income level (**SalM**) is the average of the middle income band of the distribution of insurable earnings, i.e. from 30 percentile to 70 percentile values.
- Range: For the insurable ages (min: 15, max: 69), from 5 years ago to the end of the projection year;
- Remark: These earnings are on the declaration basis and therefore under-declaration is not taken into account.

Figure III.2.6. Format of SalL, SalM and SalH worksheets

	A	B	C	D	E	F	G	H	I	J
1	Salary	Low								
3	Year	-5	-4	-3	-2	-1	0	1	2	
4	Age									
5	15	2,700	2,700	2,700	2,700	2,700	2,700	2,813	2,925	3,
6	16	3,150	3,150	3,150	3,150	3,150	3,150	3,285	3,398	3,
7	17	3,600	3,600	3,600	3,600	3,600	3,600	3,735	3,893	4,
8	18	4,050	4,050	4,050	4,050	4,050	4,050	4,208	4,388	4,
9	19	4,500	4,500	4,500	4,500	4,500	4,500	4,680	4,860	5,
10	20	4,950	4,950	4,950	4,950	4,950	4,950	5,153	5,355	5,
11	21	5,400	5,400	5,400	5,400	5,400	5,400	5,625	5,850	6,
12	22	5,850	5,850	5,850	5,850	5,850	5,850	6,075	6,323	6,
13	23	6,300	6,300	6,300	6,300	6,300	6,300	6,548	6,818	7,
14	24	6,750	6,750	6,750	6,750	6,750	6,750	7,020	7,290	7,
15	25	7,200	7,200	7,200	7,200	7,200	7,200	7,493	7,785	8,
16	26	7,650	7,650	7,650	7,650	7,650	7,650	7,965	8,280	8,
17	27	8,100	8,100	8,100	8,100	8,100	8,100	8,415	8,753	9,
18	28	8,550	8,550	8,550	8,550	8,550	8,550	8,888	9,248	9,
19	29	9,000	9,000	9,000	9,000	9,000	9,000	9,360	9,743	10,
20	30	9,450	9,450	9,450	9,450	9,450	9,450	9,833	10,215	10,
21	31	9,900	9,900	9,900	9,900	9,900	9,900	10,305	10,710	11,
22	32	10,350	10,350	10,350	10,350	10,350	10,350	10,755	11,205	11,
23	33	10,800	10,800	10,800	10,800	10,800	10,800	11,228	11,678	12,
24	34	11,250	11,250	11,250	11,250	11,250	11,250	11,700	12,173	12,
25	35	11,700	11,700	11,700	11,700	11,700	11,700	12,173	12,645	13,
26	36	12,150	12,150	12,150	12,150	12,150	12,150	12,645	13,140	13,
27	37	12,600	12,600	12,600	12,600	12,600	12,600	13,095	13,635	14,
28	38	13,050	13,050	13,050	13,050	13,050	13,050	13,568	14,108	14,

(4) Family structure worksheet

The format of the Family structure (**Family**) worksheet is shown in figure III.2.7; the following data is required for input to this worksheet and is applied for estimating the survivors’ pensions paid out by the scheme (associated data descriptions are provided under subheadings (a) to (f) below):

- Average probability of having spouse (married);
- Average age of spouse;
- Average number of children;
- Average age of children;
- Continuing probability of the orphans’ pension.

Figure III.2.7. Format of Family structure worksheet

	A	B	C	D	E	F	G	H
1	Demographic factors							
2								
3								
4	Age	ESP	AAW	ECH	AAO	PO	ECH if NOT marr.	
47	42	0.33	46	5.64	12	0	0.15	
48	43	0.32	47	5.05	12	0	0.15	
49	44	0.31	47	4.46	12	0	0.1	
50	45	0.30	48	3.87	12	0	0.1	
51	46	0.29	49	3.28	12	0	0.1	
52	47	0.28	50	2.69	13	0	0.1	
53	48	0.29	51	2.34	13	0	0.1	
54	49	0.30	52	1.99	13	0	0.1	
55	50	0.31	53	1.64	13	0	0.05	
56	51	0.32	54	1.29	13	0	0.05	
57	52	0.33	55	0.94	13	0	0.05	

(a) *Average probability of having spouse (see column B)*

Data description: The percentage of covered persons whose spouse is eligible for the widow(er)s' pensions (with reference to the age of covered persons).

- Range: From age 15 to age 99;
- Remark: In this model, the future change in these rates are not considered.

(b) *Average age of spouse (see column C)*

Data description: The average age of the spouse of covered persons (with reference to the age of covered persons).

- Range: From age 15 to age 99;
- Remark: In the model, the future change in these ages are not considered. In ILO-PENS, a certain dispersion of the average age is made. See also the explanation of the **SDIST()** submodule.

(c) *Average number of children (see column D)*

Data description: The average number of children eligible for the orphans' pensions (with reference to the age of covered persons).

- Range: From age 15 to age 99;
- Remark: In the model, the future change in these ages are not considered.

(d) *Average age of children (see column E)*

Data description: The average age of the children of covered persons (with reference to the age of covered persons).

- Range: From age 15 to age 99;
- Remark: In the model, the future change in these ages are not considered. In ILO-PENS, a certain dispersion of the average age is made. See also the explanation of the **SDIST()** submodule.

(e) *Continuing probability of the orphans' pension (see column F)*

Data description: The probability that the child of the deceased member/pensioner continues receiving the benefits from the previous year. This probability is subject to the benefit eligibility prescribed in the scheme rules and the probability of the child surviving to the next year.

- Range: From age 0 to age 99 (with reference to the age of the survivor benefit recipient);
- Remark: In ILO-PENS, the future changes in these ages are not considered.

(f) *Average number of children if NOT married (see column G)*

Data description: The average number of children eligible for the orphans' pensions (with reference to the age of covered persons) with respect to an unmarried member.

- Range: From age 15 to age 99;
- Remark: This data field is not generic to the current version of ILO-PENS. If there is sufficient basis to incorporate this input data set, a separate source file will need to be created and the information subsequently included in the Family worksheet.

(5) Past credits worksheet

The format of the Past credits (**Pasts**) worksheet is shown in figure III.2.8; data on the distribution of the past credits, by age, in the reference year is required for input to this worksheet.

Data description: The distribution of the past credits of the covered population, by age, in the reference year t .

- Range: For the insurable ages (min: 15, max 69).

Figure III.2.8. Format of Past credits worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	
1	Past Service Credit												
2	Yrs of Service												
3													
4	Age	1	2	3	4	5	6	7	8	9	10	11	
5	15	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0
6	16	93.55%	6.45%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0
7	17	61.19%	38.80%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0
8	18	33.34%	60.03%	6.60%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0
9	19	24.52%	48.98%	23.92%	2.53%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0
10	20	20.51%	36.46%	31.03%	10.52%	1.41%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0
11	21	18.26%	27.73%	29.94%	17.50%	5.53%	0.94%	0.09%	0.00%	0.00%	0.00%	0.00%	0
12	22	16.84%	21.87%	26.34%	20.50%	10.30%	3.34%	0.70%	0.10%	0.00%	0.00%	0.00%	0
13	23	14.00%	16.97%	22.49%	21.41%	14.64%	7.19%	2.53%	0.64%	0.13%	0.00%	0.00%	0
14	24	12.07%	13.49%	18.78%	20.18%	16.73%	10.70%	5.29%	2.01%	0.59%	0.16%	0.00%	0
15	25	10.68%	10.99%	15.66%	18.13%	17.04%	13.00%	8.06%	4.05%	1.66%	0.55%	0.19%	0
16	26	9.64%	9.14%	13.15%	15.95%	16.30%	14.04%	10.19%	6.24%	3.22%	1.40%	0.51%	0
17	27	8.85%	7.75%	11.16%	13.93%	15.07%	14.14%	11.50%	8.11%	4.96%	2.63%	1.21%	0
18	28	9.01%	6.69%	9.33%	11.65%	13.04%	13.07%	11.74%	9.44%	6.80%	4.39%	2.54%	1
19	29	9.13%	5.88%	7.98%	9.92%	11.30%	11.80%	11.28%	9.89%	7.94%	5.84%	3.94%	2
20	30	9.23%	5.24%	6.95%	8.58%	9.86%	10.56%	10.53%	9.78%	8.46%	6.81%	5.11%	3
21	31	9.32%	4.73%	6.14%	7.52%	8.68%	9.44%	9.68%	9.36%	8.54%	7.34%	5.94%	4
22	32	9.39%	4.31%	5.50%	6.67%	7.71%	8.47%	8.86%	8.81%	8.34%	7.52%	6.44%	5
23	33	8.03%	3.77%	4.88%	6.02%	7.09%	7.95%	8.51%	8.69%	8.46%	7.85%	6.95%	5
24	34	6.87%	3.30%	4.32%	5.41%	6.47%	7.40%	8.09%	8.45%	8.44%	8.05%	7.34%	6
25	35	5.89%	2.87%	3.81%	4.84%	5.88%	6.84%	7.62%	8.13%	8.31%	8.13%	7.62%	6
26	36	5.05%	2.51%	3.26%	4.21%	5.21%	6.29%	7.12%	7.75%	8.00%	8.10%	7.78%	7

(6) Pensioner (Pens) worksheet

The format of the Pensioner (**Pens**) worksheet is shown in figure III.2.9; the following data is required for input to this worksheet:

- The number of pensioners existing in the base year t , by benefit and by age;
- The average amount of monthly pension of the pensioners above, by benefit type (invalidity, normal, survivor pension, etc.) and by age.

Data description: The average number of pensioners (including survivor beneficiaries) who receive each applicable benefit type, by age, in the base year t . The average amount of pensions paid during base year t also needs to be collected.

- Range: From age 15 to 99 (retired, invalids, widow(er)s), from age 0 to 99 (children);
- Remark: In the programme, after reading the averages, the total amounts are calculated and are generally used instead of averages;

- Remark: Normally, this data is taken at a certain time point. If the timing is well chosen (e.g. mid-year), then one can assume that the number of pensioners at that time would represent the average number of pensioners for the given year. In the same way, one can assume that the average amount of pensions at that time would represent the annual average of the pensions. It must be noted that the adjustment of pension is assumed to take place at the beginning of the year; if this is not the case, the average pensions should be modified accordingly;
- Remark: To ensure consistency with the macrodata found in the financial statements, a quick check is made to compare the input pension benefit data with actual data as sourced from the financial statements. The total amount of pension benefits potentially payable (as referenced from the pension benefit data) is calculated from the sum of the number of pensioners and the respective average pensions (by type) during base year t . The calculated total amount of pension benefits potentially payable is then compared to the actual financial statements, for consistency. If these two figures do not correlate, then the average pension(s) values should be rechecked.

Figure III.2.9. Format of Pension worksheet

Age	RET Number	RET Average	INV Number	INV Average	WID Number	WID Average	ORP Number	ORP Average
59	54	1	360	5	153	117	103	0
60	55	1	360	5	125	104	108	0
61	56	1	360	5	125	90	108	0
62	57	2	360	5	125	76	108	0
63	58	7	360	4	125	69	108	0
64	59	12	360	3	125	63	108	0
65	60	17	393	3	100	56	107	0
66	61	22	393	2	100	49	107	0
67	62	28	393	1	100	43	107	0
68	63	24	393	1	100	40	107	0
69	64	21	393	1	100	38	107	0
70	65	18	423	1	536	36	103	0
71	66	15	423	0	0	34	103	0
72	67	12	423	0	0	32	103	0
73	68	10	423	0	0	28	103	0
74	69	8	423	0	0	24	103	0
75	70	5	230	0	0	20	104	0
76	71	3	230	0	0	16	104	0
77	72	1	230	0	0	12	104	0
78	73	1	230	0	0	12	104	0

(7) Invalidity (Inv) worksheet

The format of the **Invalidity** (Inv) worksheet is shown in figure III.2.10; data on invalidity probability rates, by age, as at base year t is required for input to this worksheet.

Data description: Invalidity entry probability rates of those aged x in year t .

- Range: From age 15 to age 99, from the base year to the end of the projection year;
- Remark: These rates can be changed over time. They can therefore be overwritten for a specific projection year. See the explanation of the **Projection()** submodule.

Figure III.2.10. Format of the Invalidation (Inv) worksheet

Year	0	1	2	3	4	5	6	7	8	9	10	11
Age 15	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Age 16	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Age 17	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Age 18	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Age 19	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045	0.00045
Age 20	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006
Age 21	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006
Age 22	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006
Age 23	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006
Age 24	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006
Age 25	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014
Age 26	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014
Age 27	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014
Age 28	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014	0.00014
Age 29	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145
Age 30	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145
Age 31	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145
Age 32	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145
Age 33	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145
Age 34	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145	0.00145
Age 35	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302
Age 36	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302
Age 37	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302
Age 38	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302
Age 39	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302
Age 40	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302	0.00302

(8) Inactive (Inact) worksheet

Data description: Data on the number of the inactive population by age and by past credits in the base year t is required for input to this worksheet.

- Range: For the insurable ages (min: 15, max: 69).

(9) Re-entry (ReEnt) worksheet

The format of the Re-entry (**ReEnt**) worksheet is shown in figure III.2.11; data on the re-entry rates from the inactive population into the covered population, by age in the base year t , is required for input to this worksheet.

Data description: The re-entry rates of those aged x in year t . This is the probability for an inactive person aged $x-1$ in year $t-1$ to become a covered person in year t . A typical scenario would be in the case of resuming employment.

- Range: For the insurable ages (min: 15, max: 69);
- Remark: These rates can be changed over time. They can therefore be overwritten for a specific projection year. See the explanation of the **Projection()** and **InsIns()** submodules.

Figure III.2.11. Format of the Re-Entry worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Re-entrance rates												
2													
3	Year	0	1	2	3	4	5	6	7	8	9	10	11
4	Age												
5	15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	17	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	18	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	21	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	23	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
14	24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
41	51	16.0%	17.0%	18.0%	19.0%	20.0%	21.0%	22.0%	23.0%	0.0%	0.0%	0.0%	0.0%
42	52	15.0%	16.0%	17.0%	18.0%	19.0%	20.0%	21.0%	22.0%	0.0%	0.0%	0.0%	0.0%
43	53	14.0%	15.0%	16.0%	17.0%	18.0%	19.0%	20.0%	21.0%	0.0%	0.0%	0.0%	0.0%
44	54	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	19.0%	20.0%	0.0%	0.0%	0.0%	0.0%
45	55	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	19.0%	0.0%	0.0%	0.0%	0.0%
46	56	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	0.0%	0.0%	0.0%	0.0%
47	57	10.0%	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	0.0%	0.0%	0.0%	0.0%
48	58	9.0%	10.0%	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	0.0%	0.0%	0.0%	0.0%
49	59	8.0%	9.0%	10.0%	11.0%	12.0%	13.0%	14.0%	15.0%	0.0%	0.0%	0.0%	0.0%
50	60	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	13.0%	14.0%	0.0%	0.0%	0.0%	0.0%
51	61	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	13.0%	0.0%	0.0%	0.0%	0.0%
52	62	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	0.0%	0.0%	0.0%	0.0%
53	63	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	0.0%	0.0%	0.0%	0.0%

(10) Leaving worksheet

The format for the **Leaving** worksheet is shown in figure III.2.12; data on the leaving rates from covered population to the inactive population, by age, in the base year t are required for input to this worksheet.

Data description: The leaving rates of those aged x in base year t . This is the probability of a covered person aged $x-1$ in year $t-1$ becoming inactive in year t . Typical scenarios are (i) becoming unemployed and (ii) retiring earlier than the normal retirement age. If a person of the latter case satisfies the eligibility condition for the early retired old-age pension, he/she could become a pensioner.

- Range: For the insurable ages (min: 15, max: 69);
- Remark: These rates can be changed over years. They can therefore be overwritten for a specific projection year. See the explanation of the **Projection()** and **InsIns()** submodules.

Figure III.2.12. Format of the Leaving worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Early Retirement rates												
2													
3	Year	0	1	2	3	4	5	6	7	8	9	10	11
4	Age												
5	15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	17	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	18	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	21	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	23	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
14	24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
41	51	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
42	52	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
43	53	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
44	54	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
45	55	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	19.0%	19.0%	19.0%	19.0%	19.0%
46	56	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	18.0%	18.0%	18.0%	18.0%
47	57	13.0%	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	17.0%	17.0%	17.0%	17.0%
48	58	14.0%	10.0%	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	16.0%	16.0%	16.0%	16.0%
49	59	15.0%	9.0%	10.0%	11.0%	12.0%	13.0%	14.0%	15.0%	15.0%	15.0%	15.0%	15.0%
50	60	16.0%	8.0%	9.0%	10.0%	11.0%	12.0%	13.0%	14.0%	14.0%	14.0%	14.0%	14.0%
51	61	17.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	13.0%	13.0%	13.0%	13.0%	13.0%
52	62	18.0%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	12.0%	12.0%	12.0%	12.0%	12.0%
53	63	19.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	11.0%	11.0%	11.0%	11.0%	11.0%

2.3. Compilation of input files

2.3.1. Using ancillary models

As noted above, some of the data inputs for the ILO-PENS projection can be sourced from ancillary ILO models, as follows:

- ILO-POP provides the future mortality rates used for the national population projection, which can be imported into the **MortM** and **MortF** worksheets;
- ILO-ECO provides the assumptions of macroeconomic indicators, including wage increases, interest and inflation, which can be imported into the worksheet **Econ**;
- ILO-DIST provides the results of insurable salary with respect to the three income groups, which can be imported into the **SalL**, **SalM** and **SalH** worksheets. The assumption of the wage increase embedded in this model is in accordance with economic assumptions (see ILO-ECO);
- ILO-LAB provides labour-force population and employed population data, which can be used as a basis for the projection of the insured population.

The use of these ILO models not only facilitates the compilation of input files but also helps to maintain the consistency of data and assumptions across the whole ILO modelling process.

2.3.2 Using input-making files

The following sets of Excel files, called “Input-making files”, have been developed to aid the preparation of input data:

- Covpop.xls
- Famstr.xls
- Penpop.xls
- Credist.xls

(A) Covpop.xls

The Covpop input-making file consists of the following 8 worksheets:

- | | |
|-------------|-------------|
| – InitialM | – InitialF |
| – EmplpopM | – EmplpopF |
| – CovratesM | – CovratesF |
| – CovpopM | – CovpopF |

The postscripts **M** and **F** denote gender-specific files (males and females). The explanations below are given for only one gender set; the methodology is equally applicable to the alternate gender files.

