## Development of a national pension model for policy-making purposes
## VS/2013/0275

# Final report on micro-simulation model of the evolution of public pension system of Romania

**September 2015**

With financial support from the European Union

# Contents


1. OBJECTIVES OF THIS REPORT ..... 4
2. CONTEXT OF THE REPORT ..... 4
3. PENSION MODELS IN EUROPE ..... 5
3.1 COHORT MODELS ..... 7
3.2 TYPICAL AGENT/INCOME STANDARDIZED INDIVIDUAL ..... 8
3.3 MICRO-SIMULATION MODELS ..... 9
3.4 DYNAMIC MICRO-SIMULATION MODELS ..... 10
3.5 SELECTING THE MOST SUITABLE MODEL ..... 12
4. DATA AND DATA SOURCES ANALYSIS ..... 14
4.1 INPUT DATA FOR THE MICRO-SIMULATION MODEL ..... 14
4.2 NECESSARY DATA, USED DATA, DATA SOURCES ..... 16
5. MODELLING APPROACH OVERVIEW ..... 21
5.1 MODEL IMPLEMENTATION ..... 21
5.2 MODEL OBJECTS – MODELPOINTS ..... 21
5.4 CALCULATION TIME FLOW ..... 21
*5.4.1 Events ..... 21*
*5.4.2 Life statuses ..... 22*
*5.4.3 Labour statuses ..... 23*
*5.4.4 Gross salary/income ..... 23*
5.5 ASSUMPTIONS ..... 24
5.6 MAIN VARIABLES FOR REPORTING ..... 24
*5.6.1 Aggregate Reporting ..... 24*
*5.6.2 Individual (Modelpoint-level) Reporting ..... 26*
6 ILLUSTRATIVE MODEL RESULTS ..... 28
6.1 DEMOGRAPHIC EVOLUTION OF POPULATION (2015-2065) ..... 28
6.2 POPULATION STRUCTURE ..... 29
*6.2.1 Public pension system beneficiaries – chorot of males born in 1995 ..... 29*
*6.2.2 Inactive population – cohort of males and females ..... 30*
*6.2.3 Public pension system beneficiaries – analysis of population evolution ..... 31*
*6.2.3.1 Evolution of existing population at projection start ..... 31*
*6.2.3.2 Evolution of total population ..... 32*
*6.2.4 Beneficiaries – single participant simulation ..... 33*
*6.2.5 Evolution of contributors - cohort (male born in 1995) ..... 34*
*6.2.6 Evolution of contributors - population ..... 35*
*6.2.6.1 Evolution of existing population at projection start ..... 35*
*6.2.6.2 Evolution of total population ..... 36*
6.3 EVOLUTION OF EMPLOYEES - COHORT (MALES BORN IN 1995) ..... 37
6.4 REVENUES AND CONTRIBUTIONS OF PARTICIPANTS ..... 38

*6.4.1 Population* ..... 38
*6.4.1.1 Evolution of existing population at projection start* ..... 38
*6.4.1.2 Evolution of total population* ..... 39
*6.4.1.3 Evoltion of revenues and salaries at total population level – nominal values* ..... 40
*6.4.1.4 Evolution of contributions at total population level – nominal values* ..... 41
*6.4.1.5 Evolution of revenues and salaries at total population level – non-indexed values* ..... 42
*6.4.1.6 Evolution of contributions at total population level – non-indexed values* ..... 43
**6.5 EVOLUTION OF AVERAGE INCOME** ..... 44
*6.5.1.1 Evolution of average income – nominal values and non-indexed values* ..... 44
**6.6 VALUE OF PENSIONS PAID FROM PILLAR I** ..... 45
*6.6.1 Evolution of cohort (males born in 1995)* ..... 45
*6.6.2 Evolution of population – nominal values* ..... 46
*6.6.3 Population evolution – non-indexed values* ..... 47
*6.6.4 Average old-age pension – indexed value and non-indexed value* ..... 48
**6.7 AVERAGE REPLACEMENT RATE INCLUDING ANNUITIES FROM PILLAR 2 AND WITHOUT ANNUITIES FROM PILLAR 2** ..... 49
**6.8 DEPENDENCY RATIO** ..... 50
**6.9 DEFICIT / SURPLUS OF PILLAR I** ..... 51

# 1. Objectives of this report

The scope of this report is to present the characteristics of the micro-simulation model developed for CNPP. Thus, in this report the main models used for predictions and decision making in the pension sector will be presented, the data which they use and what processing is done on them, but also a general presentation of the results generated by the model.

# 2. Context of the report

By presenting the relevant elements for the development of the micro-simulation model, in a complete format, this will bring a better understanding of how this tool can be used and how to improve the modelling/simulation capabilities of the public pensions sector in Romania, with direct impact on the process of developing public sector policies regarding the pension system. Understanding the links and dependencies between the input data and the results generated by the model it gives a better knowledge of how this tool can be used in an optimum way.

The analysis of the data used by the model (input data such as model points and evolution parameters – hypothesis and legislative parameters) and analysis and understanding of the methods of processing will help to improve the performances of the model in the future by identifying inconsistencies in the data used, ultimately helping the model generate a likely course of evolution.

Romania does not have a developed pension micro-simulation model adapted to the country's specific pension system.

In order to develop its micro-simulation capacity in the field of public pensions, as such supporting the development, implementation and monitoring of public policies and assessing their impact upon the public pension system, the National House of Public Pension accessed European financing through the project „Development of a national pension modelling instrument with the purpose of policies' development – SimProVision", VS/2013/0275, financed by European Commission, through the PROGRESS programme, whose objective is to achieve a robust tool for modelling the public pension system in Romania which should capture some of the following issues of the public pension system in Romania:

- The impact on the public pension system sustainability of enrolment in anticipated retirement pension, partial-anticipated retirement pension and invalidity pension;
- The impact of using incentives for people that remain employed after meeting retirement conditions;
- Statistical analysis of the sustainability of Pillar I and Pillar II depending on the replacement rate.

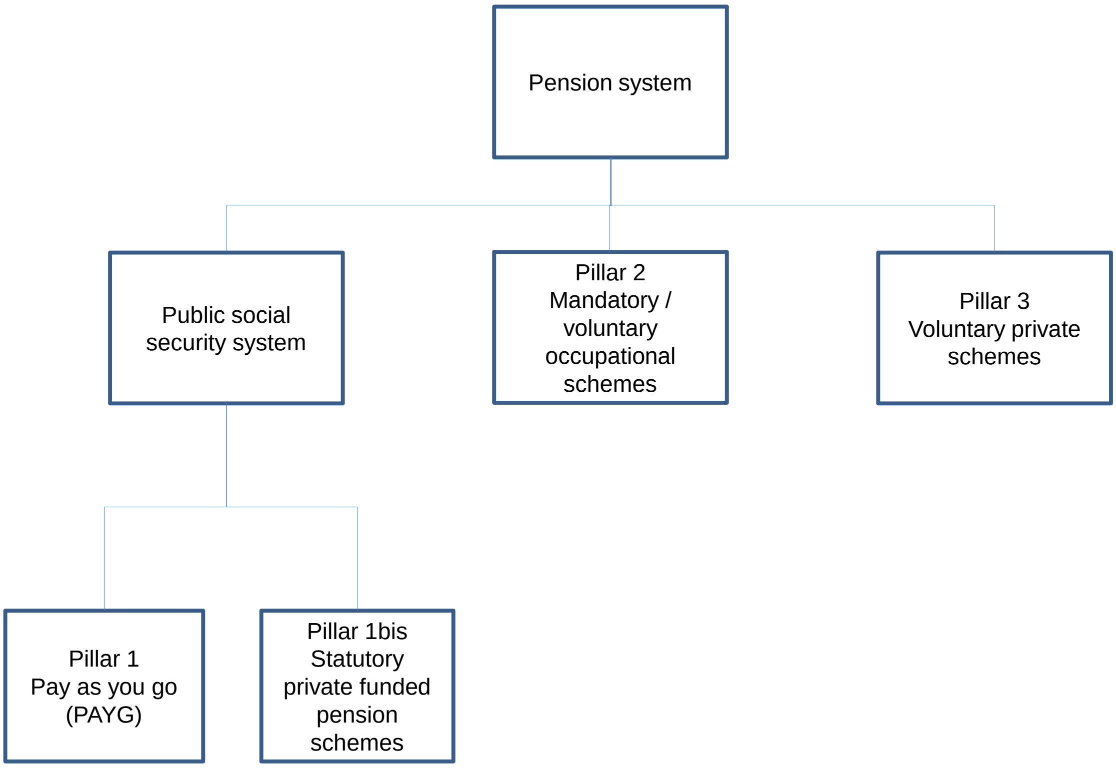
**Project stakeholders are:**

- Contracting Authority – National House of Public Pensions (NHPP)
- Responsible for administrative and procedural matters related to launching, contracting and contract management – Public procurement service, NHPP
- Provider (Consultant / Contractor) – responsible for the delivery of products and services covered by the procurement procedure

# 3. Pension models in Europe

In order to understand the pension simulation models already implemented within the EU Member States, a brief description of Pension models in Europe was included. The description is based on *the IZA Research Report no. 42 – Pension Systems in the EU – Contingent Liabilities and Assets in the Public and Private Sector*[1], based on a study conducted for the European Parliament in 2011.

Across EU-28 there are different pension systems making it hard to go into the details of each Member State pension system. Nonetheless, all Member States have a strong public sector involvement that can provide old-age provision and typically also early retirement, disability and maybe survivors' pensions. In general, the variation across Member States is more significant with respect to the role of occupational and private pension provisions. The Figure below presents a general classification off pension types divided into pillars[2].




The strong involvement by the public sector is represented by the public social security system consisting of pillar 1 and pillar 1bis. Pillar 1 has a redistributive element where persons who have only accrued small pensions can receive a higher benefit. The pension types within pillar 1 are on a PAYG basis, where tax payments and/or contributions to pension funds are used for the payments of current pensions rather than contributions to prevent poverty in old age. The pillar 1bis has grown recently as some countries have switched part of their social security pension schemes into funded schemes that are generally operated and managed by private institutions. Provision and participation in the pension scheme is usually statutory.

1 IZA Research Reports, Report No. 42: Pension Systems in the EU – Contingent Liabilities and Assets in the Public and Private Sector, pages 25-27, Bonn 2011

2 ibidem

Nine of the 28 EU Member States switched part of their social security pension provision into statutory funded private pension schemes[3].

Among the old EU-15 Member States, statutory private schemes can be found in Sweden and Denmark. Among the new EU Member States, seven switched part of their social security pension provision: Bulgaria, Estonia, Hungary, Latvia, Lithuania, Poland and Slovakia. Hungary is, however, not 1bis anymore as its pension system has been brought under Pillar 1 later on[4].

Savings within the second pillar aim to provide retirees with an adequate replacement rate (i.e. an adequate pension income relative to their previous earnings), which is more advantageous than just a poverty-preventing minimum level of living[5].

Not all Member States have occupational pension schemes. Where they exist, these pension schemes may be voluntary or mandatory while some Member States have both types. Occupational pension schemes do not exist in the Czech Republic, Estonia, Latvia, Lithuania and Slovakia. In Member States such as Malta and Poland they only exist to a minor extent and in Luxembourg they only exist in for example banking and large foreign companies. The legal framework for occupational pension schemes has been prepared in Greece recently, so their occupational pension schemes are not very mature yet[6].

The third pillar represents individual private pension schemes in the private sector. Individual pension schemes do not exist in Cyprus and Luxembourg and they only exist to a minor extent in Austria, Malta, the Netherlands and Portugal. Normally, the private pension schemes are voluntary. As the pension types in pillar 1bis can be regarded as a switched part of the social security pension scheme into a private scheme, it could also have been possible to organize these types of pension schemes into the group of private schemes in Figure 4. This is done by Eurostat data arguing that the switched part of the social security pension scheme belongs to pillar 3 (i.e. the private sector) because the transactions are between the individual and the pension fund.8 Consequently, they do not have an impact on the government surplus or deficit[7].