(1) *InitialM, InitialF*

The format of the **InitialM** and **InitialF** worksheets are shown in figure III.2.13. These worksheets transform the initial (source) data of the covered population into a format that can be utilized by ILO-PENS.

Figure III.2.13. Format of InitialM and InitialF worksheets

Initial data Males				Interpolate			class	For SP	ag
	Covpop	Employed	Cov rate		Covpop	Employed	Cov rate		
15-19	13220	285971	5%	15	0	24724	0%	15-19	1
20-24	142682	463167	31%	16	0	39398	0%	20-24	10
25-29	236558	398707	59%	17	2644	52490	5%	25-29	100
30-34	160220	280654	57%	18	7822	73655	11%	30-34	100
35-39	106965	235894	45%	19	13001	95704	14%	35-39	100
40-44	103690	192493	54%	20	18179	105433	17%	40-44	100
45-49	81726	169497	48%	21	23358	99803	23%	45-49	100
50-54	56600	124704	45%	22	28536	91131	31%	50-54	100
55-59	41094	107997	38%	23	32291	84357	38%	55-59	100
60-64	20318	81543	25%	24	36046	82444	44%	60-64	1000
65-69	7579	37498	20%	25	39802	84147	47%	65-69	10000
TOT	970652.7	2378124	41%	26	43557	80241	54%		
				27	47312	80407	59%	Sprague	
				28	44258	79050	56%	Uniform	
				29	41205	74861	55%	Linear	
				30	38151	67634	56%		
				31	35097	61062	57%		
				32	32044	54502	59%		
				33	29914	49724	60%		
				34	27784	47731	58%		
				35	25653	47765	54%		

The covered population data for the base year is sourced from data-collection exercises. In some cases, the source population data is presented in 5-year age-groups as opposed to single-age population values. To transform this data into single-age-specific data:

- First, input the 5-year age-group data to column B of the InitialM and InitialF worksheets;
- Second, select one of the interpolation modules in the drop-down bar in cell G3.

ILO-PENS offers three options to change the 5-year age-groups data to single-age data – the Sprague formulae, uniform distribution or linear interpolation - which are explained below. The resultant age-specific population values are displayed in column G.

Sprague formulae

This is the most widely used option. It applies interpolating polynomials to generate approximate population values for each specified age. This formulae can, however, produce negative values, especially at the end points. If there are some negative values generated, the model will indicate “Negative value found” in cell G1 and the corresponding negative numbers will be indicated in red. If negative values are observed, they can be manually modified so that the total population of the 5-year age group is consistent with the source data.

If there are no negative values in column G, cell G1 will indicate “No negative value”.

Uniform distribution

This option simply assumes the uniform distribution of population at each specific age. It is suggested to use this option when the other interpolating options generate numerous negative values and or other inconsistencies.

Linear interpolation

This option assumes a linear relationship of the population values at each specific age. It should be noted that the totals of the linear interpolated age-specific population values will not necessarily be equal to the total population of the 5-year age group (source data) to which they belong.

Where single-age data is already available, it should be entered directly in column G, thus overwriting the underlying formulae in this column. In this case, the linkage between column B and column G is lost and the formulae in column G should be copied to column B in order to yield a 5-year age-group data summary.

The coverage rate in the base year *t* is calculated by utilizing both single-age and 5-year age-group data. The coverage rate results are shown in columns D (5-year age-group) and column I (single-age). By definition, the coverage rates should range between 0 and 100 per cent. By virtue of the negative value check with reference to cell G1, the coverage rate cannot have negative values. To ensure that the coverage does not exceed 100 per cent (over coverage check), another data-quality check is done in cell G2. If there are values bigger than 1 in column I, cell G2 will indicate “Over coverage”; otherwise it will show “No over coverage”. If some coverage rates are bigger than 100 per cent, the covered population data should be modified in columns G (single-age) and B (5-year age group) so that the coverage is less than 100 per cent. When making these adjustments, care should be taken to retain consistency with the total covered population (source data); the employed population (columns C for 5-year age group and H for single-age) could also be referenced for consistency. Alternatively, a coverage rate higher than 100 per cent could be admitted due to the inconsistency of the data source.

(2) *EmplpopM, EmplpopF*

The employed population is given in the **EmplpopM** and **EmplpopF** worksheets. The format of these worksheets is shown in figure III.2.14.

Normally, the projection of the employed population is done by using ILO-LAB. The single-age specific results should be imported in the range B19:CX73. They will then be abridged into the 5-year age-group data in the range B7:CX18.

Figure III.2.14. Format of **EmplpopM** and **EmplpopF** worksheets

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Employed Males												
4	Year												
5		0	1	2	3	4	5	6	7	8	9	10	11
6	Age												
7	15-19	285971	301058	314926	326553	334836	338602	335825	327670	317677	308750	300720	293780
8	20-24	463167	492630	526103	560434	593170	624580	655132	681707	699853	707114	704452	692176
9	25-29	398707	403691	407512	415999	432151	454629	483094	515489	548580	580041	610149	639377
10	30-34	280654	296549	315038	331400	343037	350954	354931	358291	365927	380433	400502	425616
11	35-39	235894	227024	218687	214978	217417	225064	237955	253134	266529	276120	282751	286267
12	40-44	192493	191485	190707	188666	184640	179282	172561	166594	164136	166388	172622	182877
13	45-49	169497	164653	158451	152969	149083	146529	145492	144909	143339	140261	136164	131026
14	50-54	124704	128479	132672	135281	135266	133104	128871	123686	119034	115636	113282	112115
15	55-59	107997	103864	99642.4	96905	96328.6	97406	100032	102967	104597	104177	102104	98470.3
16	60-64	81543	81278	81746.8	81647.1	80389.6	78266.1	75242.5	72200.4	70282.3	69935	70773.1	72700.8
17	65-69	37497.8	34337.2	31577.2	29929.6	29337	29419.2	29942.8	30405	30374.5	29807.8	28902.8	27769.6
18	TOT	2378124	2425048	2477061	2534762	2595655	2657836	2719078	2777052	2830331	2878662	2922423	2962175
19	15	24724	25801	26289	25948	25078	24325	23640	22974	22382	21903	21576	21477
20	16	39398	41130	42897	43725	43159	41713	40462	39323	38217	37232	36436	35893
21	17	52490	55006	57402	59882	61038	60249	58231	56484	54894	53350	51976	50864
22	18	73655	77681	81380	84938	88606	90315	89145	86158	83572	81218	78932	76897
23	19	95704	101440	106959	112060	116954	122000	124347	122731	118612	115047	111801	108649
24	20	105433	112175	118870	125338	131306	137029	142928	145666	143761	138924	134736	130924
25	21	99803	106923	113729	120513	127056	133089	138873	144834	147590	145641	140723	136463
26	22	91131	98682	105688	112410	119098	125545	131487	137181	143047	145747	143800	138922
27	23	84357	89909	97323	104225	110836	117410	123745	129579	135166	140921	143555	141611
28	24	82444	84941	90493	97947	104875	111506	118098	124447	130289	135881	141638	144257
29	25	84147	84604	87116	89801	90402	90768	89102	86105	82705	79242	75915	72619

(3) *CovratesM, CovratesF*

The format of the **CovratesM** and **CovratesF** worksheets is shown in figure III.2.15. The age-specific coverage rates should be input in the range C19:CX73. The 5-year age-group rates are displayed in the range B7:CX18. The 5-year age-group rates are calculated by dividing the abridged results of the CovpopM and CovpopF by the 5-year age-group employed population (see **EmplpopM** and **EmplpopF** worksheets).

Figure III.2.15. Format of the CovratesM and CovratesF worksheets

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Cov rates Males												
4	Year												
5		0	1	2	3	4	5	6	7	8	9	10	11
6	Age												
7	15-19	8%	8%	8%	8%	8%	9%	9%	9%	9%	9%	9%	9%
8	20-24	30%	30%	30%	30%	30%	30%	30%	30%	30%	31%	31%	31%
9	25-29	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%
10	30-34	58%	58%	58%	58%	58%	58%	58%	58%	58%	58%	58%	58%
11	35-39	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
12	40-44	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%	53%
13	45-49	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
14	50-54	46%	46%	46%	46%	46%	46%	46%	46%	46%	46%	46%	46%
15	55-59	37%	37%	37%	38%	38%	38%	38%	38%	38%	38%	38%	37%
16	60-64	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%
17	65-69	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
18	TOT	41%	40%	40%	40%	40%	40%	40%	40%	41%	41%	42%	42%
24	20	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%	17%
25	21	23%	23%	23%	23%	23%	23%	23%	23%	23%	23%	23%	23%
26	22	31%	31%	31%	31%	31%	31%	31%	31%	31%	31%	31%	31%
27	23	38%	38%	38%	38%	38%	38%	38%	38%	38%	38%	38%	38%
28	24	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%	44%
29	25	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
30	26	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%	54%
31	27	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%
32	28	56%	56%	56%	56%	56%	56%	56%	56%	56%	56%	56%	56%

(4) *CovpopM, CovpopF*

The format of the **CovpopM** and **CovpopF** worksheets is shown in figure III.2.16. The age-specific covered population can be calculated by multiplying the coverage rates (see **CovratesM** and **CovratesF** above) with the employed population (see **EmplpopM** and **EmplpopF** worksheets) for import to the Covpop worksheets in the range C19:CX73.

The 5-year age-group covered population is imported to the range B7:CX18. It is calculated by multiplying the 5-year age-group coverage rates with the abridged 5-year age-group employed population data.

Figure III.2.16. Format of the CovpopM and CovpopF worksheets

Year	0	1	2	3	4	5	6	7
Age								
15-19	23,467	24,801	26,064	27,260	28,373	29,200	29,293	28,668
20-24	138,412	146,822	157,029	167,738	177,952	187,786	197,324	205,984
25-29	216,132	218,836	220,751	224,982	233,335	245,331	260,748	278,333
30-34	162,990	172,199	182,971	192,558	199,434	204,102	206,422	208,331
35-39	112,963	108,709	104,832	103,330	104,825	108,703	114,990	122,248
40-44	101,447	100,891	100,498	99,491	97,451	94,664	91,119	87,912
45-49	81,347	78,961	75,984	73,400	71,603	70,436	69,975	69,690
50-54	57,755	59,511	61,463	62,682	62,688	61,688	59,722	57,314
55-59	40,461	38,854	37,299	36,388	36,331	36,874	37,929	39,004
60-64	21,283	21,270	21,393	21,320	20,925	20,312	19,493	18,714
65-69	7,579	6,970	6,424	6,088	5,969	5,976	6,068	6,156
TOT	963,836	977,825	994,707	1,015,238	1,038,885	1,065,072	1,093,084	1,122,353
20	18,179	19,342	20,496	21,612	22,641	23,628	24,645	25,117
21	23,358	25,024	26,617	28,205	29,736	31,148	32,502	33,897
22	28,536	30,901	33,095	35,200	37,294	39,313	41,174	42,957
23	32,291	34,417	37,255	39,897	42,427	44,944	47,369	49,602
24	36,046	37,138	39,566	42,825	45,854	48,753	51,635	54,411
25	39,802	40,013	41,205	43,895	47,501	50,851	54,056	57,240
26	43,557	43,778	43,987	45,295	48,242	52,195	55,865	59,374
27	47,312	47,136	47,349	47,572	48,977	52,154	56,418	60,374
28	44,258	44,798	44,604	44,803	45,008	46,330	49,327	53,352

(B) FAMSTR.xls

The format of the **FAMSTR** worksheet is shown in figure III.2.17. This file utilizes embedded family structure assumptions to generate family structure data; it should be used as a standard in cases where only 5-year age-group data is available. When the 5-year abridged data is entered in the worksheet (note the male-specific and female-specific data columns), the worksheet will automatically generate linearly interpolated results in the output columns.

The integrity of the output results is vetted by the negative value check displayed in row 1 of the respective column. If negative values are found, the model will indicate “Negative value!”. The negative values can be manually adjusted, but care should be taken to retain consistency with the source data. When no negative values are detected in the output columns, the row 1 cells will display “OK”.

Figure III.2.17. Format of the FAMSTR worksheet

INPUT	MALES				FEMALES			
	max age grp= 20							
Age-class	prob married	ave. age sp	ave. num. ch	ave. age ch	prob married	ave. age sp	ave. num. ch	ave. age ch
	ESP(X) m	AAW(X) m	ECH(X) m	AAO(X) m	ESP(X) f	AAW(X) f	ECH(X) f	AAO(X) f
15-19	13.40%	17	0.14	1	13.40%	17	0.14	1
20-24	44.80%	20	0.42	1	57.70%	24	0.61	1
25-29	76.90%	24	0.87	2	82.90%	30	1.26	3
30-34	88.52%	29	1.59	4	93.50%	35	2.09	5
35-39	93.66%	34	2.39	7	93.90%	40	2.84	8
40-44	92.54%	39	2.95	10	90.50%	45	3.12	11
45-49	90.14%	44	3.06	13	89.60%	50	2.98	14
50-54	88.88%	49	2.90	16	87.80%	55	2.78	16
55-59	87.08%	54	2.67	17	86.00%	60	2.51	17
60-64	85.28%	59	2.28	18	84.20%	65	1.93	18
65-69	83.48%	64	1.80	19	82.40%	70	1.55	19
70-74	81.68%	69	1.39	20	80.60%	75	1.16	20
75-79	79.16%	74	1.01	20	77.00%	80	0.77	20
80-84	75.56%	80	0.62	20	73.40%	84	0.39	20
85-89	71.24%	85	0.23	20	68.00%	89	0.00	20
90-94	65.12%	91	0.00	20	60.80%	93	0.00	20
95-	57.92%	95	0.00	20	53.60%	95	0.00	20

(C) PENPOP.xls

The **PENPOP** worksheet is used as a standard tool to transform the 5-year age-group pensioner population data into single-age data. The interpolation methodology applied to transform the pensioner population data is similar to that applied in the **InitialM** and **InitialF** worksheets. There are three options for interpolating the number of pensioners of the 5-year age-class into single-age: the Sprague formulae, uniform distribution or linear interpolation. The uniform distribution is always applied for average pensions data. The **PENPOP.xls** input-making file contains the following five worksheets:

- INPUT
- Sprague
- Uniform
- Linear
- COPY

The initial step is to enter the 5-year age-group pensioner population data in the **INPUT-PENPOP** worksheet; the format of this worksheet is shown in figure III.2.18.

Figure III.2.18. Format of the INPUT-PENPOP worksheet

age-class	RET Number	RET Average	DIS Number	DIS Average	WID Number	WID Average	ORP Number	ORP Average
0- 4	0	0	0	0	0	0	3	100.28
5- 9	0	0	0	0	0	0	3	100.28
10-14	0	0	0	0	0	0	5	109.28
15-19	0	0	0	0	0	0	24	116.55
20-24	0	0	11	101.46	112	103.10	0	0
25-29	0	0	72	119.17	124	110.52	0	0
30-34	0	0	124	173.23	98	106.24	0	0
35-39	0	0	182	161.42	85	119.47	0	0
40-44	0	0	281	150.96	124	106.14	0	0
45-49	0	0	323	164.00	106	111.36	0	0
50-54	0	0	314	137.29	124	104.16	0	0
55-59	63	281.39	377	114.45	164	105.53	0	0
60-64	2391	308.15	44	162.93	149	148.06	0	0
65-69	1097	299.75	5	197.83	132	127.16	0	0
70-74	68	266.80	0	0	92	104.76	0	0
75-79	66	251.11	1	100.00	46	104.43	0	0
80-84	8	230.44	0	0.00	21	100.00	0	0
85-89	1	545.30	0	0.00	8	90.86	0	0
90-94	0	0.00	0	0.00	0	0	0	0
95-99	0	0.00	0	0.00	0	0	0	0
TOTAL	3695	303.33	1735	144.46	1385.6464	113.4476	34.75139	112.69392

The interpolations of this 5-year age-group pensioner population data are generated in the three intermediate worksheets labelled Sprague, Uniform and Linear.

The **COPY-PENPOP** worksheet is used to display the selected interpolated data. A drop-down menu is used to select the appropriate interpolation module to be applied to the various data sets, as presented in each column (cells B3, D3, F3, H3). The standard setting is to use the Sprague formulae for the old-age, invalidity and widow(er)s’ pensioner population data and to use the uniform distribution for the orphans’ pensioner population data.

The results of automated data-integrity checks are displayed in row 1 of this worksheet. When no negative values are detected in the output columns, the row 1 cells will display “OK”. If negative values are found, the row 1 cells will indicate “Negative value!” against the respective data column. The negative values can be manually adjusted, but care should be taken to retain

consistency with the totals of the source data. Row 2 indicates the calculated population totals of each interpolated data column to aid in cross-checking the consistency with the source data.

The format of the **COPY-PENPOP** worksheet is shown in figure III.2.19.

Figure III.2.19. Format of the **COPY-PENPOP** worksheet

(D) **CREDIST.xls**

The **CREDIST** file generates a distribution of the past credits data. ILO-PENS assumes that the past credits data is normally distributed. User input is required to define the average and standard deviation assumptions.

The **CREDIST.xls** file consists of the following 3 worksheets:

- Input
- Normdist
- Realdist

(1) *Input*

The following data needs to be entered in the **INPUT-CREDIST** worksheet, as at the base year t against each (membership) age bracket:

- the average years of past contributions (column C). The average years of the past contributions should be calculated from the available scheme data;
- the standard deviation of credit distribution (column D). There is no standard approach to estimate the standard deviation factor. It should, therefore, be assumed in an ad hoc way. One possible approach is to set the standard deviation equal to a prescribed percentage of the average, to be applied across the data sets for each specified age;
- the number of the covered population (column B), which can be sourced from the **Covpop.xls** file (see **CovpopM** and **CovpopF** above).

The format of the **INPUT-CREDIST** worksheet is shown in figure III.2.20.

Figure III.2.20. Format of the INPUT-CREDIST worksheet

Age	Covered population	Average	Standard deviation	Average service	standard deviation
15	275	0.5	0.3		
16	275	0.6	0.3	0.50	
17	275	0.9	0.3	0.58	0.921777222
18	353	1.2	0.5	0.83	
19	431	1.5	0.8	1.05	
20	509	1.8	1.0	1.40	
21	587	2.1	1.2	1.86	
22	665	2.4	1.5	2.46	2.425925926
23	662	2.9	1.7	2.94	
24	658	3.3	1.9	3.39	
25	654	3.7	2.2	4.00	
26	651	4.1	2.4	4.19	
27	647	4.6	2.6	4.29	4.552509908
28	641	5.0	3.0	4.97	
29	634	5.5	3.4	5.41	
30	628	6.0	3.7	5.79	
31	621	6.4	4.1	6.40	
32	615	6.9	4.5	7.05	6.898542386
33	594	7.4	4.6	7.45	
34	573	8.0	4.7	8.07	
35	553	8.5	4.8	8.50	
36	532	9.0	4.9	9.00	

(2) *Normdist*

The **Normdist** worksheet uses the two determinant parameters assumed in the INPUT worksheet, namely the average and standard deviation assumptions, to generate the credit distribution. The format of this worksheet is shown in figure III.2.21.

Figure III.2.21. Format of the Normdist worksheet

Age	1	2	3	4	5	6	7	8	9	10	11
5	15	92.85%	7.15%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	16	93.26%	6.46%	0.28%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
7	17	78.77%	19.47%	1.54%	0.11%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%
8	18	64.31%	28.00%	7.03%	0.57%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%
9	19	54.68%	27.30%	13.82%	3.76%	0.42%	0.02%	0.00%	0.00%	0.00%	0.00%
10	20	48.59%	26.01%	15.50%	7.60%	2.09%	0.17%	0.03%	0.00%	0.00%	0.01%
11	21	40.69%	25.51%	16.96%	10.58%	4.73%	1.36%	0.17%	0.01%	0.01%	0.00%
12	22	33.13%	25.17%	18.12%	11.92%	6.56%	3.46%	1.41%	0.18%	0.03%	0.00%
13	23	29.32%	22.69%	18.21%	12.92%	7.95%	4.65%	2.70%	1.09%	0.41%	0.03%
14	24	26.19%	20.71%	18.05%	13.42%	9.10%	5.39%	3.48%	2.03%	1.07%	0.52%
15	25	23.08%	19.61%	17.43%	13.11%	9.87%	6.35%	4.54%	2.70%	1.72%	1.17%
16	26	19.47%	18.04%	17.12%	13.18%	10.13%	7.44%	5.52%	3.41%	2.46%	1.83%
17	27	16.26%	16.44%	16.43%	13.28%	10.48%	7.72%	6.23%	4.40%	3.59%	2.45%
18	28	13.53%	14.52%	15.03%	13.62%	10.91%	8.77%	6.91%	5.21%	4.15%	3.30%
19	29	11.99%	12.92%	13.54%	12.33%	11.40%	9.53%	7.73%	6.05%	4.84%	3.83%
20	30	9.49%	10.61%	11.38%	11.17%	10.76%	10.17%	8.65%	7.30%	6.15%	4.71%
21	31	8.64%	9.38%	10.02%	9.63%	10.04%	9.82%	8.98%	7.79%	7.14%	5.76%
22	32	7.27%	8.38%	9.05%	8.76%	9.23%	9.10%	9.00%	8.26%	7.43%	6.34%
23	33	6.93%	7.40%	7.83%	7.82%	8.08%	8.20%	8.37%	8.33%	7.94%	7.35%
24	34	6.04%	6.57%	6.80%	7.13%	7.38%	7.78%	7.65%	8.20%	7.77%	7.81%
25	35	5.66%	6.21%	6.30%	6.57%	6.53%	6.82%	7.32%	7.42%	7.57%	7.89%
26	36	5.00%	5.58%	5.88%	5.99%	6.38%	6.39%	6.78%	7.15%	7.29%	7.38%

The methodology of the Normdist worksheet is explained as follows:

Let:

XX : X-15, i.e. age-15 (see column A);

I : Year of past contributions ($I=1,2,3,\dots,55$) (see row 3);

$f(I)$: Percentage of covered persons whose past contribution year is between $I-1$ and I (see area B5:BE59);

$N(\zeta;\mu,\sigma)$: Probability density function of the normal distribution of average (μ) and standard deviation (σ);

$AN(\zeta;\mu,\sigma)$: Distribution function of the normal distribution of average (μ) and standard deviation (σ).

From the assumption, we know the values of μ_x and σ_x for each X . For each age group, there are four different formulae to be applied for the calculation of credit distribution $f_x(I)$ against the various past contributions values:

$$(1) \quad f_x(I) = AN(I;\mu_x,\sigma_x) \text{ (for } I = 1)$$

$$(2) \quad f_x(I) = AN(I;\mu_x,\sigma_x) - AN(I-1;\mu_x,\sigma_x) \text{ (for } 2 \leq I \leq XX)$$

$$(3) \quad f_x(I) = I - AN(XX;\mu_x,\sigma_x) \text{ (for } I = XX+1)$$

$$(4) \quad f_x(I) = 0 \text{ (for } XX+2 \leq I \leq 55)$$

The formulae (1), (3) and (4) are necessary to truncate the tails of the distribution which lie outside the appropriate range of the contribution year, thus yielding more credible values. The generated results should be imported into the **Past** worksheet of the group file.

(3) *Realdist*

The number of the initial covered population by credit year is calculated by applying the credit distribution (generated by the **Normdist** worksheet) to the total covered population by age. This application will yield the global credit distribution.

3. Projections

In this section, we explain the structure of the projection programme, how to modify the programme and finally how to run the programme.

3.1. General

Overview of the programme

- To make projections, the input files are needed. The explanation of the preparation of the input files is given in part III, section 2.3.2 above.
- Prior to making projections, it may be necessary to make modifications to the programme. The explanation of how to make these modifications is given in part III, section 3.3 below.
- Part III, section 3.4 below, explains the procedure for running the projection programme. The maximum years of projection is set at 100 years.
- Where projections have been made for multiple population groups, the projection results are stored in unique text files for each group. These text files are then converted into Excel files and consolidated into the total result file. The explanation of the result files is given in part III, section 4 below.

Contents of ILO-PENS projection files

The content of ILO-PENS.xls is shown in figure III.3.1. The **ILO-PENS** projection programme consists of several worksheets. Two of these are normal Excel spreadsheets, entitled “Cover” and “InputS”, while the remaining worksheets consist of modules programmed in VBA. Each VBA worksheet contains one or several modules. The modules are grouped with respect to their functions and are stored in different worksheets.

Figure III.3.1. Contents of ILO-PENS projection files

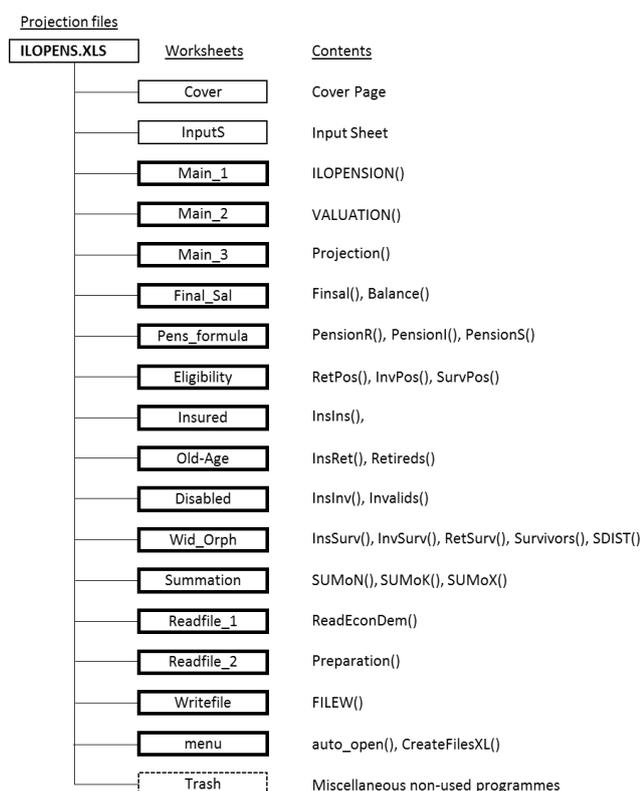
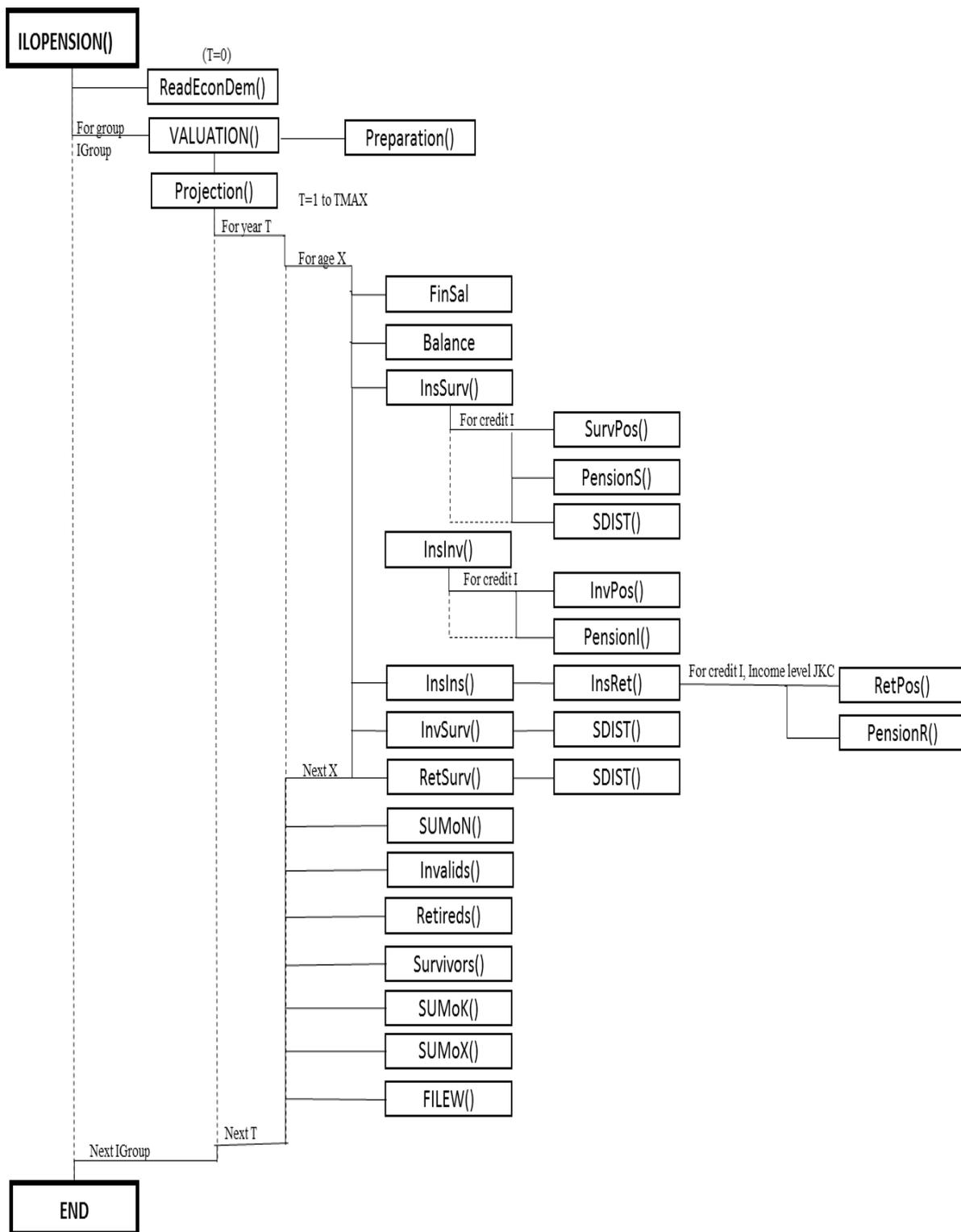


Figure III.3.2. Module flow of ILO-PENS



The following sections explain, in detail, the workings of the different (simulation) modules and the **Cover** and **Inputs** Excel worksheets. The modules stored in the **Menu** worksheet are used for generating result files.

3.2. Structure of the simulation module

3.2.1. The module flow

The flow chart of the VBA projection programme is shown in figure III.3.2. Each box in this diagram represents a simulation module. There are three main modules in the programme: **ILOPENSION()**, **VALUATION()** and **Projection()**.

The flow of the simulation process begins at **ILOPENSION()**, where it incorporates the economic and demographic input data from the **ReadEconDem()** module.

Once the data has been incorporated, the process flows next to the **VALUATION()** module, where the data is formatted by the **Preparation()** module.

The VBA programme is then ready to process projections of the scheme membership and their dependants, commencing at base year t and the current age x . Within the **Projection()** module, the future expected earnings and the accrued contributions are generated and compiled by the **FinSal()** and **Balance()** modules, respectively.

With reference to the **InsSurv()** worksheet, the *active membership* is further subjected to benefit eligibility conditionalities, accrued pension benefit determinations and the probabilistic distribution of survivors, vis-à-vis the **SurvPos()**, **PensionS()** and **SDIST()** modules, respectively.

The projection module further considers the *new cases of invalidity* (during the base year t) via the **InsInv()** module. The file output (new invalids) is similarly subject to benefit eligibility and accrued pension benefit determinations via the **InvPos()** and **PensionI()** modules, respectively.

Next, the *new retirees* (during the base year t) are quantified by the **InsIns()** and **InsRet()** modules. This output (new retirees) is similarly subjected to benefit eligibility and accrued pension benefit simulations via the **RetPos()** and **PensionR()** modules, respectively.

The *existing (normal, invalid and survivor) pensioners* (prior to base year t) output is quantified by the **InvSurv()**, and **RetSurv()** modules. This output is subjected to death attrition possibilities via the **SDIST()** module.

Once these iterations of the demographic and economic profile of the scheme are undertaken by the modules above, a summation of the resultant retirement benefits paid out to these groups is processed by the *sequential* application of the **SumoN()**, **Invalids()**, **Retireds()**, **Survivors()**, **SumoK()** and **SumoX()** modules. Next, the collective outputs of the membership by class, age, benefit accrued, benefits paid out, etc. are written in the results file by the **FILEW()** module.

The projection module will then repeat the same iteration as at $t+1$, against the revised membership and age profile as at $x+1$.

Module flow (summary)

- (1) **ILOPENSION()** uploads the economic-demographic data file.
- (2) **VALUATION()** formats the economic-demographic data file at $t=0$.
- (3) **Projection()** derives the profile of earnings and accrued credits for *registered members* via **FinSal()** and **Balance()** modules, respectively.

-
- (4) Survival rates, benefit eligibility and accrued pension benefits in respect of *active members* are derived from **Insurv()**, **Survpos()**, **PensionS()** and **SDIST()** modules.
 - (5) *New cases of invalidity* and the related invalidity pension benefit eligibility, as well as payable invalidity pension benefits, are determined by **InsInv()**, **InvPos()**, and **PensionI()** modules.
 - (6) *New cases of retirement* and the related retirement pension benefit eligibility, as well as payable retirement pension benefits, are determined by **InsIns()**, **InsRet()**, **RetPos()** and **PensionR()** modules.
 - (7) *Existing (invalid, retirement, survivor) pensioners* are subjected to expected mortality experience by **InvSurv()**, **RetSurv()** and **SDIST()** modules.
 - (8) *Membership profile* and *benefit payment* iterations are summed up and written in the file by **SUMON()**, **Invalids()**, **Retireds()**, **Survivors()**, **SUMOK()**, **SUMOX()** and **FILEW()** modules.
 - (9) The **Projection()** module is repeated in its entirety (steps (3) to (8) above)) with respect to residual membership profile for the period $T+1$. This process can be looped repeatedly until the desired $T+n$ projection time frame has been reached and related reports generated.
 - (10) The programme can then terminate or be repeated from the initial module **ILOPENSION()** to consider a new population and or scheme profile.

3.2.2. Descriptions of the modules

In this section, detailed descriptions of each simulation submodule is given.

(1) Submodule: ILOPENSION()

Worksheet: Main_1

Links (calls): ReadEconDem(), VALUATION()

Operation:

- 1) Defining variables.
- 2) Setting maximum age (=69) and minimum age (=15) of coverage and the ultimate age of life span (=99).
- 3) Reading general information from the input worksheet "InputS" (link: ReadEconDem()).
- 4) Reading economic factors and future mortality tables from economic-demographic file (link: ReadEconDem()).
- 5) Controlling simulation by group (link: VALUATION()).

(2) Submodule: VALUATION()

Worksheet: Main_2

Links (called from): ILOPENSION()

Links (calls): Preparation(), SUMoK(), SUMoX(), FILEW(), Projection()

Operation:

- 1) Reading output file information of the group.
- 2) Preparing names of four text files (see output files naming convention).
- 3) Reading data of initial year ($t=0$) (link: Preparation()).
- 4) Summarizing data of initial year (link: SUMoK(), SUMoX()).
- 5) Opening output text files.
- 6) Writing results of initial year in text files (link: FILEW()).
- 7) Making projection (link: Projection()).
- 8) Closing output text files.
- 9) Erasing variables.

(3) Submodule: PROJECTION()

Worksheet: Main_3

Links (called from): VALUATION()

Links (calls): Finsal(), Balance(), InsSurv(), InsInv(), InsIns(), InvSurv(), RetSurv(), Invalids(), Retireds(), Survivors(), SUMoN(), SUMoK(), SUMoX(), FILEW()

Operation:

- 1) Simulation by year ($t=1$ to TMAX).
- 2) Reading data of year t .
- 3) Simulation by age ($X=(Jmax-1)$ to $Jmin$, step -1).
- 4) Preparing average insurable earnings.
- 5) Preparing survivors' components.
- 6) Calculating final average salary (link: Finsal()).
- 7) Calculating accumulated value of contributions (link: Balance()) (option).
- 8) Decrement from active population.
- 9) Decrement from inactive population.
- 10) Transition from insureds to survivors pensioners (link: InsSurv()).
- 11) Transition from insureds to invalidity pensioners (link: InsInv()).
- 12) Transition from insureds to insureds or old-age pensioners (link: InsIns()).
- 13) Transition from invalidity pensioners to survivors pensioners (link: InvSurv()).

-
- 14) Transition from old-age pensioners to survivors pensioners (link: RetSurv()).
 - 15) Next age X-1 (Return to (3)).
 - 16) Calculating total number of newly awarded pensioners over categories (link: SUMoN()).
 - 17) Transition of existing pensioners in last year and aggregating newly awarded pensioners for invalidity pension (link: Invalids()).
 - 18) Transition of existing pensioners in the last year and aggregating newly awarded pensioners for old-age pension (link: Retireds()).
 - 19) Transition of existing pensioners in the last year and aggregating newly awarded pensioners for survivors pension (link: Survivors()).
 - 20) Calculating total number of existing pensioners over categories (link: SUMoK()).
 - 21) Calculating total number of existing pensioners over ages (link: SUMoX()).
 - 22) Writing the results of the initial year on the text files (link: FILEW()).
 - 23) Next year T+1 (return to (1)).