According to Eurostat, the government guarantee for such a fund is not an adequate condition to classify the schemes as social security schemes because it is a contingent liability. Seen from the perspective of the citizens, the private pension schemes in pillar 1bis are often mandatory. In some Member States, the pension is mandatory for younger generations and voluntary for older generations. This is for example the case in Latvia where it is mandatory for persons under the age of 30 and voluntary for persons aged 30-49 and in Romania where it is mandatory for employees of 15–35 years old and voluntary for the 35–45 years old[8].

EU Member States use different simulation models for pension projections, but all models used within EU may be classified within two main categories: standard models and micro-simulation models. The table below summarizes the different types of models used by EU Member States.

[3] ibidem
[4] ibidem
[5] ibidem
[6] ibidem
[7] ibidem
[8] ibidem

| Model type | Subtype | Description | Countries using the model |
|---|---|---|---|
| **Standard** | ***Cohort*** | Aggregate level calculations, no or limited use of individual data | Poland, Lithuania, Spain, The Czech Republic, Slovakia, Austria and others. |
| | ***Typical agent*** | Simulation of selected fictitious individuals, no or limited use of individual data | The Czech Republic, Slovakia, Greece and others. |
| **Micro-simulation** | ***Static*** | Use of individual data (a large number of individuals), comparative statics, absence of historical time | Belgium, Denmark, Luxembourg |
| | ***Dynamic with static aging*** | Use of individual data (a large number of individuals), time shift by changing weights | The Netherlands |
| | ***Dynamic with dynamic aging*** | Use of individual data (a large number of individuals), complete life projection of all individuals in time | Great Britain, Sweden, France<br>Hungary, Czech Rep., Poland etc. |

***Source:***

PENMICRO - Monitoring pension developments through micro-socio-economic instruments based on individual data sources: feasibility study, TARKI Social Research Institute

The following chapter analyses each type of models used in more detail. The main source of the description of each type of model, as well as the features of each model is the report developed by PENMICRO - *Monitoring pension developments through micro-socio-economic instruments based on individual data sources: feasibility study,* study that was developed for the European Commission.

## 3.1 Cohort models

The majority of models used in the EU by Member States can be best classified as standard cohort models. Instruments of this type start from current cross-sectional information on labour market position and social security contributions of various social groups, most frequently cohorts, which are sometimes further disaggregated by gender and some labour-market attributes, including demographic features such as marital status, and level of education. The information set, which consists of group-averages, is sometimes extended to include retrospective data on contributory or wage history. Current information is projected then into the future subject to assumptions on demographic and labour market developments. These parameters in effect re-weigh the group-averages. A partial equilibrium concept is usually applied in order to assure consistency among the aggregates resulting from the re-weighing process and some exogenous macroeconomic variables. In addition, often some mechanisms are applied in order to ensure internal consistency among the parameters of the projection. Standard cohort models have the advantage, as compared with the typical agent models (see below), that it is easier to obtain aggregate conclusions, such as future revenues or expenditures of the pension system. It requires special care from the modeller to secure consistency between projections on wages and those of employment levels and wages. Translating exogenous cross-section labour force assumptions into cohort average (longitudinal) career characteristics (length of service, benefit base) is often a critical point in these cohort models.

***Disadvantages***

- not possible to capture nonlinearities in pension formula – distortion of results
  - ✓ Retirement conditions, ceilings, reduction limits, minimal pensions, etc.
- The results are average values, not the distribution
  - ✓ Not possible to determine the number of pensioners below the poverty line
  - ✓ Not possible to assess the redistributiveness of the system
  - ✓ Not possible to capture the differences between participants inside cohorts

***Advantages***

- Easy implementation
- Lower demands on input data
- Easy to ensure consistency with external population and macroeconomic projections
- Usually sufficient for reliable modelling of the overall system balance

## 3.2 Typical agent/income standardized individual

Another branch of models is the typical agent model. Instruments of this type draw typical histories of fictitious individuals (i.e. the unemployed or minimum wage earners as such, etc.), based on which the level of benefits is calculated. This method has a strong longitudinal element, but the cross-sectional view is rather ad hoc, especially as transitions across the fictitious sub-groups that form the basis of this model are usually not accounted for. This approach yields a sophisticated estimate of replacement rates, given that this type of model usually contains the country-specific institutional setting with all its non-linearity, ceilings etc.

In addition, the acquisition of pension rights is properly tracked, as full life histories are available. Typical agent models are well suited to assess incentives in the pension system to work longer as well as to compare the relative generosity of schemes across various life paths and/or countries. The main challenge of this approach is to come up with a fiscal projection, given that it is incapable of weighing the fictitious groups of individuals in a way that would reflect the composition of society. For the same reason, it is not possible to analyse distributional effects of policy alternatives. Also, this “typical agent” method does not incorporate a model for individual behaviour, e.g. the choice of the year of retirement, or macroeconomic repercussions (e.g. higher contribution rates reduce labour force participation).

Typical agent models may differ in the main features and life-path characteristics of typical agents, the motivations of choosing these particular fictitious actors, the way their life-paths are set, and the mechanism that ensures consistency between core scenarios/assumptions. In addition, there are different approaches to aggregating the results derived from typical life paths as non-exhaustive components and the empirical models used to derive behavioral responses of typical agents to exogenous effects.