(4) Submodule: INSINS()

Worksheet: Insured

Links (called from): Projection()

Links (calls): InsRet()

Operation:

- 1) Calculating credit distribution of ZACT and ZNACT.
- 2) Transition between active and inactive populations.
- 3) Calculating sum of inactive population.
- 4) If the sum is positive, then consider transition to old-age pension (link: InsRet()).
- 5) Calculating sum of active and inactive populations.
- 6) Adjusting credit distribution of active population by taking into account contribution density in the relevant year.
- 7) Adjusting credit distribution of inactive population.

(5) Submodule: FINSAL()

Worksheet: Final_Sal

Links (called from): Projection()

Return values: FINS(I, JKC) (I=1 to I_{max}; JKC=0 to 3)

Operation:

- 1) Calculating the final average salary of the last I years for each credit and each income level (see note on final salary).

(6) Submodule: BALANCE()

Worksheet: Final_Sal
Links (called from): Projection()
Return values: BAL(I, JKC) (I=1 to I_{max}; JKC=0 to 3)

Operation:

- 1) Calculating the accumulated values of contributions for each credit and each income level (see note on final salary).

(7) Submodule: PENSIONR()

Worksheet: Pens_formula
Links (called from): InsRet()
Main input values: CDT: credit; I: credit year; JKC: income level
Return values: P: pension amount, JPR: subcategory of old-age pensions

Operation:

- 1) Calculating old-age pension by pension formula for each credit I and for each income class JKC (see note on modification of pension formula).
- 2) Check maximum pension.
- 3) Check minimum pension and judge whether or not original pension is lower than minimum pension (see note on estimation of beneficiaries receiving minimum pensions).

(8) Submodule: PENSIONI()

Worksheet: Pens_formula
Links (called from): InsInv()
Main input values: CDT: credit (including additional years); I: credit year
Return values: P: pension amount; JPI: subcategory of invalidity pensions

Operation:

- 1) Calculating invalidity pension by pension formula for each credit I (unlike old-age pension, income class is not considered; see note on modification of pension formula).
- 2) Check maximum pension.

-
- 3) Check the minimum pension and judge whether or not the original pension is lower than the minimum pension (see note on estimation of beneficiaries receiving minimum pensions).

(9) Submodule: PENSIONS()

Worksheet: Pens_formula

Links (called from): InsSurv()

Main input values: CDT: credit (including additional years); I: credit year

Return values: P: pension amount

Operation:

- 1) Calculating survivors pension on death of active persons by pension formula for each credit I (unlike old-age pension, income class is not considered; see note on modification of pension formula).
- 2) Check maximum pension.
- 3) Check minimum pension and judge whether or not original pension is lower than minimum pension (see note on estimation of beneficiaries receiving minimum pensions).

(10) Submodule: RETPOS()

Worksheet: Eligibility

Links (called from): InsRet()

Main input values: CDT: credit (including additional years); X+1: age

Return values: GER: result of examination of eligibility condition

Operation:

- 1) Check eligibility condition for old-age pension.

(11) Submodule: INVPOS()

Worksheet: Eligibility

Links (called from): InsInv()

Main input values: CDT: credit (including additional years); X+1: age

Return values: GEI: result of examination of eligibility condition

Operation:

- 1) Check eligibility condition for invalidity pension.

(12) Submodule: SURVPOS()

Worksheet: Eligibility

Links (called from): InsSurv()

Main input values: CDT: credit (including additional years); X+1: age

Return values: GES: result of examination of eligibility condition

Operation:

- 1) Check eligibility condition for survivors' pension on death of active persons.

(13) Submodule: INSRET()

Worksheet: Old-age

Links (called from): InsIns()

Links (calls): RetPos(), PensionR()

Main input values: B(I): number of inactive persons (after considering transition from active population); X+1: age

Main intermediate values: RACT, RRACT, ARET, ARES, AREU

Return values: NPR: newly awarded pensioners; AGRT: beneficiaries of grant

Operation:

- 1) Calculating ad hoc correlation between credits and income levels (see note on correlation).
- 2) For each credit year I and income level JKC, simulating old-age pensions and grants (link: RetPos(), PensionR()) (see note on transition).

(14) Submodule: RETIREDS()

Worksheet: Old-age

Links (called from): Projection()

Main input values: NPR: newly awarded pensioners; Q: mortality rates; RINFB: rate of increase of benefits

Return values: RET: total pensioners

Operation:

- 1) For each age XR and for each category K, estimating the survival of previous pensioners and aggregating newly awarded pensioners.
- 2) Identifying a reporting for minimum pensions.

(15) Submodule: INSINV()

Worksheet: Disabled

Links (called from): Projection()

Links (calls): InvPos(), PensionI()
Main input values: F(I, XX), Fg(I, XX), VACT, VNACT, PNINV
Return values: NPI: newly awarded pensioners, AGRT: beneficiaries of grant

Operation:

- 1) For each credit year I, simulating old-age pensions and grants (link: InsPos(), PensionI()).

(16) Submodule: INVALIDS()

Worksheet: Disability
Links (called from): Projection()
Main input values: NPI: newly awarded pensioners, QI: mortality rates, RINFB: rate of increase of benefits
Return values: DIS: total pensioners

Operation:

- 1) For each age XI and for each category K, estimating the survival of previous pensioners and aggregating newly awarded pensioners.
- 2) Identifying a reporting for minimum pensions.

(17) Submodule: InsSurv()

Worksheet: Wid_Orph
Links (called from): Projection()
Links (calls): SurvPos(), PensionS(), SDIST()
Main input values: DACT, DNACT, F(I,XX), Fg(I,XX), PFUNB
Main intermediate values: DDACT, DDD1, DDD2, JCG, P, PDW
Return values: AFUNB, AGRT, (NPW, NPO)

Operation:

- 1) Calculating funeral benefit.
- 2) For each credit I, simulating survivors' pensions (link: SurvPos(), PensionS(), SDIST()).

(18) Submodule: RetSurv()

Worksheet: Wid_Orph
Links (called from): Projection()
Links (calls): SDIST()

Main input values: RET, Q, PFUNB
Main intermediate values: DRET, DDD1, DDD2, JCG, PDW
Return values: AFUNB, AGRT, (NPW, NPO)

Operation:

- 1) Calculating funeral benefit.
- 2) Simulating survivors' pensions on death of old-age pensioners (link: SDIST()).

(19) Submodule: INVSURV()

Worksheet: Wid_Orph
Links (called from): Projection()
Links (calls): SDIST()
Main input values: DIS, Q
Main intermediate values: DINV, DDD1, DDD2, JCG, PDW
Return values: AFUNB, AGRT, (NPW, NPO)

Operation:

- 1) Calculating funeral benefit.
- 2) Simulating survivors' pensions on death of invalidity pensioners (link: SDIST()).

(20) Submodule: SURVIVORS()

Worksheet: Wid_Orph
Links (called from): Projection()
Main input values: NPW, NPO, PW, PO, RINFB
Return values: WID, ORP

Operation:

For each age XS and for each category K, estimating the survival of previous pensioners and aggregating newly awarded pensioners.

(21) Submodule: SDIST()

Worksheet: Wid_Orph
Links (called from): InsSurv(), InvSurv(), RetSurv()
Main input values: DDD1, DDD2, AVSP, RWP, ROP, AVCH, JCG
Main intermediate values: DISW, DISO
Return values: NPW, NPO

Operation:

- 1) Ad hoc deviation from average age difference (center=2).
- 2) For each age JS and for each category JCG, summing newly awarded survivors' pensioners.

3.3. Modification of the programme

The VBA projection programme is modifiable to reflect the national legislative framework of a specified country and the unique design parameters of the underlying scheme(s). The VBA programme can model common defined-benefit and defined-contribution design parameters as well as hybrid schemes. The impact of proposed reform measures can also be modelled.

For ease of programming, the submodules with close functional relationships are grouped together in the same worksheet. This makes it easier to identify the segment of the programme where necessary modifications are to be made. The following section outlines the typical changes that can be introduced to the ILO-PENS model to better align the VBA programme with the profile of each unique scheme. Modifications that can be made include eligibility conditions, pension formula, scheme entry and withdrawal rates.

Although the modifications guide provided below does not cover the full scope of possible modifications, it does provide a useful modification framework that users can expand to attain the full scope of required tailoring. It should be kept in mind that the success of effective modelling ultimately depends on the ability of the user to source credible data and projection assumptions and to modify projection parameters to accurately reflect the profile of the scheme.

3.3.1. Brief technical guide to the modification of the programme

The following are examples of the types of modifications that can be made with respect to the pension formula. Note that in these submodules the main input variables include **CDT** (number of credit years), **FINS(I, JKC)** (final average salary), **BAL(I, JKC)** (accumulated balance of individual DC savings accounts), **FPEN(T)** (flat-rate pension) with the output variable P (accrued pension), **RINFB(T)** (pension in payment adjustment factor).

Other input variables may be introduced to attain a more refined profiling of the unique scheme characteristics. These include **BP1(T)** and **BP2(T)** (salary bands/thresholds at time t), **RSAL1** and **RSAL2** (unique reference salaries against which specific benefit accruals are assigned), **ANN** (annuity factor) and **ARINFS(T)** (the accumulated values of the salary increase at base year t).

(1) Eligibility conditions

Worksheet: Eligibility

Submodules: RetPos(), InvPos(), SurvPos()

Note: Eligibility conditions are defined by national legislation and specific scheme rules and are simulated in the above submodules.

Example 1 (vesting period)

If the pension benefit formula is premised on first completing the required minimum contributory period and then subsequently defined with respect to a pension formula as follows:

- Benefit Eligibility / Vesting Period: 10 credit years (i.e. contributory service).

Where **CDT** < 10 years.

Then the accrued pension (P) is equal to the withdrawal benefit.

Where **CDT** >=10 years.

Then the accrued pension (P) is defined by the accrued pension formula.

(2) Pension formula

Worksheet: Pens_formula

Submodules: PensionR(), PensionI(), PensionS()

Note: The pension benefit formula is defined by national legislation and specific scheme rules and is modelled in the submodules provided above.

Example 2 (Defined benefit; earnings-related pension)

If the pension benefit formula is defined with respect to reference salary and length of service within these parameters:

- Basic benefit rate 40 per cent;
- Supplementary rate 2 per cent in excess of 25 credit years.

Let:

TT=CDT - 25 “Credit years in excess of 25 years”

If **TT**>0 then apply the resultant value

If **TT**<0 then apply **TT=0**

The accrued pension formula is denoted as:

$P = 0.01 * (40 + 2 * TT) * FINS(I, JKC)$

Note: A model that takes into account the possible correlation between the contribution period and the wage level has been developed.⁵

⁵ For the model and for further details related to this section, see K. Hirose: *Topics in quantitative analysis of social protection systems*, Issues in Social Protection, Discussion Paper 6 (Geneva, ILO, 199), Chapter 9.

Example 3 (Defined benefit; flat pension + earnings-related pension)

If the pension benefit is defined with respect to a flat (base) pension, augmented by a pension benefit formula premised on the reference salary and length of service within these parameters:

- Flat-rate portion $FPEN(T)$;
- Earnings-related portion: 1 per cent of accrual rate for each credit year.

Therefore the accrued pension formula is denoted as:

$$P = FPEN(T) + 0.01 * CDT * FINS(I, JKC)$$

- Remark: The values of $FPEN(T)$ should be provided in the **Econ** module as found in the **EconDem.xls** (the economic-demographic file).

Example 4 (Defined benefit; different benefit rate with respect to various salary bands)

If the pension benefit is defined with respect to multiple salary references, as well as **length of service**, the different benefit rates are applied to the different portions of reference salary (i.e. $BP1(T)$, $BP2(T)$):

- 0.9 * (The portion of the reference salary $RSAL1$ lower than $BP1(T)$);
- 0.3 * (The portion of the reference salary $RSAL2$ between $BP1(T)$ and $BP2(T)$);
- 0.15 * (The portion of the reference salary $RSAL3$ higher than $BP2(T)$).

The bend points $BP1(T)$ and $BP2(T)$ are given in the **Econ** module as found in the **EconDem.xls** (the economic-demographic file).

If: $RSAL2 = 0$; $RSAL3 = 0$

Then: $RSAL1 = FINS(I, JKC)$

If: $RSAL2 > 0$; $RSAL3 > 0$

Then: $RSAL2 = FINS(I, JKC) - BP1(T)$

$RSAL3 = FINS(I, JKC) - BP2(T)$

Therefore the accrued pension formula is denoted as:

$$P = 0.9 * RSAL1 + 0.3 * RSAL2 + 0.15 * RSAL3$$

- Remark: In this example, the pension formula is applied to average salaries. However, because of the disaggregation by credit and income level, each component is considered to be small enough to have little deviation around the average.

Example 5 (Defined contribution; annuitization of individual balance)

If the pension benefit is calculated by dividing the final balance of the individual savings account by the applicable annuity factor **ANN**:

Therefore the accrued pension formula is denoted as:

$$P = BAL(I, JKC) / ANN$$

- Remark: The values of **BAL(I, JKC)** are calculated in the **Balance()** module. The annuity factor **ANN** is calculated either in the accessory file **UNmort.xls** and written directly in the programme, or in an additional submodule (which the users have to create).

(3) Reference average salary

Worksheet: Final_sal

Submodules: Finsal(), Balance()

*Formula of the reference salary for pension
(for defined benefit scheme)*

Note: While the input variable **FINS(I, JKC)** (final average salary) has been previously introduced, this variable has various features which can be adjusted to conform with the specific definition as found in the scheme rules and/or national legislation, as modelled in the above submodules.

Suppose that the reference salary is calculated as the average salary of the final **K** years of one's working life. Then, **FINS(I, JKC)**,⁶ the average salary of the person aged **X** of the income level **JKC** with credit (**I**) in year **t**, is given as follows:

$$FINS(I, JKC) = \frac{1}{IE} \sum_{j=1}^{IE} SAL(X - J - 1, T - J, JKC) \times adj(T, J)$$

$$FINS(I, JKC) = \frac{1}{IE} \sum_{j=1}^{IE} SAL(X - J - 1, T - J, JKC) \times adj(T, J)$$

Let:

T : Year
X : Age
I : Years of credits
JKC : Income level (1: low , 2: medium, 3: high)
SAL(X, T, JKC) : Salary of age **X** of income class **JKC** in year **T** (exogenous).

Where:

IE = min{k, T+5, X-15} “defines the length of the k years over which salary is averaged”

and

adj(T, J) = 1 (if past salaries are not revalued) “defines the salary adjustment factor applicable to salaries earned over the period **T** to **J**”

or

adj(T, J) = **ARINFS(T-1) / ARINFS(T-J)** (if past salaries are revalued).

Where: **ARINFS(T)** is the accumulated values of the salary increase at base year **t**

⁶ Note that FINS is recalculated in each **X** and each **T**.

In deriving the above formula, we assume the following:

- (1) There is no transition between different income groups.
- (2) This model can refer to the years prior to the date of valuation (up to the past 5 years). In case more years are necessary (e.g. career average), some modification will be needed.

*Formula of the accumulated value of the contribution
(for defined – contribution scheme)*

Note: While the input variable **BAL(I, JKC)** (the accumulated balance of individual DC savings accounts) has been previously introduced, this variable has various features which can be adjusted to conform with the specific definition as found in the scheme rules and/or national legislation, as modelled in the above submodules.

$$BAL(I, JKC) = \sum_{J=1}^{IE} SAL(X - J - 1, T - J, JKC) \times CONT(T - J) \times \frac{ARINT(T - J - 1) \times RINT(T - J)^{\frac{1}{2}}}{ARINT(T - IE)}$$

Let:

T : Year
 X : Age
 I : Years of credits
 JKC : Income level (1: low , 2: medium, 3: high)
 $SAL(X, T, JKC)$: Salary of age X of income class JKC in year T (exogenous).

Where:

$IE = \min\{k, T+5, X-15\}$ “defines the length of the k years over which salary is averaged”

$CONT(T)$: Contribution rate in year T

$RINT(T)$: Annual rate of interest in year T

$ARINT(T)$: Compound rate of interest in year T (base year $T=0$).

(4) Adjustment of pensions in payment

Worksheet: Old Age, Disability, Wid_Orph

Submodules: Retireds(), Invalids(), Survivors()

Note: To introduce the adjustment factor of pensions in payment, simply change the applicable $RINFB(T)$ (pension in payment adjustment factor) in the Econ module as found in the economic-demographic file EconDem.xls.

(5) Normal retirement age

Worksheet: Old Age, Eligibility

Submodules: Retireds(), RetPos()

Note: To adjust the normal retirement age applicable to the scheme, simply change the value related to $NRA(T)$ (normal retirement age) in the Econ module as found in the economic-demographic file EconDem.xls.

3.4. How to run the programme

3.4.1. General instruction

Once the input files and scheme-specific modifications are ready, the following instructions will guide the user on how to run the VBA projection programme.

3.4.2. Input sheet

Prior to running the Projection() programme, one has first to specify the general economic and demographic file information in the input worksheet InputS.

The format of InputS is shown in figure III.3.3. In this worksheet, one has to specify the general information and the file information. After each run of the programme, the file name is automatically printed in cell B1, the date and time are updated in cell B2 and this sheet is printed. The printout can be used as the job report of the run.

(1) General information

The following information should be specified:

- **Title** (B4).
- **Base year** (B5).
- **Years of projection** (B6): The number of years of projection (maximum 100 years).
- **Number of groups** (B7): The number of groups of the covered population (maximum 10).
- **Unit of input values** (B8): The unit used for the input average amounts (as sourced from the **Econ** module in the economic-demographic file **EconDem.xls**, inclusive of **Pens** and **SalL-SalH** in the group file) can be varied (the appropriate unit should be selected from the drop-down bar: in nominal, in thousands or in millions).
- **Basis of input average amounts** (B9): The basis used for the input average amounts in the **Econ** worksheets module in the economic-demographic file and **Pens, SalL, SalM** and **SalH** in the group file (a selection should be made from the drop-down bar: either monthly, yearly or daily).
- **Unit of output total amounts** (B10): The unit used for the output total amounts in the result files (a selection should be made from the drop-down bar: either in nominal, in thousands, in millions, in billions or in trillions).
- **Unit of output average amounts** (B11): The unit used for the output average amounts in the result files (a selection should be made from the drop-down bar: in nominal, in thousands or in millions).
- **Basis of output average amounts** (B12): The basis used for the output average amounts in the result files (a selection should be made from the drop-down bar: either monthly, yearly or daily).
- **Options of the funeral grants and the invalidity and survivors' pensions (B13-B16)**: One should specify “Yes” or “No” in the drop-down bar (see also technical note 5).