***Disadvantages***

- Not possible to infer aggregate results from individual results
- Not based on real but only fictitious individuals
- The results give an idea of possible impacts on different people but do not deal with counts of such people
  - ✓ Not possible to determine the number of pensioners below the poverty line
  - ✓ the redistributiveness of the system is possible to assess only approximately (selected cases)

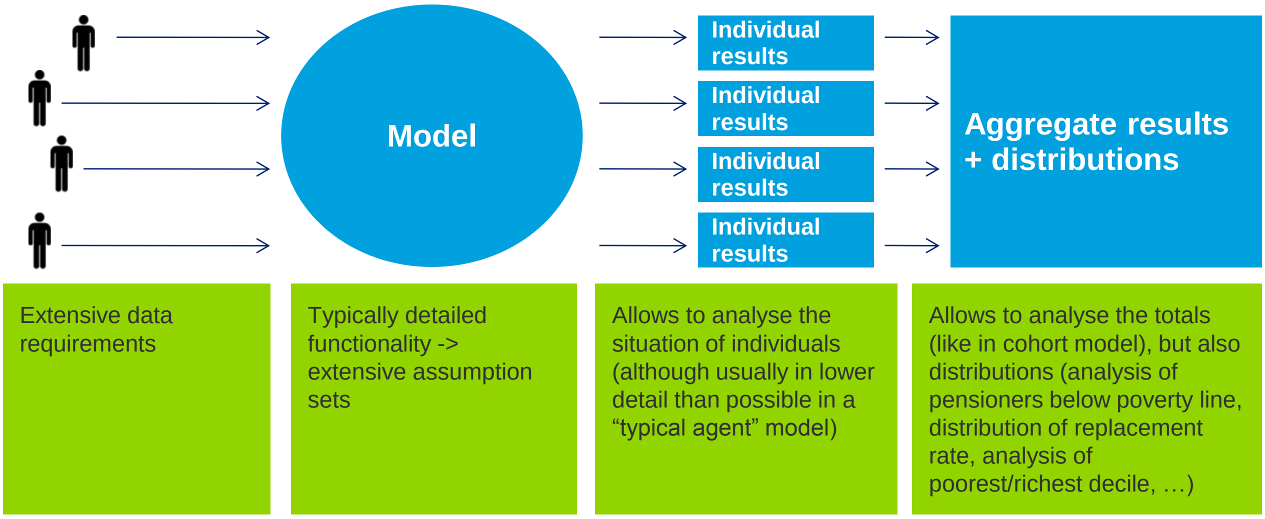
***Advantages***

- Possible to capture nonlinearities in pension formula
  - ✓ Retirement conditions, ceilings, reduction limits, minimal pensions, etc.
- By selecting suitable individuals one can get an idea of possible impact on different individuals
  - ✓ The results can be compared e.g. for different income brackets

## 3.3 Micro-simulation models

Micro-simulation models simulate changes in a sample of a large number: thousands and sometimes hundreds of thousands of individuals. Information on the sample can be collected in surveys or by the data processing of various government agencies such as the tax authority or the social security administration. They can be cross-sectional, if individuals appear in the sample only once, or panel, if individuals can be followed over a period of time. Some samples include information only on the individual; some also contain data on other household members. Administrative data have some obvious limitations compared to survey data, because administrative data are not collected for research purposes and thus usually lack some information that would be required. Questionnaires for survey data may be designed specifically for defined research purposes. On the other hand, administrative data is in general more detailed, complete, timely, regular and accurate than survey data.

In their simplest form, micro-simulation models are static, i.e. they compare two states of the world, or two different institutional settings and simulate “overnight effects” (Dekkers 2007). In contrast, dynamic micro-simulation models include time, and explicitly model life paths of individual units as they age. Zaidi and Rake (2001) point out that while static models do not attempt to incorporate behavioural changes, dynamic models are concerned to take on board behavioural responses as well as simulating the policy environment.




***Disadvantages***

- Demanding on volume of inputs and assumptions
- More demanding implementation and longer run time
- Challenging to ensure consistency with external assumptions and macro-level-only projections (demography, macroeconomic scenario)

***Advantages***

- Possible to capture nonlinearities in pension formula
  - ✓ Retirement conditions, ceilings, reduction limits, minimal pensions, etc.
- Non-biased aggregate results
- Complete individual results including distribution
  - ✓ possible to determine the number of pensioners below the poverty line
  - ✓ possible to assess the redistributiveness of the system

## 3.4 Dynamic micro-simulation models

Zaidi and Rake (2001) distinguish two approaches to introducing ageing in a dynamic micro-simulation model. The first is dynamic micro-simulation with static ageing, in which cross-section characteristics are updated by exogenous future aggregate data, so that time is traced as a series of world states. In practice, dynamic micro-simulation models with static ageing first reweigh the individual cases in order to adjust the sample to projected demographic and labour market developments. Then, as a second step the resulting aggregate results are adjusted by some exogenous developments, such as economic growth (Harding 1996, Dekkers 2007). This reweighing-updating process resembles what standard cohort models achieve, except that for micro-simulation the number of cases reweighed and updated is much larger.

Dynamic micro-simulation models with dynamic ageing go further, by building up complete life histories of each individual in the dataset. Within this latter group, Dekkers (2007) differentiates between cross-sectional models and cohort/longitudinal models as being two major directions. In the former, individuals, who are the basic unit of modelling, are moved ahead in time one-by-one a period, while each of their attributes is updated. In the latter an entire individual life cycle is followed through from birth to death before the model takes in the next individual. The advantage of cross-sectional models is that they allow for interactions between individuals, such as a marriage or death of a partner, in a straightforward way. In contrast, longitudinal models make it possible to introduce forward-looking elements to individual behaviour. Zaidi and Rake (2001) also draw a distinction between models where the relationships are entirely determined by the parameters defined within the model (deterministic models) and models where random processes are also applied (stochastic models). Most of the micro models are dynamic, cross-sectional micro-simulation models with dynamic ageing

The initial databases used for these simulations may be various. While standard simulation models are most frequently based on administrative data, micro-simulation models tend to rely on samples from censuses or surveys. Some tools use administrative databases or samples thereof, others take surveys as a starting point. The crucial issues are whether surveys are representative and whether one database (survey or administrative) contains the level of detail necessary to capture all relevant attributes of individuals. The matching of databases provides some help in both of these matters.