Figure III.3.3. Format of the InputS worksheet

	A	B	C	D	E	F
1	Job Report	PEN_US_NEW.xls				
2	DATE & TIME:	07/07/2017 13:59				
3	General information					
4	Title	With aids run				
5	Base Year	2012				
6	Years of projection (max. 100)	52				
7	Number of groups (max. 10)	2				
8	Unit of input average amounts:	in nominal				
9	Basis of input average amounts:	monthly				
10	Unit of output total amounts:	in million				
11	Unit of output average amounts:	in nominal				
12	Basis of output average amounts:	monthly				
13	Do you pay funeral grants?	Yes				
14	Do you pay funeral grants on the death of spouses?	No				
15	Do you pay invalidity pension for inactive persons?	Yes				
16	Do you pay survivors pension on the death of inactive persons?	Yes				
17						
18	File information					
19	Input files (each group):	Group1	Group2			
20	Description	Male (general)	Female (general)			
21	Sex (Male or Female)	Male	Female	Male	Female	
22	Drive and directory:(e.g. c:\projections)	h:\zimbabwe\model	h:\zimbabwe\model	US_NEW\ilopens\proj		
23	File name (e.g. Male1)	Male1	Female1			
24	Normal Retirement Age	60	60			
25	Benefit rate for widows	40%	40%			

(2) File information

Input files (group files)

According to the number of groups that one inputs in cell B7, the headings of the groups appear in row 19. For each group, the following information should be specified:

- **Description** (row 20): The name of the group (this is for clarification).
- **Sex** (row 21): The appropriate sex should be selected from the drop-down bar.
- **Drive and directory** (row 22): The name of the drive and directory under which the file is stored, e.g. I:\pensmod\test.
- **File name** (row 23): The name of the file, e.g. Male1: Full name is created in the programme, i.e. I:\pensmod\test\Male1.
- **Normal retirement age** (row 24): see variable NRA.
- **Benefit rates for widows and orphans** (row 25 and 26) (see variable RWP, ROP; note the partition rule of the survivors' pension in the legislation).

Input file (economic-demographic file)

The following information should be specified:

- Description (row 29): The name of the assumption (this is for clarification).
- Drive and directory (row 30).
- File name (row 31).

Result files

The following information should be specified:

- **Drive and directory** (row 34).
- **Prefix of the file name** (row 35): The prefix of the name of the result file (see naming convention of result file given in part III.4).
- **Option for printing** (row 37): The kind of results files that will be converted into Excel files should be specified in the drop-down bar (this is to save execution time; see naming convention of result file given in part III.4).

Base files

The base files are used to convert text files into Excel files. These are Excel files in which the format framework is already prepared (see part III.4). The following information should be specified:

- **Drive and directory** (row 43).
- **Name of the file name** (row 44).

3.4.3. Special menu bar

In the **Cover** and **InputS** worksheets, a special menu bar entitled “**Actuarial**” has been created (see figure III.3.3). There are two commands within the **Actuarial** sub-menu, namely: “**Calculation**” and “**Creating result files**”. If “**Calculation**” is selected, the main module **ILOPENSION()** will be opened. If “**Creating result files**” is selected, then the result file-making module **CreateFilesXL()** will be opened. To see the mechanism of this menu bar, go to any module or worksheet, select **Tools** and then select **Menu Editor**.

4. Results

After the VBA projection programme has completed processing the data, there is a need to consolidate the generated files and prepare them to produce output reports. This process is outlined below.

4.1. Text output files

The general file flow of the output files is outlined in figure III.4.1. The results of the projection programme are generated in the text files, by group. The headlines of these results are shown in figure III.4.2. For each group, the demographic and financial results are presented together, in two reporting versions. The first report presents the results in a consolidated manner, presenting a year-by-year evolution of the scheme, while the second report presents the same data with a membership and beneficiary age-profile breakdown.

Two additional reports are also produced that focus on the year-by-year evolution of new beneficiaries only; the first report presents the total number of new beneficiaries and associated benefit expenses, while the second report presents the same data with a beneficiary age-profile breakdown.

All in all, the VBA programme produces four output text files. The names of these output files are automatically generated by the **VALUATION()** submodule, following the convention shown below.

Let “aaa” be the prefix of the result file, while “k” designates the group name:

- **aaakT.TXT** Consolidated reporting of total membership and beneficiary numbers, as well as amounts of associated benefit expenses (including new cases) for each year of projection t.
- **aaakTN.TXT** Consolidated reporting of total numbers and benefit amounts, for new beneficiaries only, for each year of projection t.
- **aaakX.TXT** Detailed reporting of total membership and beneficiary numbers, as well as amounts of associated benefit expenses (including new cases), aggregated by age x and relevant year of projection t.
- **aaakXN.TXT** Detailed reporting of total numbers and benefit amounts for new beneficiaries only, aggregated by age x and relevant year of projection t.

Note that the financial results in the age-specific file are expressed in the average, while those in the consolidated file are expressed in total.

Figure III.4.1. Creation of the result files

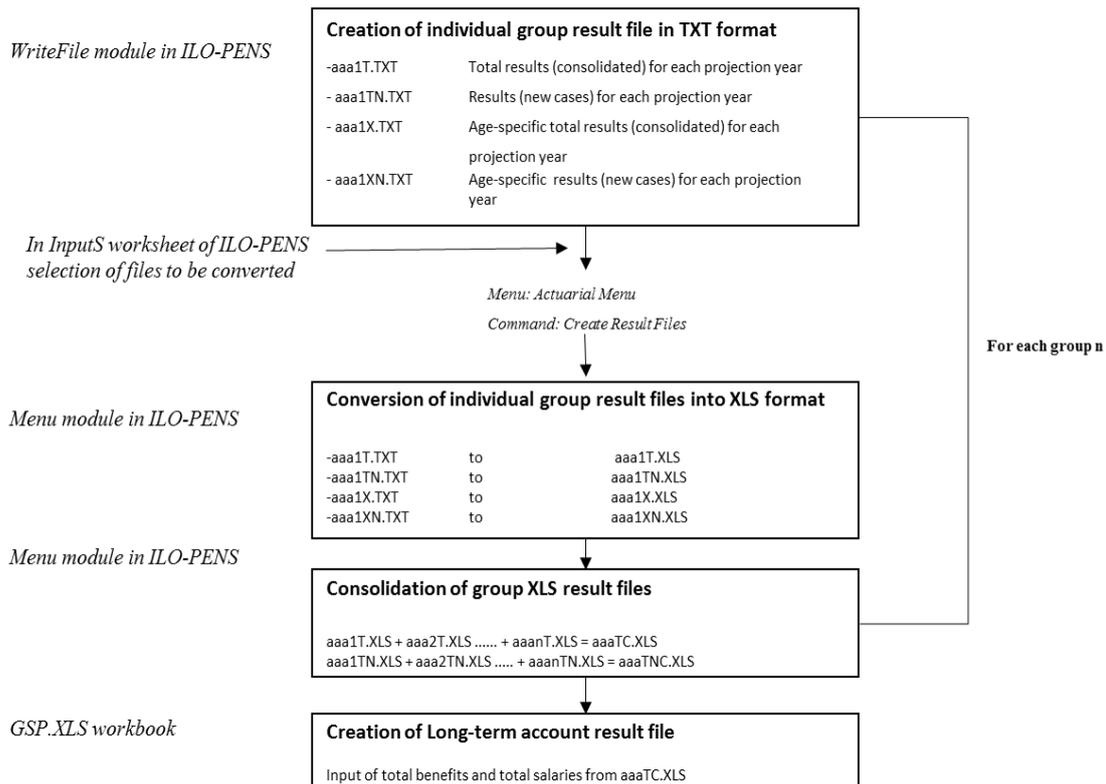
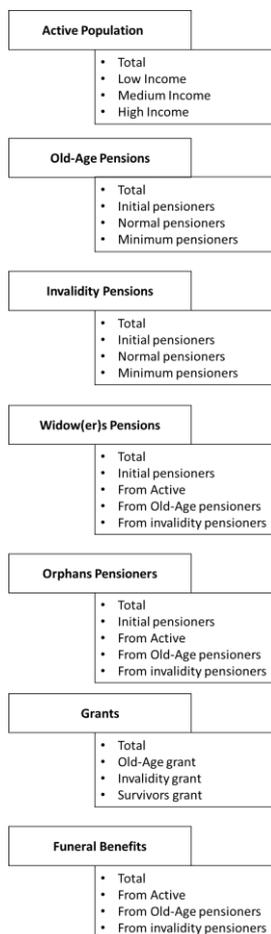


Figure III.4.2. Headings of the output files (Raw data)



4.2. Conversion to Excel files

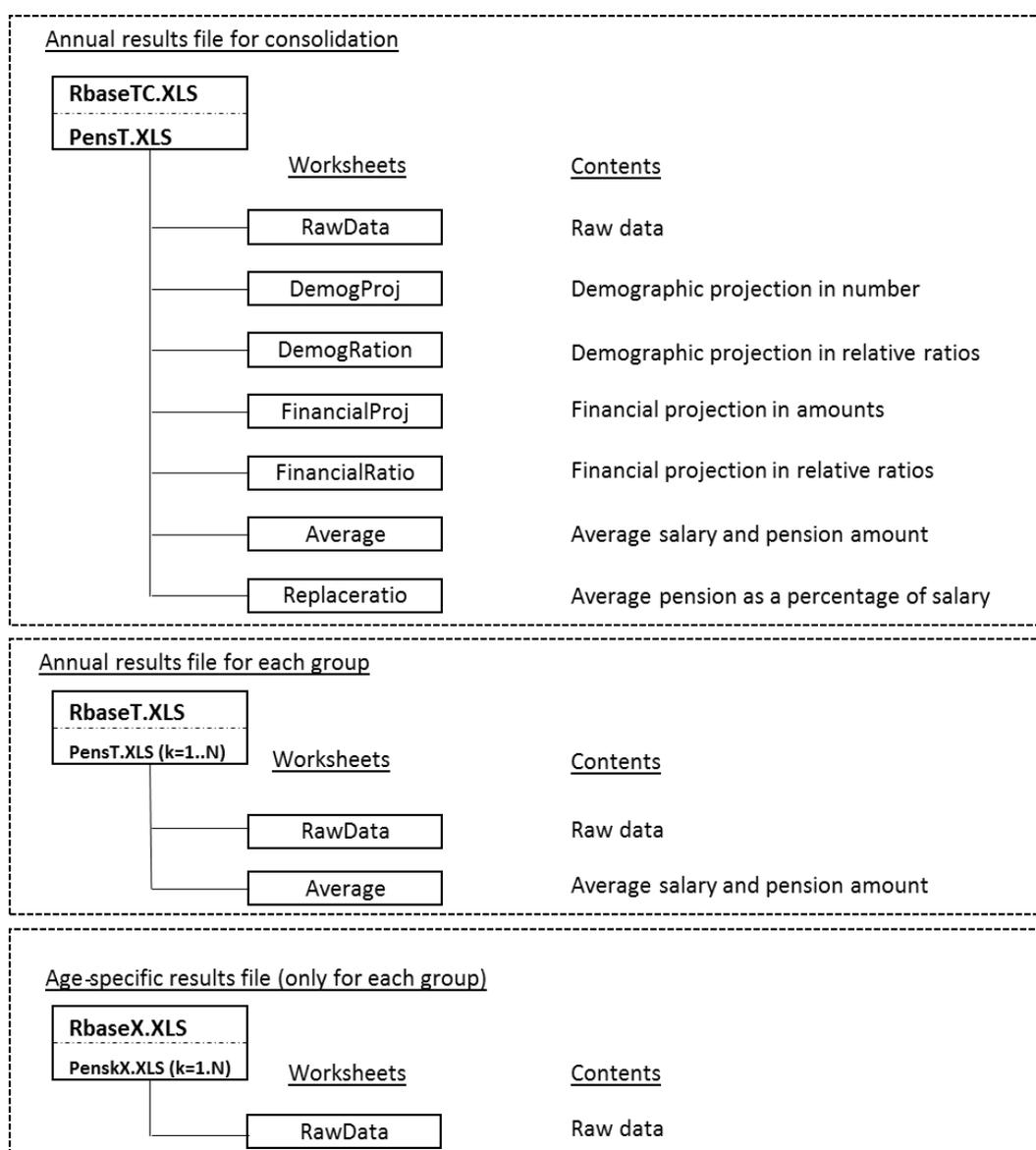
The next steps to be taken in finalizing the output reports are:

- to convert the selected results text files to Excel files;
- to consolidate the various group results (in cases where multiple group projections were undertaken) to generate the final results file.

4.2.1. The base file

The base files are Excel format files, which provide the framework of the results report and the main demographic and financial indicators. The contents of these base files are shown in figure III.4.3.

Figure III.4.3. Contents of the output files



(1) RBASET.XLS

The **RBASET.XLS** file is used for reformatting the contents of the *consolidated* TXT files, namely **aaaakT.TXT** and **aaaakTN.TXT**. This file contains two worksheets: “RawData” and “Average”. The format of this file is shown in figure III.4.4.

Figure III.4.4. Format of RBASET.xls file

Year of Projection	Total Act F	Low Act F	Medium Act F	High Act F	Total Pensions Ret F	Total Ret F	Initial Ret F	Normal Ret F	Minimum Ret F	Total Dis F	Initial Dis F	Nor Dis
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
16	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
19	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
27	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(2) RBASEX.XLS

The **RBASEX.XLS** file is used for reformatting the age-specific TXT files, namely **aaaakX.TXT** and **aaaakXN.TXT**. This file contains three worksheets: “RawData”, “cohort” and “worksheet1”. The format of this file is shown in figure III.4.5.

Figure III.4.5. Format of the RBASEX.xls file

Year of Projection	Age	Total Act D	Total Act Av	Low Act D	Low Act Av	Medium Act D	Medium Act Av	High Act D	High Act Av	Total Ret D	Total Ret Av	Initial Ret D
1	20	601	2.376	180	2.376	240	2.376	180	2.376	0	0.000	0
2	21	609	2.592	183	2.592	244	2.592	183	2.592	0	0.000	0
3	22	612	2.808	184	2.808	245	2.808	184	2.808	0	0.000	0
4	23	608	3.024	182	3.024	243	3.024	182	3.024	0	0.000	0
5	24	598	3.240	179	3.240	239	3.240	179	3.240	0	0.000	0
6	25	589	3.456	177	3.456	236	3.456	177	3.456	0	0.000	0
7	26	579	3.672	174	3.672	232	3.672	174	3.672	0	0.000	0
8	27	568	3.888	170	3.888	227	3.888	170	3.888	0	0.000	0
9	28	555	4.104	167	4.104	222	4.104	167	4.104	0	0.000	0
10	29	540	4.320	162	4.320	216	4.320	162	4.320	0	0.000	0
11	30	524	4.536	157	4.536	210	4.536	157	4.536	0	0.000	0
12	31	507	4.752	152	4.752	203	4.752	152	4.752	0	0.000	0
13	32	492	4.968	148	4.968	197	4.968	148	4.968	0	0.000	0
14	33	480	5.184	144	5.184	192	5.184	144	5.184	0	0.000	0
15	34	470	5.400	141	5.400	188	5.400	141	5.400	0	0.000	0
16	35	460	5.616	138	5.616	184	5.616	138	5.616	0	0.000	0
17	36	449	5.832	135	5.832	180	5.832	135	5.832	0	0.000	0
18	37	436	6.048	131	6.048	174	6.048	131	6.048	0	0.000	0
19	38	418	6.264	125	6.264	167	6.264	125	6.264	0	0.000	0
20	39	397	6.480	119	6.480	159	6.480	119	6.480	0	0.000	0
21	40	377	6.696	113	6.696	151	6.696	113	6.696	0	0.000	0

4.2.2. The conversion of text files into Excel files

To convert the text files into Excel format, go to the **InputS** worksheet and choose the **Menu()** submodule in ILO-PENS. Access the *special menu bar* **Actuarial** and select **Create Result Files** to run this command. *Prior* to running this command you must first select the files to be converted.

Select the files to be converted

In the worksheet **InputS** of the projection file, select the drop-down bar in the cell B37, which asks “*which results would you like?*”. Four choices are given:

- all results (*t, x, tn, xn*)
- year results (*t, tn*)
- total cases (*t, x*)
- year & total (*t*)

Select the relevant results file and proceed to the conversion stage.

Conversion

The conversion is undertaken by the **Menu()** submodule. Access the special menu bar **Actuarial** and select **Create Result Files** to run this command.

The **Menu()** submodule reads the contents of the text files and copies them onto the worksheet **RawData** of the appropriate base file. This process is repeated for each group where there are multiple group projections.

The generated Excel files will have the same naming convention as was applied to the text files. The **.TXT** extension is simply replaced by the **.XLS** extension in the converted file (e.g. **aaaakT.TXT** will become **aaaakT.XLS**).

4.2.3. The consolidation of group Excel files

RBASET.C.XLS

The **RBASET.C.XLS** file is used for consolidating group results (in cases where multiple group projections were undertaken) to generate the final result file. It contains seven worksheets:

RawData	Raw data;
DemogProj	Demographic results (in nominal number);
DemogRatio	Demographic results as a percentage of the covered population;
FinancialProj	Financial results (total amount);
FinancialRatio	Financial results as a percentage of total insurable earnings;
Average	Average benefit expenditure amounts;
ReplaceRatio	Average benefit expenditure results as a percentage of average insurable earnings.

Additional worksheet

For the *consolidated* text files, the average benefit expenditure amounts are automatically calculated in the **Average** worksheet.

For the *age-specific* text files, the classification of data by different characteristics can be done in the **Cohort** worksheet. If “age” is selected in the *drop-down bar*, projected data is returned classified by age *x* and the relevant year of projection *t*.

Subsequently, the consolidation of Excel results files of the various groups is done (in circumstances where multiple group projections were undertaken). The consolidation is done only for the consolidated results (**t, tn**). In the naming of the consolidated group files, the group number is dropped and the postscript “C” is added to the name of the consolidated file (e.g. **aaaaTC.XLS** and **aaaaTNC.XLS**).

4.3. Main output results

The results are generally classified into **demographic** and **financial** projection outcomes.

4.3.1. Results of demographic projection

The demographic results are presented in the **DemogProj** worksheet. They are presented in the form of nominal numbers of relevant persons for each relevant scheme category (registered, active, inactive, pensioner, etc.). The age breakdown is available from the *age-specific* files (**postfix X**). The results for the *newly awarded* pensioners are available from the *new case* files (**postfix N**).

The ratio/percentage of pensioners with respect to the active population is calculated in the **DemogRatio** worksheet.

4.3.2. Results of financial projection

The financial results are presented in the **FinancialProj** worksheet. They are presented in the form of nominal amounts of relevant pensions for each category indicated above. The age breakdown is available from the *age-specific* files (**postfix X**). The results for newly awarded pensioners are available from the *new case* files (**postfix N**).

The ratio/percentage of pension benefit expenditures with respect to total insurable earnings is calculated in the **FinancialRatio** worksheet.

The average amounts of pension benefit expenditures, insurable earnings, etc. are calculated in the **Average** worksheet.

The average replacement ratio, which is the average pension as a ratio/percentage of average insurable earnings, is available from the **ReplaceRatio** worksheet.

5. Analysis, report and conclusion

5.1. Financial analysis of projection results

Once the long-term estimates of the contribution base and the benefit expenditures have been established, the next step is to project the long-term financial development of the scheme and to test the financial solvency of the scheme under different financing options.

There are generally two different scenarios under which the financial solvency of the scheme may be assessed. In the first scenario, the contribution rate of the scheme is already given and one would therefore project the future evolution of the surplus/deficit positions of the scheme and assess how its reserves would develop under a defined-benefit scheme.

In this scenario, the main objective of the actuarial valuation is to ensure that the adopted contribution rate is sufficient to guarantee the long-term financial solvency of the scheme. Where the projection results indicate a deteriorating long-term financial solvency position, recommendations on how to restore/maintain financial solvency should be submitted.

In the second scenario, the contribution rate has to be determined consistent with the financial system adopted by the scheme. The main financial systems that are adopted by social security pension schemes include a pay-as-you-go contribution rate, a level contribution rate, a variable contribution rate to maintain a target reserve ratio and a variable contribution rate to maintain a target operational balance.

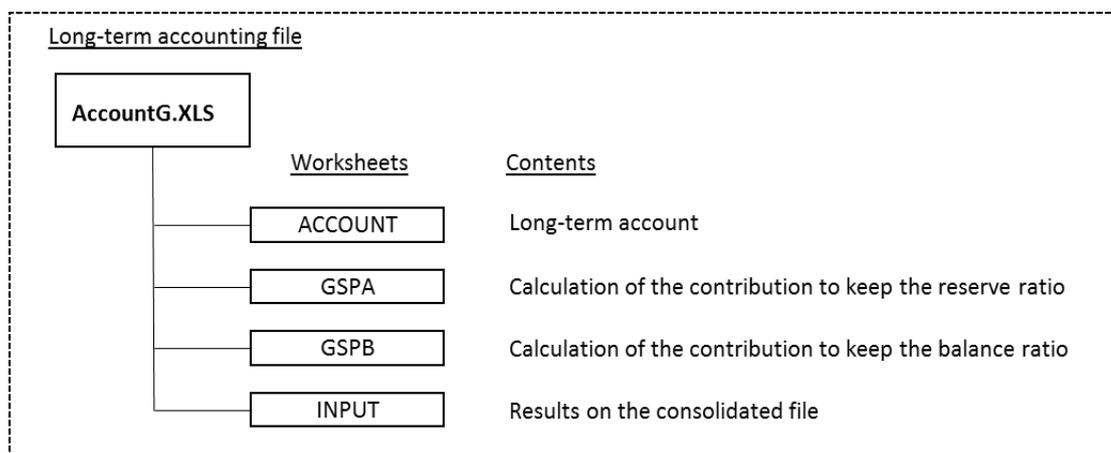
Generally, the legal provisions of a scheme define an actuarial equilibrium as a specific level of reserves that the scheme has to maintain over a defined period (period of equilibrium).

5.2. Long-term account file

In order to establish the long-term reserve on the basis of projected expenditure and base earnings, an Excel file, **AccountG.xls**, has been developed. The contents of this file are shown in figure III.5.1. This file contains the following worksheets:

INPUT
ACCOUNT
GSPA
GSPB

Figure III.5.1. Contents of the AccountG.xls file



(1) INPUT

The consolidated result file as generated by the **FinancialProj** worksheet is initially imported into the **INPUT** file.

(2) ACCOUNT

The **Account** worksheet will then use the imported **FinancialProj** worksheet data to generate the long-term financial accounts of the scheme. The format of the **Account** worksheet is shown in figure III.5.2.

To generate the ongoing financial equilibrium of the scheme, the contribution rate of each year and the amount of the reserve at the beginning of the base year are entered. The financial equilibrium of the scheme is then assessed with respect to two parameters, namely:

- to maintain a target reserve ratio
(i.e. **Reserve at end year (T) / Annual expenditure in year (T)**)
- to maintain a target operational balance ratio
(i.e. **Annual expenditure in year (T) – Annual contribution income in year (T) / Annual Interest Income in year (T)**).

The reserve ratio target value and the balance ratio target should be specified in cell S2 and cell T2, respectively.

Figure III.5.2. Format of the Account worksheet

YEAR	contribution rates (%)	TOTAL INCOME	contribut	invest	TOTAL EXPEND	benefits	SURPLUS
1	7.3%	2,709.49	1,741.40	968.09	93.10	93.10	2,616.39
2	7.3%	4,026.84	2,147.34	1,879.51	128.10	128.10	3,898.74
3	7.3%	6,564.55	3,756.85	2,807.71	264.40	264.40	6,300.16
4	7.3%	8,825.97	5,664.10	3,161.88	518.66	518.66	8,307.31
5	7.3%	11,286.51	7,645.83	3,640.68	806.50	806.50	10,480.01
6	7.3%	12,807.01	9,887.50	2,919.51	1,088.37	1,088.37	11,718.64
7	7.3%	15,089.88	12,183.31	2,906.57	1,395.14	1,395.14	13,694.74
8	7.3%	17,282.16	13,586.88	3,695.28	1,757.36	1,757.36	15,524.79
9	7.3%	19,328.34	14,763.50	4,564.84	2,159.85	2,159.85	17,168.49
10	7.3%	20,403.37	15,808.41	4,594.97	2,600.02	2,600.02	17,803.35
11	7.3%	21,751.45	16,727.62	5,023.84	3,102.13	3,102.13	18,649.33
12	7.3%	24,189.31	18,697.29	5,492.02	3,710.58	3,710.58	20,478.73
13	7.3%	26,196.04	19,876.70	6,319.33	4,477.81	4,477.81	21,718.23
14	7.3%	28,186.83	20,994.12	7,192.71	5,360.33	5,360.33	22,826.50
15	7.3%	30,284.32	22,175.34	8,108.98	6,379.56	6,379.56	23,904.76
16	7.3%	32,492.67	23,425.93	9,066.74	7,550.86	7,550.86	24,941.81
17	7.3%	34,981.15	24,914.86	10,066.28	8,945.47	8,945.47	26,035.68
18	7.3%	37,418.92	26,313.75	11,105.17	10,472.67	10,472.67	26,946.26

(3) GSLA, GSLB

The **GSLA** and **GSLB** worksheets generate the required year-by-year **contribution rates** required to guarantee the given target value of the **reserve ratio** in **column S**, while the contribution rate to guarantee the given target value of the **balance ratio** is given in **column T** over an arbitrary period **[n, m]**. In both cases, the contribution determination period starts in the base year t.

The format of the **GSLA** and **GSLB** worksheets is shown in figure III.5.3.

Figure III.5.3. Format of the GSLA and GSLB worksheets

YEAR	contribution rates (%)	FUND at beginning of	1	2	3	11	12	13	14
1	0.07	3,719	0.39%	0.44%	0.52%	1.36%	1.45%	1.65%	1.87%
2	0.07	6,335		0.44%	0.52%	1.36%	1.45%	1.65%	1.87%
3	0.07	10,234			0.52%	1.36%	1.45%	1.65%	1.87%
4	0.07	16,534				1.36%	1.45%	1.65%	1.87%
5	0.07	24,841				1.36%	1.45%	1.65%	1.87%
6	0.07	35,321				1.36%	1.45%	1.65%	1.87%
7	0.07	47,040				1.36%	1.45%	1.65%	1.87%
8	0.07	60,735				1.36%	1.45%	1.65%	1.87%
9	0.07	76,259				1.36%	1.45%	1.65%	1.87%
10	0.07	93,428				1.36%	1.45%	1.65%	1.87%
11	0.07	111,231				1.36%	1.45%	1.65%	1.87%
12	0.07	129,881					1.45%	1.65%	1.87%
13	0.07	150,359						1.65%	1.87%
14	0.07	172,078							1.87%
15	0.07	194,904							
16	0.07	218,890							

5.3. By way of conclusion: Contents of the actuarial report

Actuarial reports for social security pension schemes are much more than descriptions of model results. The essential message of an actuarial report is whether or not a scheme will be financially sound in the long term. Although the ILO actuarial models provide a solid base on which to formulate perspectives regarding the financial soundness of schemes, it should be remembered that *models can only serve as a support and should not be expected to replace sound personal 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 actuary.

The reports will normally include the following:

- The necessity of the actuarial valuation and a description of recent scheme developments;
- The social, demographic, economic (and political) context underlying the social security scheme;
- A brief description of the scheme benefit design, including coverage targets;
- A description of the scheme’s financial system, including the ease of collection of contributions and experience regarding collection rates;
- A brief overview of ILO-PENS, including related capacities and limitations;
- A description of the demographic and economic assumptions adopted for the valuation and background data on those assumptions;

-
- Demographic and financial projections based on status quo conditions that yield a financial diagnosis of the scheme;
 - Identification and/or recommendation of scheme reforms;
 - Financial analysis of reform options;
 - Discussion of the impact of reform options and the formulation of final reform strategies;
 - Conclusions and recommendations, including:
 - suitability of the financial system;
 - adequacy of actual or proposed contribution rates;
 - efficiency of benefit provisions;
 - adequacy of the (inflation) adjustment of pensions in payment;
 - efficiency and cost of administration systems;
 - investment policy and performance (safety, return, liquidity).
 - An appendix containing base data, detailed results and the methodological basis of the estimates.

The ILO-ISSA *Guidelines on actuarial work for social security* (Geneva, 2016) provide additional guidance on the best-practice for actuarial valuation reporting frameworks. Further reference can be made to the *International Standard of Actuarial Practice 2 (ISAP-2): Financial analysis of social security programs* (Ottawa, International Actuarial Association, 2013), which a number of national and regional actuarial associations are considering to adopt as their financial analysis and reporting standard. Finally, reporting should also be in line with national legislation, where applicable.

References

Hirose, K. 1999. *Topics in quantitative analysis of social protection systems*, Issues in Social Protection, Discussion Paper 6 (Geneva, ILO).

Jordan, C. W. 1967. *Life contingencies* (Chicago, Society of Actuaries).

Technical guides of other ILO actuarial models

ILO (International Labour Office). 1998. *Internal guidelines for the actuarial analysis of a national social security pension scheme* (Geneva).

—. 1999. *The ILO social budget model: A technical guide (Version 8/1999)* (Geneva).

—. 2001. *Social security data required for the valuation of a national social security system: Old age, invalidity and survivors pensions; Sickness and maternity benefits; Work injury benefits; Health care benefits; Unemployment benefits; Family benefits* (Geneva).

—. 2002. *The ILO population projection model (ILO-POP): A technical guide (Version 1.1. 8/2002)* (Geneva).

Textbooks: Quantitative Methods in Social Protection (ILO/International Social Security Association (ISSA))

Iyer, S. 1999. *Actuarial mathematics of social security pensions*, Quantitative Methods in Social Protection Series (Geneva, ILO/ISSA).

Plamondon, P. et al. 2002. *Actuarial practice in social security*, Quantitative Methods in Social Protection Series (Geneva, ILO/ISSA).

Cichon et al. 1999. *Modelling in health care finance: A compendium of techniques for health care financing*, Quantitative Methods in Social Protection Series (Geneva, ILO/ISSA).

Scholz et al. 2000. *Social budgeting*, Quantitative Methods in Social Protection Series (Geneva, ILO/ISSA).

Statistical and other reports

ILO. 2000. *Estimates and projections of the economically active population 1950-2010*, Sources and Methods, Labour Statistics, Vol. 10 (Geneva).

—. 2001. *Economically active population 1950-2010* (4th ed. rev.1, computer file) (Geneva).

UN (United Nations). Various years. *World Population Prospects* (New York).

—. 1982. *Model Life Tables for Developing Countries*, Population Studies No. 77 (New York).

—. 1982. *Unabridged Model Life Tables Corresponding to the New United Nations Model Life Tables for Developing Countries* (New York).

UNDP (United Nations Development Programme). Various years. *Human Development Report* (New York).

World Bank. Various years. *World Development Report* (Washington, DC).

Appendix 1

List of variables used in ILO-PENS

Globally-used variables

T

Type: Integer; indicator
Range: Varies from 0 to TMAX (max 100)
Description: The year of projection

X

Type: Integer; indicator
Range: Varies from 0 to 100
Description: Age

XX

Type: Integer; indicator
Range: Varies from 0 to 54
Description: Equal to Age - 15
Remark: Used for saving memory

XMAX

Type: Integer; endogenous constant
Range: Varies from 0 to 84
Description: Equal to Age - Jmin (i.e. maximum years of coverage at age X)
Remark: Used for saving memory

I

Type: Integer; indicator
Range: Varies from 0 to I_{maxAX} (max 54)
Description: Year of credits (the number of periods, measured by year, in which contributions are paid)

JKC

Type: Integer; indicator
Range: Varies from 0 to 3
JKC=0 (Total average)
JKC=1 (High income class, i.e. the highest 30 percentile income group)
JKC=2 (Medium income class, i.e. between 30 and 70 percentile income group)
JKC=3 (Low income class, i.e. the lowest 30 percentile income group)
Description: Indicating the income level for the calculation of the old-age pension

Appendix 2

Main variables (in alphabetical order)

A(I)

Type: Real number (double precision), Dim(55); endogenous intermediate
Range: I=1 to 54
Description: Put equal to $ZACT * F(I, XX)$. (The number of the active persons aged X, excluding the withdrawal by death and invalidity, who have I years of past credits in year T).
Reference: `InsIns()`

AAO(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=0 to 100
Description: The average age of the children of an insured or of a pensioner aged X+1.
Remark: Read from the worksheet "Family" in the group file.
Reference: `Projection()`, `Preparation()`

AAW(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=0 to 100
Description: The average age of the spouse of an insured or of a pensioner aged X+1.
Remark: Read from the worksheet "Family" in the group file.
Reference: `Projection()`, `Preparation()`

ACT(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=15 to 69; overwritten for T=0 to TMAX.
Description: The number of the active persons aged X in year T.
Remark: Read from the group file worksheet "Covpop". See also note on density factors.
Reference: `Projection()`, `InsIns()`, `InsSurv()`, `Preparation()`, `SUMoX()`, `FILEW()`

ACT1(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=15 to 69; overwritten for T=0 to TMAX.
Description: The number of the active persons aged X in the previous year t-1.
Remark: Read from the group file worksheet "Covpop". Necessary for calculating the new pensioners of the year T.
Reference: `Projection()`

AFUNB1(X, K), AFUNB2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=15 to 99; K=0 to 3
K=0 (Total)
K=1 (On the death of active persons)
K=2 (On the death of old-age pensioners)
K=3 (On the death of invalidity pensioners)

Description: AFUNB1: The number of the beneficiaries of the funeral grant on the death of persons at age X in year T for each category K.
AFUNB2: Total amount of funeral grants (ibid)

Reference: InsRet(), InsInv(), InsSurv(), SUMoK(), SUMoX(), FILEW()

AGRT1(X, K), AGRT2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous

Range: X=15 to 99; K=0 to 3
K=0 (Total)
K=1 (Old-age grant)
K=2 (Invalidity grant)
K=3 (Survivors grant)

Description: AGRT1: The number of the beneficiaries of the grant at age X in year T for each category K.
AGRT2: Total amount of grants (ibid).

Reference: InsRet(), InsInv(), InsSurv(), SUMoK(), SUMoX(), FILEW()

ARET, ARES, AREU

Type: Real number (double precision); temporary

Description: Temporary variables for calculating the PCOV(I, JKC).

Remark: See the note on the correlation between credits and the income level.

Reference: InsRet()

ARINFB(T)

Type: Real number (double precision), Dim(-5 to 100); endogenous

Range: T=-5 to 100

Description: Accumulated increase rate of the benefit in year T (base year T=0).

Remark: See RINFB(T).

Reference: ReadEconDem()

ARINFS(T)

Type: Real number (double precision), Dim(-5 to 100); endogenous

Range: T=-5 to 100

Description: Accumulated increase rate of the salary in year T (base year T=0).

Remark: See RINFS(T).

Reference: Finsal(), ReadEconDem()

ARINT(T)

Type: Real number (double precision), Dim(-5 to 100); endogenous

Range: T=-5 to 100

Description: Compound rate of interest in year T (base year T=0).

Reference: ReadEconDem()

AVCH

Type: Real number (double precision); endogenous

Range: Put equal to $(ECH(X)+ECH(X+1))/2$; overwritten for X and T

Description: The average number of children of an insured or a pensioner aged $X+1/2$.

Remark: Changes over time are not considered.