Dynamic models with dynamic ageing carry individuals through life-events. The level of detail provided in the initial database determines to a great extent what life-events may be tracked in the simulation. Individuals' age and sex, as in standard models, is known of course, so all models include birth and death. The Dutch MICROS, the Belgian MIDAS, the French PRISME and DESTINIE simulate school-leaving age, first "marriage"/cohabitation, recoupling, divorce, and children born. With the exception of PRISME, they provide detailed information on household structure, including size and combined income. DESTINIE also simulates kinship ties between non-core people, for instance the survival of parents or siblings and applies differentiated mortality rates depending on age at leaving school. SESIM provides the highest level of detail on the education front, while also tracking the age at which children leave home. Hungary's NYIKA model is only concerned with life and death among the demographic parameters.

**Approaches to careers modelling**

<u>Deterministic approach</u>

- The transitions between states are modelled all at once – known only the average state
- Only average values of variables (e.g. number of years of insurance, paid out pension) are tracked across all careers of the model point
- The resulting distribution is coming only from the distribution of model points at start, in the model there are no other variances or extreme paths
- From a computational point of view this is actually a cohort model with more detailed model points

<u>Deterministic calculation with stochastic components</u>

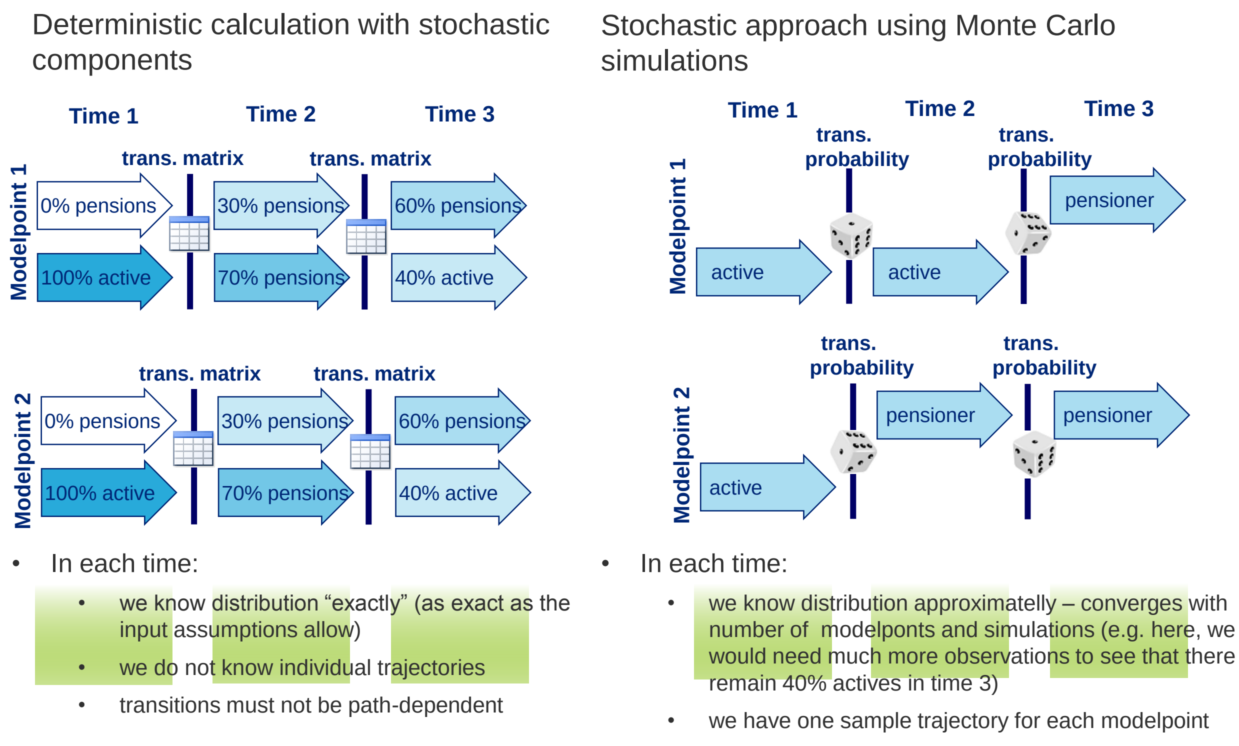
- For selected variables the distribution is calculated (e.g. number of years of insurance)
- Can project the distribution of the results further ahead
- The distribution of the selected variable is known but the particular career is not known, it is not possible to use not-markovian transitions (dependence on the length of the state etc.)
- Computationally demanding (matrix multiplication)
- In reality possible only for one stochastic variable (or very few), complexity grows exponentially with dimension of the transition matrices and with the number of selected variables

<u>Stochastic approach using Monte Carlo simulations</u>

- State transitions are (pseudo)random on the basis of given probabilities

- At one moment each model point is in just one state
- The complete history of the individual is generated – possibility of not-markovian transitions
- At retirement there is precisely known the duration of insurance and other variables in the pension formula. It is possible to precisely model nonlinearities in pension formula for extreme careers.
- To achieve stability of results is necessary to use the sufficient amount of model points or simulations → long rung times, necessity to review convergence
- In comparison with previous approach, calculation for one model point is easier because there is no need to branch careers and record the distribution
- Very difficult to ensure exact consistency with external macro-projections
- Stochastic character of the results
- The results in two runs with different seed work out a bit differently
- Some variables, especially changing variables (the number of deaths etc.) are not smooth even at the high number of simulations/model points

The differences between deterministic calculation with stochastic components and the stochastic approach using Monte Carlo simulations are illustrated below.




## 3.5 Selecting the most suitable model

Selecting the most suitable model depends on the data availability and the intended use of the Beneficiary.