Reference: Projection(), SDIST()

AVL, AVM, AVH

Type: Real number (double precision); temporary
Description: Temporary variables for calculating the reference salary.
Reference: Finsal()

AVSP

Type: Real number (double precision); endogenous
Range: Put equal to $(ESP(X)+ESP(X+1))\div 2$; overwritten for X and T
Description: The probability of having a spouse for an insured or pensioner aged $(X+1/2)$.
Remark: Should be interpreted as the average number of spouse, in the case of polygamy. Changes over time are not considered.
Reference: Projection(), SDIST()

B(I)

Type: Real number (double precision), Dim(55); endogenous intermediate
Range: I=1 to 54
Description: Put equal to $ZNACT * Fg(I, XX)$. (The number of the inactive persons aged X, excluding the withdrawal by death and invalidity, who have I years of past credits in year T).
Reference: InsIns(), InsRet()

BAL(XX, JKC)

Type: Real number (double precision), Dim(55, 3); endogenous
Range: I=0 to XMAX; overwritten for each X and T; JKC=0 to 3
JKC=0 (Total average)
JKC=1 (High income class, i.e. the highest 30 percentile income group)
JKC=2 (Medium income class, i.e. between 30 and 70 percentile income group)
JKC=3 (Low income class, i.e. the lowest 30 percentile income group)
Description: The accumulated value of the contribution including the interest with credit I at age X in year T for each income class JKC.
Remark: See note on income level.
Reference: Balance()

BVL, BVM, BVH

Type: Real number (double precision); temporary
Description: Temporary variables for calculating the accumulated values of contributions.
Reference: Balance()

CDT

Type: Real number (double precision); endogenous
Description: The years of past credits (=I).
Remark: Used for calculating the pension.
Reference: InsRet(), InsInv(), InsSurv(), RetPos(), InvPos(), SurvPos(), PensionR(), PensionI(), PensionS()

COLL(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Contribution collection rate in year T. (Global).
Remark: Read from the worksheet "Econ" in the economic-demographic file.
Reference: ReadEconDem(), Preparation()

CONT(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Rate of contribution in year T.
Remark: Read from the worksheet "Econ" in the economic-demographic file. Used for the defined-contribution schemes.
Reference: Balance(), ReadEconDem()

DACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T
Description: The number of withdrawals on grounds of death from the active population aged X in the year t-1.
Remark: See note on decrement.
Reference: Projection(), InsSurv()

DDACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for I, X and T.
Description: Put equal to $DACT * F(I, X) + DNACT * Fg(I, X) * PNSURV$. The number of persons withdrawn on grounds of death from the active and the inactive (if the survivors pension is payable) population with credit I.
Reference: InsSurv()

DDD1, DDD2

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for I, X and T.
Description: Intermediate value for the calculation of the survivors pensions. DDD1: number, DDD2: amount of pensions.
Reference: InsSurv(), RetSurv(), InvSurv(), SDIST()

DENS(XX)

Type: Real number (double precision), Dim(55); exogenous
Range: XX=0 to 54 (X=15 to 69); overwritten for T=0 to TMAX.
Description: For each year T and each age X, the ratio of the annual average number of the active contributors to the annual total number of insureds who make at least one contribution period during that year.
Remark: Read from the group file worksheet "Dens". See also the note on the density factors.
Reference: Projection(), InsIns(), SUMoX(), FILEW(), Preparation()

DENS1(XX)

Type: Real number (double precision), Dim(55); exogenous
Range: XX=0 to 54 (X=15 to 69); overwritten for T=0 to TMAX.
Description: The density factor of age X in the previous year t-1.
Remark: Read from the group file worksheet "Dens".
Reference: Projection()

DINV1, DINV2

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T.
Description: DINV1: The number of invalidity pensioners who lost their pension right on grounds of death in age X in year T-1.
DINV2: Total amount of invalidity pensions (ibid).
Reference: InvSurv()

DIS1(X, K), DIS2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=15 to 99; K=0 to 3; adjusted every year T
K=0 (Total)
K=1 (Existing pensioner in the initial year)
K=2 (Newly awarded pensioner after the initial year whose pension is higher than the minimum pension)
K=3 (Newly awarded pensioner after the initial year whose pension is equal to the minimum pension)
Description: DIS1 The number of the total existing invalidity pensioners aged X in year T for each category K.
DIS2 Total amounts of the invalidity pension (ibid).
Reference: Projection(), Invalids(), InvSurv(), SUMoK(), SUMoX(), FILEW(), Preparation(), VALUATION()

DISO(JS)

Type: Real number (double precision), Dim(4); exogenous
Range: JS=0 to 4
DISO(0)=0.15 (=average-2 years)
DISO(1)=0.20 (=average-1 year)
DISO(2)=0.30 (=average)
DISO(3)=0.20 (=average+1 year)
DISO(4)=0.15 (=average+2 years)
Description: The *ad hoc* age deviation of the orphans' age.
Remark: Defined in SDIST(). See note on survivors age.
Reference: SDIST()

DISW(JS)

Type: Real number (double precision), Dim(4); exogenous
Range: JS=0 to 4
DISW(0)=0.15 (=average-2 years)
DISW(1)=0.20 (=average-1 year)
DISW(2)=0.30 (=average)
DISW(3)=0.20 (=average+1 year)
DISW(4)=0.15 (=average+2 years)
Description: The *ad hoc* age deviation of the widow(er)s' age.
Remark: Defined in SDIST(). See the note on the survivors age.
Reference: SDIST()

DNACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T.
Description: The number of withdrawals on grounds of deaths from the inactive population aged X in the year t-1.
Remark: See note on decrement.
Reference: Projection(), InsSurv()

DOUT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T
Description: The number of persons who move from the active population to the inactive population aged X in year T.
Remark: See note on decrement.
Reference: InsIns()

DRET1, DRET2

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T.
Description: DRET1: the number of old-age pensioners who lost their pension right on grounds of death in age X in year T-1.
DRET2: total amount of old-age pensions (ibid).
Reference: RetSurv()

ECH(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=0 to 100
Description: The average number of children of an insured or a pensioner aged X.
Remark: Read from the worksheet "Family" in the group file.
Reference: Projection(), Preparation()

ESP(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=0 to 100
Description: The probability of having a spouse for an insured pensioner aged X.
Remark: Read from the worksheet "Family" in the group file.
Reference: Projection(), Preparation()

F(I, XX)

Type: Real number (double precision), Dim(55, 55); endogenous
Range: I=1 to 54; XX=0 to 54 (X=15 to 69)
Description: The percentage of the active persons aged X who have I years of past credits in year T.
Reference: Projection(), InsIns(), InsInv(), InsSurv(), Preparation()

Fg(I, XX)

Type: Real number (double precision), Dim(55, 55); endogenous
Range: I=1 to 54; XX=0 to 54 (X=15 to 69)
Description: The percentage of the inactive persons aged X who have I years of past credits in year T.
Reference: Projection(), InsIns(), InsInv(), InsSurv(), Preparation()

FINS(I, JKC)

Type: Real number (double precision), Dim(55, 3); endogenous
Range: I=0 to XMAX; overwritten for each X and T; JKC=0 to 3
JKC=0 (Total average)
JKC=1 (High income class, i.e. the highest 30 percentile income group)
JKC=2 (Medium income class, i.e. between 30 and 70 percentile income group)
JKC=3 (Low income class, i.e. the lowest 30 percentile income group)
Description: The reference final average salary for calculating the pension benefit due with credit I at age X in year T for each income class JKC.
Remark: See note on income level.
Reference: Finsal(), InsRet(), InsInv(), InsSurv(), PensionR(), PensionI(), PensionS()

FUNB(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Amount of the funeral benefit in year T.
Remark: Read from the worksheet "Econ" in the economic-demographic file.
Reference: InsSurv(), RetSurv(), InvSurv(), ReadEconDem()

Gcom

Type: Character; exogenous
Range: Read from the input sheet.
Description: Name of the economic-demographic file.
Remark: Specified in the cell B31 in the input worksheet "InputS". (e.g. EcoDem)
Reference: ReadEconDem()

GcomDir

Type: Character; exogenous
Range: Read from the input sheet.
Description: Name of the directory where the economic-demographic file is stored.
Remark: Specified in the cell B30 in the input worksheet "InputS". (e.g. C:\Projections)
Reference: ReadEconDem()

GcomFile

Type: Character; endogenous
Description: The full name of the economic-demographic file.
Remark: (e.g. C:\Projections\EcoDem)
Reference: ReadEconDem()

GEI

Type: Character; exogenous
Range: GEI= "PENSION" (satisfying the eligibility condition for the invalidity pension)
GEI= "GRANT" (not satisfying the eligibility condition for the invalidity pension, and opting for the lump-sum grant)
GEI= "RETURN" (not satisfying the eligibility condition for the invalidity pension, and returning to the inactive population)
Description: The results of examining the eligibility condition for the invalidity pension.
Reference: InvPos(), InsInv()

GER

Type: Character; exogenous

Range: GER= "PENSION" (satisfying the eligibility condition for the old-age pension)
GER= GRANT" (not satisfying the eligibility condition for the old-age pension, and opting
" for the lump-sum grant)
GER= "RETURN" (not satisfying the eligibility condition for the old-age pension, and
returning to the inactive population)

Description: The results of examining the eligibility condition for the old-age pension.

Reference: RetPos(), InsRet()

GES

Type: Character; exogenous

Range: GES= "PENSION" (satisfying the eligibility condition for the survivors pension)
GES= "GRANT" (not satisfying the eligibility condition for the survivors pension, and
opting for the lump-sum grant)
GES= "RETURN" (not satisfying the eligibility condition for the survivors pension,
and returning to the inactive population)

Description: The results of examining the eligibility condition for the survivors pension on the death of
active persons.

Reference: SurvPos(), InsSurv()

GFile

Type: Character; endogenous

Description: The full name of the economic-demographic file.

Remark: (e.g. C:\Projections\Group2)

Reference: Preparation()

GinputDir

Type: Character

Range: Set in the input file.

Description: The name of the directory under which all input files are created.

Remark: Read from the row 22 in the input worksheet "InputS" (e.g. C:\projections) for each group.

Reference: Preparation().

GInputFile

Type: Character; exogenous

Range: Set in the input worksheet.

Description: The prefix of all output files. See also the convention of the output file naming.

Remark: Read from the row 235 in the input worksheet "InputS" (e.g. Group2) for each group.

Reference: Preparation().

GroupNo

Type: Character

Description: The number of the group as a character, i.e. if IGroup=1, then GroupNo= "1". (See the
function CStr() in a manual of Excel VBA.)

Remark: In the CreateFilesXL(), the same variable is redefined.

Reference: VALUATION(), CreateFilesXL()

GoutputDir

Type: Character
Range: Set in the output file.
Description: The name of the directory under which all output files are created.
Remark: Read from the cell B34 in the input worksheet "InputS" (e.g. C:\projections). In the CreateFilesXL(), the same variable is redefined.
Reference: VALUATION(), CreateFilesXL().

GoutputPrefix

Type: Character
Range: Set in the input worksheet.
Description: The prefix of all output files. See also the convention of the output file naming.
Remark: Read from the cell B35 in the input worksheet "InputS" (e.g. pens). In the CreateFilesXL(), the same variable is redefined.
Reference: VALUATION(), CreateFilesXL().

GoutputT, GOutputX, GOutputTN, GOutputXN

Type: Character
Description: The name of all output files.
Remark: Defined as "Directory name" + "\" + "Prefix" + "Group number" + "T (X, TN, XN)" + ".TXT" (e.g. C:\projection\pens2TN.TXT). See also the convention of the output file naming.
Reference: VALUATION().

H(J)

Type: Real number (single precision), Dim(59); endogenous intermediate
Range: Overwritten for each year T.
Description: Intermediate variable for file making. See FILEW().
Remark: Change the notation of scientific format 99.999D+9 to 99.999E+9. Because the Excel sheet does not recognizes the format "99.999D+9".
Reference: FILEW()

IE

Type: Integer; exogenous
Range: To be specified in the programme (IE=1)
Description: The year over which the average is taken for calculating the reference salary.
Remark: See the note on the income level.
Reference: Finsal()

Igroup

Type: Integer; counter
Range: Varies from 1 to ITotalGroups (max. 10)
Description: Indicator of the group, i.e. when its value is equal to N, it indicates the N-th group.
Reference: ILOPENSION(), VALUATION(), Preparation().

Imax

Type: Integer; endogenous constant
Range: Fixed at 54
Description: Defined as Jcov - Jmin (i.e. maximum years of coverage).
Reference: ILOPENSION(), Preparation(), Projection(), InsIns().

ISEX

Type: Integer; exogenous
Range: Takes the value 0 or 1.
Description: Sex of the relevant group.
ISEX=0: males
ISEX=1: females
Remark: Specified in the row 21 in the input worksheet "InputS" for each group.
Reference: Projection(), Preparation()

ItotalGroups

Type: Integer; exogenous constant
Range: Set in the input file.
Description: Total number of groups.
Remark: Read from the cell B7 in the input worksheet "InputS".
Reference: ILOPENSION(), VALUATION(), Preparation().

JCG

Type: Integer; indicator
Range: Takes the values from 2 to 4.
Description: The cause of the survivors pensions.
JCG=2: death of the active or inactive persons
JCG=3: death of the old-age pensioners
JCG=4: death of the invalidity pensioners
Remark: JCG=1 is not used. (JCG=1 is for the initial pensioners)
Reference: InsSurv(), RetSurv(), InvSurv(), SDIST()

Jcov

Type: Integer; constant
Range: Fixed at 69
Description: Maximum age of coverage by the pension scheme.
Remark: On attaining this age, all persons (actives or inactives) have to withdraw from the scheme. (See RetPos())
Reference: ILOPENSION(), Preparation(), Projection(), InsIns(), RetPos()

Jmax

Type: Integer; constant
Range: Fixed at 99
Description: Ultimate age of lifespan (i.e. maximum age of life tables).
Reference: ILOPENSION(), Preparation(), Projection().

Jmin

Type: Integer; constant
Range: Fixed at 15
Description: Minimum age of coverage by the pension scheme.
Reference: ILOPENSION(), Preparation(), Projection().

JO

Type: Integer; endogenous
Range: Put equal to AAO(X+1); overwritten for X and T
Description: The average age of the children of an insured or of a pensioner aged X+1.
Remark: Changes over time are not considered.
Reference: Projection(), SDIST()

JPI

Type: Integer; exogenous
Range: JPI=1 (Existing pensioner in the initial year)
JPI=2 (Newly awarded pensioner after the initial year whose pension is higher than the minimum pension)
JPI=3 (Newly awarded pensioner after the initial year whose pension is equal to the minimum pension)
Description: Indicating the category of the invalidity pensioners.
Reference: PensionI(), InsInv()

JPR

Type: Integer; exogenous
Range: JPR=1 (Existing pensioner in the initial year)
JPR=2 (Newly awarded pensioner after the initial year whose pension is higher than the minimum pension)
JPR=3 (Newly awarded pensioner after the initial year whose pension is equal to the minimum pension)
Description: Indicating the category of the old-age pensioners.
Reference: PensionR(), InsRet()

JW

Type: Integer; endogenous
Range: Put equal to AAW(X+1); overwritten for X and T
Description: The average age of the spouse of an insured or of a pensioner aged X+1.
Remark: Changes over time are not considered.
Reference: Projection(), SDIST()

NACT(X)

Type: Real number (double precision), Dim(100); endogenous
Range: X=15 to 69
Description: The number of the inactive persons aged X in year T.
Remark: See also the note on the decrement.
Reference: Projection(), InsIns()

NEWENT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T
Description: The number of new entrants aged X in year T.
Remark: See the note on the decrement.
Reference: InsIns()

NPI1(X, K), NPI2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=15 to 99; K=0, 2 and 3
K=0 (Total)
K=2 (Newly awarded pensioner after the initial year whose pension is higher than the minimum pension)
K=3 (Newly awarded pensioner after the initial year whose pension is equal to the minimum pension)
Description: NPI1: The number of the newly awarded invalidity pensioners aged X during the year T for the category K=JPI.
NPI2: Total amount of the newly awarded invalidity pensions (ibid).
Remark: K=1 is missing since JPI varies between 2 or 3.
Reference: Inslnv(), Invalids(), SUMoN(), SUMoK(), SUMoX(), FILEW(), VALUATION()

NNPI1(X, K), NNPI2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=15 to 99; K=0, 2 and 3
Description: The values of NPI1 and NPI2 of the previous year.
Reference: Invalids(), VALUATION()

NPO1(X, K), NPO2(X, K)

Type: Real number (double precision), Dim(100, 4); endogenous
Range: X=15 to 99; K=0, 2, 3, 4
K=0 (Total)
K=2 (On the death of active persons)
K=3 (On the death of old-age pensioners)
K=4 (On the death of invalidity pensioners)
Description: NPO1: The number of the newly awarded orphans pensioners aged X during the year T for the category K=JPI.
NPR2: Total amount of the newly awarded orphans pensions (ibid).
Remark: K=1 is missing. (K=1 is used for the initial pensioners)
Reference: Survivors(), SDIST(), SUMoN(), SUMoK(), SUMoX(), FILEW(), VALUATION()

NNPO1(X, K), NNPO2(X, K)

Type: Real number (double precision), Dim(100, 4); endogenous
Range: X=15 to 99; K=0, 2, 3, 4
Description: The values of NPO1 and NPO2 in the previous year.
Reference: Survivors(), VALUATION()

NPR1(X, K), NPR2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=15 to 99; K=0, 2 and 3
K=0 (Total)
K=2 (Newly awarded pensioner after the initial year whose pension is higher than the minimum pension)
K=3 (Newly awarded pensioner after the initial year whose pension is equal to the minimum pension)

Description: NPR1: The number of the newly awarded old-age pensioners aged X during the year T for the category K=JPR.
NPR2: Total amount of the newly awarded old-age pensions (ibid).

Remark: K=1 is missing. (K=1 is used for the initial pensioners)

Reference: InsRet(), Retireds(), SUMoN(), SUMoK(), SUMoX(), FILEW(), VALUATION()

NNPR1(X, K), NNPR2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous

Range: X=15 to 99; K=0, 2 and 3

Description: The values of NPR1 and NPR2 in the previous year.

Reference: Retireds(), VALUATION()

NPW1(X, K), NPW2(X, K)

Type: Real number (double precision), Dim(101, 4); endogenous

Range: X=15 to 99; K=0, 2, 3, 4

K=0 (Total)

K=2 (On the death of active persons)

K=3 (On the death of old-age pensioners)

K=4 (On the death of invalidity pensioners)

Description: NPW1: The number of the newly awarded widow(er)s pensioners aged X during the year T for the category K=JPI.

NPW2: Total amount of the newly awarded widow(er)s pensions (ibid).

Remark: K=1 is missing. (K=1 is used for the initial pensioners)

Reference: Survivors(), SDIST(), SUMoN(), SUMoK(), SUMoX(), FILEW(), VALUATION()

NNPW1(X, K), NNPW2(X, K)

Type: Real number (double precision), Dim(101, 4); endogenous

Range: X=15 to 99; K=0, 2, 3, 4

Description: The values of NPW1 and NPW2 in the previous year.

Reference: Survivors(), VALUATION()

NRA

Type: Real number (double precision); exogenous constant

Range: Set in the input sheet.

Description: The normal retirement age of the relevant group.

Remark: Read from the row 24 of the input worksheet "InputS". Only used for the eligibility condition and the calculation of the complementary credits for the invalidity and survivors pension.