- Long-term modelling

  - ✓ All described models are appropriate for long-term (for example horizon of 10-100 years)

- Short-term modelling
  - ✓ For example estimation of budget for next year
  - ✓ None of the mentioned models are appropriate for this type of estimation
- Micro-level analyses:
  - ✓ micro-simulation model allows modelling the distribution of career developments, distribution of pension wealth/poverty, replacement ratios, and other detailed analyses from individual (model point) level
- Macro-level analyses:
  - ✓ cohort models allow easier matching aggregated statistics (number of unemployed, wages growth, costs for whole economy etc.) to externally provided projections
- No model can do all perfectly

For example, aggregated salaries growth in the micro-simulation model is a complex combination of nominal wage inflation and employment development in various income strata, career development of individuals, entrances/leaves of the individuals to/from labour market; total-level salaries growths projections taken from external institutions will be based on different assumptions, often prepared in detail only for 5-10 years and then set constant. As such, the model can either match the total-level projection of the external institution, or use realistic individual-level assumptions, but not both

- Micro-simulation models complex → to be used where they add value (distributions)
- Macro- and aggregate-level models can produce simple aggregated overviews in simpler way

As per the IT applications used for simulation in the European Union, there is no unitary approach, different countries using models developed on different platforms or even from scratch. For example:

- Bulgaria, Slovakia, Latvia, Lithuania developed models in Excel + Visual Basic for Applications (Microsoft Corporation
- Hungary, Czech Repubic, Poland developed their models on Prophet platform, provided by Sungard
- Netherland – developed models on MATLAB developed by MathWorks
- UK – developed models on SAS analytics tools
- Spain model has been developed using ModGen, a generic dynamic micro-simulation programming language developed and maintained by Statistics Canada
- Austria used MicroSim – a generic micro-simulation toolbox that provides the basic infrastructure to model situations that should be simulated using this approach

# 4. Data and data sources analysis

Micro-simulation models need data at individual level. Each individual (or a small group of individuals with the same traits) will have a projection in the future, based on his initial situation and on transfer probabilities or probabilities of events to happen. In the model, these individuals (or a group of individuals) are represented by model points, which cannot be split inside the model.

In order to produce quality results the model needs exact information when it comes to:

- Data referring to model points which include all relevant factors, directly or indirectly, for calculating pension benefits of a person( for example: age, sex, salary/income, pension rights already accumulated, number of children etc).
- Decision making processes, such as information referring to the distribution of factors in the population (for example: fertility rates by age, number of children, probability of becoming employed by age and sex or the probability of being a student by age and sex)

## 4.1 Input data for the micro-simulation model

In accordance with project objectives, the main intended uses of the model are:

- Primary objective: **the projection of aggregate public pension system sustainability**
- Secondary objective: ***pensions and projection distribution in the population replacement rate***

To achieve this, the model must be a micro-simulation model, while enabling distribution analysis of key variables in the population, and the estimation of aggregate results. According to CNPP agreed technical specifications, design features will include:

- The projection of the number of pensioners on categories / types of pensions (old age, early, disability, survivors, etc.);
- The projection amount of the benefits of Pillar I on categories / types of pensions (old age, early, disability, survivors, etc.);
- Projection influence the payroll tax and pension contributions over benefits paid health;
- The projection of gross revenues and net income of the insured / taxpayers and pensioners;
- The separate reporting of outcomes for retirees coming from the former agricultural cooperatives;
- Simplified projection (of cohorts) for policyholders from the military system
- numerical key system parameters (such as percentages and applied capping pensionable age etc.) can be easily changed via input data tables in the model.

The model will cover the benefits of Pillar I and Pillar II. There will be modeled contributions and other benefits (such as those under Pillar III, granted for maternity benefits, unemployment benefits, etc.)

State budget contribution for the achievement of the minimum pension will be modeled and special allowances and pension service for magistrates and other social categories. In addition, other benefits that are covered by the state budget (such as pension, disability, etc.) will not be modeled.

The model will be a micro-simulation model simulation with a (pseudo) random Monte Carlo individuals and will be implemented in software Prophet 8. actuarial modeling will be conducted at the level of the model. For example, the pattern unit can be considered to be an individual, and its projection can be taken as the lifetime of the individual.

The input data for the simulation model can be divided into two broad categories:

- Model points
- Simulation hypothesis.

***Model points***

Each unit will generate a model career path (ie no more will be designed for a life trajectories of the same unit of model) model each unit will have a unique status in the labor market every time. The projection's life represented by the model unit will cease when designing his death. However, the projection unit can continue after his death model to design its corresponding survivor's pension.

The model will require two separate sets of model units:

- a model that represents the current unit make the labor market (in all statutes modeled: employees, employees in their own name, retired etc.).
- a model units representing future participants in the labor market entrants. These units will be the model profiles and future of the whole population should be based on:
- an existing population structure;
- a demographic projections, assumptions concerning future immigration etc. - Elements used to estimate the volume of new entrants into the labor market

The necessary data modeling pension system will cover at least the following: stages of contribution, paid retirement benefits, education, age, employment status (employed, unemployed, inactive, deceased), marital status etc.

***Simulation parameters***

Based on the parameters estimated expected future developments. To complement these parameters, assumptions have been developed which fall within the following types:

- economy (inflation, wage developments in the economy, pay increases linked to individual career etc.)
- Portfolio / Behavior (distribution of individual statutes and transfer all probability, the distribution of marriages / divorces, births distribution etc.)
- Legislation: assumptions about future values of the parameters given by legislation (the parameters for the calculation of pensions, increase in minimum / maximum and other parameters used in the formula for calculating the pension etc.)
- A population (the population projections for the construction of model units of future labor market entrants representative current population statistics by age, sex etc.)

## 4.2 Necessary data, used data, data sources

The micro-simulation model designed each model point using simulation assumptions to determine their evolution. Following the simulation model all units at the end, the results are aggregated to study the overall evolution of public pension system in Romania.

By defining the functional specifications of the model were established relevant attributes in future simulation model units for determining future contributions to the pension system and future benefits.

For information processing and to achieve the file containing the model units was used SQL (Structured Query Language - Structured Query Language) database server is implemented with MySQL 5.6.

The following table contains the attributes of each model units in the subdivisions are detailed method of completing their attributes. Where appropriate, were also included suggestions for improving the accuracy of the data.

| Column name | Column description | Data type |
|---|---|---|
| cnp_id | It represents the unique identifier assigned to each unit of model. | Combination alphanumeric |
| d_birth | It is the date of birth of the model unit. | date calendar |
| alive | Remember attribute value "alive" for each unit model. | Yes No |
| Sex | Remember sex each model units. | Male / Female (M / F) |
| curr_pen_amount | Remember the current value of the pension, where appropriate. | Numeric (RON) |
| curr_dis_amount | Remember the current value of invalidity, where appropriate. | Numeric (RON) |
| curr_widow_amount | Remember the current value of the survivor's pension for the surviving spouse, where applicable. | Numeric (RON) |
| curr_orphan_amount | Remember survivor's pension contributions for the child, where appropriate. | Numeric (RON) |
| follower_term_date | Represents the date of termination of survivor's pension law, where applicable. | The date / value of 0 means that this right is permanent successor lifetime. |
| curr_salary | Remember the current salary amount, where appropriate. | Numeric (RON) |
| curr_income | Remember current income other than salary relevant to the calculation of the contribution (for employees themselves). | Numeric (RON) |
| curr_proff | Remember current profession (the area where employed) for each unit model, where applicable. | Alphanumeric combination (selection of predefined values a lot) |
| copyright | Remember that a model unit receive income from royalties (artists, writers etc. - should be "Yes" to make the contributions paid by the employer to Pillar I is 0). | Yes No |
| member_farmer | Remember attribute value "member of the former agricultural cooperative." | Yes No |
| marital_status | Remember marital status of the model unit. | Yes (Married) / No (single or divorced) |

| Column name | Column description | Data type |
|---|---|---|
| spouse_bd | Remember born husband / wife. | date calendar |
| wedding_d | Remember the wedding date. | date calendar |
| no_children | Remember the number of copies of a model unit. | Numeric (Integer) |
| youngest_bd | Remember born the youngest children. | date calendar |
| average_chld_bd | Remember the average age of children (average date of birth of children). | date calendar |
| time_sc | Remember percentage of time worked under special circumstances, the total period of employment. | Numeric (percent) - a score Correlated with monthly special |
| time_dc | Remember percentage of time worked in special conditions of the total period of employment. | Numeric (percent) - a score Correlated with monthly special |
| artist | Remember if your model has a certificate artist. | Yes No |
| magistrate | Remember if your model is the magistrate. Attribute static constant that indicates whether a person is a magistrate. | Yes No |
| magistrate_pen | Remember if your model is retired magistrate. | Yes No |
| p2_member | Remember if your model is participating in Pillar II. | Yes (member) / No |
| willing_p1 | Remember that a model unit Pillar I would like to help, even if it has income <35% of the average wage. | Yes (would like to contribute) / No |
| p2_net_asset | Remember the net asset value of Pillar II. | Numeric (RON) |
| p2_ret_pay | Pillar II pension payment made | Yes No |
| has_worked | Remember if your model has worked in employment; People who have worked this attribute will be filled with "Yes", and those who have never worked this attribute will be filled with "No". | Yes No |
| labour_status | Remember labor market status of each unit model. | It will complement the "employee" for employees and employees own / be completed with "unemployable" for those looking for a job, who are inactive. |
| no_months_worked | Remember the number of months worked | Numeric |
| health_status | Remember health unit model. | This column is completed as either "healthy" or the "Sick" |
| student | Remember if your model student. | Da / Nu |
| disabled | Remember if your model has invalid attribute and what degree of disability is. | "Healthy" / Level I / Level II / III level |
| special_pension | Remember if your model is a beneficiary of special allowances; Attribute static. | Yes No |
| special_pension_type | Remember type of special allowance; Attribute static. | This attribute can have the following values: "Veteran" / "political persecution" / "Persecuted ethnic" / "Participant revolution" |
| special_pension_value | Remember special allowance. | Numeric (RON) |
| retirement | Remember where appropriate if your model is retired and what type of pension is. | "not pensioned" / early retirement / early partial / magistrate (if the |

| Column name | Column description | Data type |
|---|---|---|
| | | individual is retired and receive a pension) |
| mons_elig_start | It represents the number of months of eligibility conditions for old-age pension (for model units representing pensioners). | Numeric (Integer) |
| child_care | Remember if your model is in the child care leave. | Yes No |
| household | Remember if your model has the status of household (household is, subsistence agriculture, etc.). | Yes No |
| self_employed | Remember if your model has the status of "employee in his own name." | Yes No |
| in_system | Remember if your model is in the pension system. | Yes / no (emigrant) |
| acc_monthly_score | Represents monthly points accumulated by summation. | Numeric |
| acc_st_contrib_period | Represents standard length of contribution accumulated until the start of the simulation. This internship has been accumulated from all periods of contribution: employee, engaged in his own name, maternity leave / paternity or sick leave. | Numeric |
| acc_comp_contrib_period | It represents the accumulated length of assimilated contribution until the start of the simulation. This internship corresponding periods of study, military service or time spent as invalid. | Numeric |
| Widow | Remember if your model is widowed. | Yes No |
| widow_bd | Remember surviving spouse date of birth (for current surviving spouses). | date calendar |
| widow_dur | Remember how long model unit receives a survivor's pension for widows. Time is given in number of months. | Numeric (months). |
| widow_income | Remember survivor's income (for current surviving spouses). | Numeric (RON) |
| widow_pension_add | The difference between the survivor's pension for widows and old age pension which would have benefited drive model. | Numeric (RON) |
| widow_emp | Remember if the surviving spouse is employed. | Yes No |
| Orphan | Remember if your model has the status of 'orphan' | Yes No |
| orphan_pens | Remember orphan's pension value (existing orphans). | Numeric (RON) |
| entry_date | It represents entry into a model for future participants; it will likely start modeling (eg future when that person is born). | Date calendar; Those who are already in the system have the same date (current date) |
| imm_date | It is time immigration; for future participants here will be recorded on immigration. | Date calendar; For those who are already in the system will be void. |
| caen_code | It is CAEN code | Numeric (Integer) |
| special_occ | Attribute special static indicating occupation of the individual (for future development of the model introduced by CNPP) | Combination alphanumeric |

| Column name | Column description | Data type |
|---|---|---|
| pp_acc_u2008 | It represents average annual score accumulated by 2008 | Numeric (real number to 5 decimal places) |
| pp_acc_s2008 | It represents average annual score accumulated since 2008 | Numeric (real number to 5 decimal places) |
| career_sd | Represents career start date. | date calendar |
| retirement_d | Represents retirement date. | date calendar |

In addition to the attributes of the model units, in light of the information available, it was used three methods:

- Download and filling in the table of model units of existing information in databases retirees and make public system managed by the CNPP
- Aggregation and computing fields based on existing information in databases retirees and make public system managed by the CNPP to complete in model units table (in cases correlation fields 1-1)
- Fields using statistical extrapolation methods already known information (field estimate).