Reference: InsIns(), RetPos(), InsInv(), InsSurv(), Preparation()

ORP1(X, K), ORP2(X, K)

Type: Real number (double precision), Dim(100, 4); endogenous

Range: X=15 to 99; K=0 to 4

K=0 (Total)

K=1 (Existing pensioners in the initial year)

K=2 (Newly awarded pensioners after the initial year on the death of active persons)

K=3 (Ibid: on the death of old-age pensioners)

Description: K=4 (Ibid: on the death of invalidity pensioners)
ORP1: The number of the orphan pensioners at age X in year T for each category K.
ORP2: Total amount of orphan pensions (ibid),
Reference: Survivors(), SUMoN(), SUMoK(), SUMoX(), FILEW(), Preparation(), VALUATION()

P

Type: Real number (double precision); endogenous
Description: The amount of pension.
Reference: PensionR(), PensionI(), PensionS(), InsRet(), InsInv(), InsSurv()

PCOV(I, JKC)

Type: Real number (double precision), Dim(55, 3); endogenous
Range: I=0 to XMAX; overwritten for each X and T; JKC=1 to 3
JKC=1 (High income class, i.e. the highest 30 percentile income group)
JKC=2 (Medium income class, i.e. between 30 and 70 percentile income group)
JKC=3 (Low income class, i.e. the lowest 30 percentile income group)
Description: The percentage of the new retirees of the income level JKC with credits I for each age X and each year T.
Remark: See the note on the correlation between the credits and the income level.
Reference: InsRet()

PDW

Type: Real number (double precision); endogenous
Range: Overwritten for X and T
Description: The average number persons eligible for the funeral benefit at the death of an insured or a pensioner aged X.
Reference: Projection(), InsSurv(), InvSurv(), RetSurv()

PFUNB

Type: Real number (double precision); exogenous
Range: Specified in the input sheet. Takes the value 0 or 1
Description: Possibility to provide the funeral benefit on the death of active persons or of pensioners.
Remark: Specified in the drop-down bar in B13 of the input worksheet "InputS".
Reference: InsSurv(), RetSurv(), InvSurv(), ReadEconDem()

PFUNBS

Type: Real number (double precision); exogenous
Range: Specified in the input sheet. Takes the value 0 or 1
Description: Possibility to provide the funeral benefit on the death of the spouse of active persons or of pensioners.
Remark: Specified in the drop-down bar in B14 of the input worksheet "InputS".
Reference: Projection(), ReadEconDem()

PI(X)

Type: Real number (double precision), Dim(100); exogenous
Range: X=0 to 100; overwritten for T=0 to TMAX.
Description: The probability of an insured aged X becoming invalid in year T.
Remark: Read from the group file worksheet "Inv".
Reference: Projection()

PMIN(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Amount of the minimum pension in year T.
Remark: Read from the worksheet "Econ" in the economic-demographic file.
Reference: PensionR(), PensionI(), PensionS(), Retireds(), Invalids(), ReadEconDem()

PNINV

Type: Real number (double precision); exogenous
Range: Specified in the input sheet. Takes the value 0 or 1
Description: Possibility to provide the invalidity pension for the inactive persons.
Remark: Specified in the drop-down bar in B15 of the input worksheet "InputS".
Reference: InsInv(), ReadEconDem()

PNSURV

Type: Real number (double precision); exogenous
Range: Specified in the input sheet. Takes the value 0 or 1
Description: Possibility to provide the survivors pension on the death of inactive persons.
Remark: Specified in the drop-down bar in B16 of the input worksheet "InputS".
Reference: InsSurv(), ReadEconDem()

PW(X)

Type: Real number (double precision), Dim(100); endogenous
Range: X=0 to 100; overwritten for T=0 to TMAX.
Description: The survival rates at age X in year T for the insured or pensioners.
Remark: Defined as equal to $1 - QT(X, T, 1-ISEX)$. Used for survivors pensions.
Reference: Projection(), Survivors(), SDIST()

Q(X)

Type: Real number (double precision), Dim(100); endogenous
Range: X=0 to 100; overwritten for T=0 to TMAX.
Description: The general mortality rates at age $X+\frac{1}{2}$ in year T. Applied for retired pensioners.
Remark: Transferred from $QT(X, T, ISEX)$, and adjusted by half year.
Reference: Projection(), Retireds(), RetSurv()

QA(X)

Type: Real number (double precision), Dim(100); endogenous
Range: X=0 to 100; overwritten for T=0 to TMAX.
Description: The mortality rates of the covered population at age $X+\frac{1}{2}$ in year T.
Remark: Calculated by multidecrement method based on Q(X), QI(X) and PI(X)
Reference: Projection()

QI(X)

Type: Real number (double precision), Dim(100); endogenous
Range: X=0 to 100; overwritten for T=0 to TMAX.
Description: The mortality rates of the invalidity pensioners at age $X+\frac{1}{2}$ in year T.
Remark: Based on Q(X).
Reference: Projection(), Invalids(), InvSurv()

QLA(X), QLD(X), QLT(X)

Type: Real number (double precision), Dim(100); temporary
Range: X=0 to 100; overwritten for T=0 to TMAX.
Description: The survival functions of active, disabled, total populations.
Remark: Temporary variable to calculate QA(X)
Reference: Projection()

QT(X, T, ISEX)

Type: Real number (double precision), Dim(100, 100, 1); exogenous
Range: X=0 to 100; T=0 to TMAX; ISEX=0 (males), =1 (females)
Description: The general mortality rates at age X in year T for each sex.
Remark: Read from the worksheets "MortM" and "MortF" in the economic-demographic file.
Reference: Projection(), ReadEconDem()

RACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for I and JKC, and, X and T.
Description: Total of RRACT. The total number of persons with credit I (all income levels) who are qualified for either pensions or grants.
Remark: See note on decrement.
Reference: InsRet()

RE(XX)

Type: Real number (double precision), Dim(55); exogenous
Range: XX=0 to 54 (X=15 to 69); overwritten for T=0 to TMAX.
Description: The rates of re-entrance to the scheme from the inactive population, at age X in year T.
Remark: Read from the group file worksheet "ReEnt".
Reference: Projection(), InsIns()

RENT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T
Description: The number of re-entrants from inactive population aged X in year T.
Remark: See note on decrement.
Reference: InsIns()

RET1(X, K), RET2(X, K)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=15 to 99; K=0 to 3; adjusted every year T
K=0 (Total)
K=1 (Existing pensioner in the initial year)
K=2 (Newly awarded pensioner after the initial year whose pension is higher than the minimum pension)
K=3 (Newly awarded pensioner after the initial year whose pension is equal to the minimum pension)
Description: RET1: The number of the total existing old-age pensioners aged X in year T for each category K.

RET2: Total amount of the old-age pensions (ibid).
Reference: Projection(), Retireds(), RetSurv(), SUMoK(), SUMoX(), FILEW(), Preparation(), VALUATION()

RINFB(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Increase rate of the benefit in year T compared to the previous year.
Remark: Read from the worksheet "Econ" in the economic-demographic file.
Reference: InsSurv(), RetSurv(), InvSurv(), Retireds(), Invalids(), Survivors(), ReadEconDem()

RINFS(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Increase rate of the salary in year T compared to the previous year.
Remark: Read from the worksheet "Econ" in the economic-demographic file.
Reference: ReadEconDem()

RINT(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Annual rate of interest in year T.
Remark: Read from the worksheet "Econ" in the economic-demographic file
Reference: Balance(), ReadEconDem()

ROP

Type: Real number (double precision); exogenous
Range: Read from the input sheet.
Description: Benefit rate of the orphans pension. (Share of the division).
Remark: Specified in the row 26 in the input worksheet "InputS" for each group.
Reference: SDIST(), Preparation()

RR(XX)

Type: Real number (double precision), Dim(55); exogenous
Range: XX=0 to 54 (X=15 to 69); overwritten for T=0 to TMAX.
Description: The rates of leaving from scheme on the grounds other than death, invalidity or retirement, at age X in year T.
Remark: Read from the group file worksheet "Leave".
Reference: Projection(), InsIns()

RRACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for I and JKC, and, X and T.
Description: Put equal to $PCOV(I, JKC) * B(I)$. The number of inactive persons (including those who left from the active group) with credit I and the income level JKC. In light of the eligibility condition, it is classified into three groups "pensioners", "grants beneficiaries", and "non-qualified". In the last case, they return to the inactive population.
Remark: See notes on decrement.
Reference: InsRet()

RWP

Type: Real number (double precision); exogenous
Range: Read from the input sheet.
Description: Benefit rate of the widow(er)s pension. (Share of the division).
Remark: Specified in the row 25 in the input worksheet "InputS" for each group.
Reference: SDIST(), Preparation()

SALINS(X, JKC)

Type: Real number (double precision), Dim(100, 3); endogenous
Range: X=0 to 100; overwritten for T=0 to TMAX; JKC=0 to 3
JKC=0 (Total)
JKC=1 (High income class, i.e. the highest 30 percentile income group)
JKC=2 (Medium income class, i.e. between 30 and 70 percentile income group)
JKC=3 (Low income class, i.e. the lowest 30 percentile income group)
Description: The insurable salary at age X in year T for each income class.
Remark: Transferred from Sall(XX, T), SaIM(XX, T), SalLH(XX, T).
Reference: Projection(), Preparation(), SUMoX(), FILEW()

Sall(XX, T), SaIM(XX, T), SalH(XX, T)

Type: Real number (double precision), Dim(55, 100); exogenous
Range: XX=0 to 55 (X=15 to 69); T=0 to TMAX
Description: The insurable salary at age X in year T for each income class.
SalH (High income): the average salary of the highest 30 percentile income group
SaIM (Medium income): the average salary between 30 and 70 percentile income group
Sall (Low income): the average salary of the lowest 30 percentile income group
Remark: Read from the worksheets "Sall", "SaIM", "SalH" in the group file.
Reference: Projection(), Preparation(), Finsal(), Balance()

S1(N, K), S2(N, K)

Type: Real number (double precision) Dim(6, 4); endogenous
Range: Overwritten for each year T.
Description: The total number (S1) or amount (S2) (total of age) of population group N and category K in year T.
N=0
S1(0, K): Number of active population
S2(0, K): Total amount of insurable earnings
K=0: Total
K=1: Low income level
K=2: Medium income level
K=3: High income level
N=1
S1(1, K): Number of old-age pensioners
S2(1, K): Total amount of old-age pensions
K=0: Total

K=1: Existing in the initial year
K=2: Awarded after the initial year whose pension is higher than minimum pension
K=3: Awarded after the initial year whose pension is equal to minimum pension

N=2

S1(2, K): Number of invalidity pensioners
S2(2, K): Total amount of invalidity pensions

K=0: Total

K=1: Existing in the initial year
K=2: Awarded after the initial year whose pension is higher than minimum pension
K=3: Awarded after the initial year whose pension is equal to minimum pension

N=3

S1(3, K): Number of widow(er)s pensioners
S2(3, K): Total amount of widow(er)s pensions

K=0: Total

K=1: Existing in the initial year
K=2: On the death of the active population
K=3: On the death of the old-age pensioners
K=4: On the death of the invalidity pensioners

N=4

S1(4, K): Number of orphans pensioners
S2(4, K): Total amount of orphans pensions

K=0: Total

K=1: Existing in the initial year
K=2: On the death of the active population
K=3: On the death of the old-age pensioners
K=4: On the death of the invalidity pensioners

N=5

S1(5, K): Number of beneficiaries of grants
S2(5, K): Total amount of grants

K=0: Total

K=1: Old-age grant
K=2: Invalidity grant
K=3: Survivors grant

N=6

S1(6, K): Number of beneficiaries of the funeral grants
S2(6, K): Total amount of funeral grants

K=0: Total

K=1: On the death of the active population
K=2: On the death of the old-age pensioners
K=3: On the death of the invalidity pensioners

Reference: SUMoX(), FILEW()

SGA

Type: Real number (double precision); endogenous temporary
Range: Overwritten
Description: The sum of $A(l)$ over $l=1$ to l_{max} .
Remark: Used for normalizing the distribution $F(l, XX)$.
Reference: `InsIns()`

SGB

Type: Real number (double precision); endogenous temporary
Range: Overwritten
Description: The sum of $B(l)$ over $l=1$ to l_{max} .
Remark: Used for normalizing the distribution $F_g(l, XX)$.
Reference: `InsIns()`

SN1(N, K), SN2(N, K)

Type: Real number (double precision), $\text{Dim}(4, 4)$; endogenous
Range: Overwritten for each year T .
Description: The total number (SN1) or amount (SN2) (total of age) of newly awarded pensioners of type N and category K in year T . See $S1(N, K)$ and $S2(N, K)$.
Reference: `SUMoX()`, `FILEW()`

Title\$

Type: Character; exogenous
Range: To be specified in the input worksheet
Description: Title Name of the projection run.
Remark: To be specified in cell B4 in the input worksheet "InputS". The same variable is redefined in `CreateFilesXL()`.
Reference: `ReadEconDem()`

TMAX

Type: Integer; exogenous constant
Range: Set in the input worksheet.
Description: The length of projection periods (year).
Remark: Read from the cell B6 in the input worksheet "InputS" (minimum 1; maximum 100).
Reference: `ReadEconDem()`, `Projection()`, `CreateFilesXL()`.

TT

Type: Real number (double precision); ad hoc
Description: The contribution years in excess of 25 years.
Remark: Used for calculating the pension amounts.
Reference: `PensionR()`, `PensionI()`, `PensionS()`

UBInput

Type: Real number (double precision); exogenous
Range: Input value from 1 to 3. Rewritten in `ReadEconDem()`.
Description: Basis of the average values in the group files. ("SalL, M, H", "Pens")
Input=1: monthly → `UBInput=1`
Input=2: yearly → `UBInput=1/12`

	Input=3: daily→ UBInput=30
Remark:	To be specified in the drop-down bar in cell B9 in the input worksheet "InputS".
Reference:	SUMoX(), FILEW(), ReadEconDem(), InsRet(), InsInv(), InsSurv()
UBOutput	
Type:	Real number (double precision); exogenous
Range:	Takes a value from 1 to 3
Description:	Basis of the average values in the output files. Input=1: monthly→ UBOOutput=12 Input=2: yearly→ UBOOutput=1 Input=3: daily→ UBOOutput=360
Remark:	To be specified in the drop-down bar in cell B12 in the input worksheet "InputS". The same variable is redefined in CreateFilesXL().
Reference:	SUMoX(), FILEW(), ReadEconDem()
UinputAve	
Type:	Real number (double precision); exogenous
Range:	Input value from 1 to 3. Rewritten in ReadEconDem().
Description:	Unit of the average values in the group files. ("SalL, M, H", "Pens") Input=1: in nominal→ UInputAve=1 Input=2: in thousands→ UInputAve=1,000 Input=3: in millions→ UInputAve=1,000,000
Remark:	To be specified in the drop-down bar in cell B8 in the input worksheet "InputS".
Reference:	SUMoX(), FILEW(), ReadEconDem()
UOutputAve	
Type:	Real number (double precision); exogenous
Range:	Takes the value 1 to 3
Description:	Unit of the average values in the output files. Input=1: in nominal→ UOutputAve=1 Input=2: in thousands→ UOutputAve=1,000 Input=3: in millions→ UOutputAve=1,000,000
Remark:	To be specified in the drop-down bar in cell B11 in the input worksheet "InputS". The same variable is redefined in CreateFilesXL().
Reference:	SUMoX(), FILEW(), ReadEconDem()
UoutputTot	
Type:	Real number (double precision); exogenous
Range:	Input value from 1 to 5. Rewritten in ReadEconDem().
Description:	Unit of the total amount values in the output files. Input=1: in nominal UOutputTot=1 Input=2: in thousands→ UOutputTot=1,000 Input=3: in millions→ UOutputTot=1,000,000 Input=4: in billions→ UOutputTot=1,000,000,000 Input=5: in trillions→ UOutputTot=1,000,000,000,000
Remark:	To be specified in the drop-down bar in cell B10 in the input worksheet "InputS". The same variable is redefined in CreateFilesXL().
Reference:	SUMoX(), ReadEconDem()

VACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T
Description: The number of withdrawals on grounds of entry into invalidity from the active insured population aged X in the year T-1.
Remark: See notes on decrement.
Reference: Projection(), InsInv()

VNACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for X and T.
Description: The number of withdrawals on grounds of entry into invalidity from the inactive population aged X in the year T-1.
Remark: See notes on decrement.
Reference: Projection(), InsInv()

VVACT

Type: Real number (double precision); endogenous intermediate
Range: Overwritten for I, X and T.
Description: Put equal to $VACT * F(I, X) + VNACT * Fg(I, X) * PNINV$. The number of persons withdrawn on grounds of invalidity from the active and the inactive (if the invalidity pension is payable) population with credit I.
Reference: InsInv()

WID1(X, K), WID2(X, K)

Type: Real number (double precision), Dim(101, 4); endogenous
Range: X=15 to 99; K=0 to 4
K=0 (Total)
K=1 (Existing pensioners in the initial year)
K=2 (Newly awarded pensioners after the initial year on the death of active persons)
K=3 (Ibid: on the death of old-age pensioners)
K=4 (Ibid: on the death of invalidity pensioners)
Description: WID1: The number of the widow(er)s pensioners at age X in year T for each category K.
WID2: Total amount of the widow(er)s pension (ibid)
Reference: Survivors(), SUMoN(), SUMoK(), SUMoX(), FILEW(), Preparation() VALUATION()

WMIN(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Minimum monthly insurable earnings in year T.
Remark: Read from the worksheet "Econ" in the economic-demographic file.
Reference: ReadEconDem()

WMAX(T)

Type: Real number (double precision), Dim(-5 to 100); exogenous
Range: T=-5 to 100
Description: Maximum monthly insurable earnings (ceiling) in year T.

Remark: Read from the worksheet "Econ" in the economic-demographic file.

Reference: ReadEconDem()

ZACT

Type: Real number (double precision); endogenous intermediate

Range: Overwritten for X and T

Description: The number of remaining population after deducting withdrawals on grounds of death and entry into invalidity from the active insured population aged X in the year T-1.

Remark: See notes on decrement.

Reference: Projection(), InsIns()

ZNACT

Type: Real number (double precision); endogenous intermediate

Range: Overwritten for X and T.

Description: The number of remaining population after deducting withdrawals on grounds of death and entry into invalidity from the inactive insured population aged X in the year T-1.

Remark: See notes on decrement.

Reference: Projection(), InsIns()