The information used to complete table of model units were taken from several sources, which are both individual-level information (information available at the individual level) and statistical information provided by various institutions (e.g. National Statistics Institute Board of Governors Magistrates).

For the information to be used, it must meet certain criteria data integrity.

- The "cnp_id" must not contain values CNP 0. Such sites may result from the intersection of CNPP original database with the correlation table CNP - "cnp_id". Thus, if a particular NPC is not in the table contained the value "cnp_id" is initialized to 0. Such "cnp_id" in the processing performed were separated and treated as a data source attached to that in which they were part.
- The value of the "cnp_id" should refer to a single record, is about a single individual. Thus, for example, if a person works simultaneously in several places, it comes with two separate records for each nominal declaration filed by the employer. To translate the information in the table containing the model units, such cases should be reduced to one record (in the example above, adding the income in one registration). All these cases were processed so that the information for a model unit to be included in a single registration.

To complete table of model units were used the following databases, made available by the CNPP:

- database containing the population - provided by the Directorate for Personal Records and Database Administration - the level of November 2014;
- Database related insured persons - the level of September 2014:
  - Database that contains insurance contracts with Pension Fund;
  - Database containing statements of assurance signed by authorized individuals;
  - The database containing persons on maternity leave;
  - Database containing nominal insurance statements made by the employer;
  - The database containing persons participating in Pillar II pension.
- Database related retirements - the level of September 2014:

    - The database contains information about retirees, less those from the former agricultural cooperatives;
    - The database contains information about retirees coming from the former agricultural cooperatives;
    - The database contains information about veterans still in payment;
- Database containing marriages, divorces and links lineage - provided by the Directorate for Personal Records and Database Administration:
    - Database containing information on marriages;
    - Database containing information on divorces;
    - The database contains information on lineage ties.

The set of information on insured persons, and include information on retired and historical data from January 2008 - September 2014.

The set of information regarding the data collected in the work books for insured persons and historical data covering the period prior to 2001.

In order to realize a complete database containing historic data for each individual, to the reference date (September 2014), CNPP has given a database with historic information for each contributor for the period March 2001 – December 2007.

A detailed presentation of the data necessary to realize a simulation and of the processing done on these data can be found in the Report covering Phase 3 **„Available data analysis in modelling / simulations”**

# 5. Modelling approach overview

## 5.1 Model implementation

The model is a **micro-simulation** model **with** (pseudo)**random Monte-Carlo** simulation of individuals implemented in the actuarial software **Prophet 8**, developed by SunGard

## 5.2 Model objects – modelpoints

Calculations are made at the level of the model point which represents an individual from the population.

However, due to technical reasons, the model may use also model points that do not directly represent one individual:

- For model points representing existing participants, the number of model points may be reduced by grouping of individuals sharing the same attributes if this will turn out to be necessary to run the model on the Client's hardware in reasonable time; thereafter, some model points might represent more than one participants
- On the other hand, the number of existing participants model points might be increased (e.g. by copying 2x or 3x the record of each individual) in case this turned out to be necessary for convergence of the Monte-Carlo model;
- Model points representing future market entrants will be set up so that each model point will represent one profile of future entrants; together, the profiles shall represent the overall population of future entrants, but the number of these model points/profiles will be significantly lower than the expected number of individual entrants.

The model runs always one model point through all time steps, saves results, then runs the second model point etc. The results are saved in a granularity given by the SPCODE of each model point

## 5.4 Calculation time flow

Time in the model is represented by a built-in variable *t* that increments on a monthly basis. Initial projection date is set in Prophet run settings. The beginning is always $t = 0$ and it represents:

- projection start date for existing participants' model points; or
- time when a model point representing future market entrant(s) ("new business") enters the model.

All future participants of labour market have to be included in the "new business" model points. The time when the model point starts to be modelled is given by the variable MTHS_TO_SALE in the model point.

### 5.4.1 Events

Important events in life of the individual are modelled randomly, once a month, based on predefined probabilities of the events.

The following events are modelled:

- Death
- Death of the widow/widower
- Study start and end
- Disability level I-III start (or change of level) and end (recovery)

- Old-age retirement start
- Early retirement start and end (suspension and return to work)
- Partial retirement start and end (suspension and return to work)
- Magistrate retirement start
- Marriage and divorce
- Birth of a child, start of child care, end of child care
- In household status start and end
- Switch to self-employed / switch to employee career
- Emigration

### 5.4.2 Life statuses

Each model point in each time step can be in one or more life statuses:

- alive
- student
- disabled level I
- disabled level II
- disabled level III
- old-age retirement
- early retirement
- partial retirement
- married
- has children
- child care (covers both child care leave and maternity leave)
- household (is in household, self-subsistent farmer, etc...)
- career type: self-employed / employee
- in pension system (emigrants are not in pension system)
- member of Pillar II
- Pillar II retirement payout
- widow benefits entitlement
- orphan benefits entitlement
- magistrate (not retired)
- magistrate retirement
- special beneficiary (war veterans, persecuted during communism, ethnically persecuted, participant of the revolution)

These statuses can change during the projection time.

At start of projection of given model point are values of all these statuses initialized from the respective values in the model point file.

For more details about the life statuses functionality see the Technical Specification.

### 5.4.3 Labour statuses

Each model point in each time can be in (exactly) one of the following **primary labour statuses:**

- Employed
- Unemployed – seeking job
- Inactive – not seeking job; the distinction between unemployment and inactivity in the model depends on the life status the participant is in (for example, an unemployed retired pensioner is considered to be inactive).
- Dead

At each modelled time step, the participant can stay in current status or transfer to another status.

Transitions between career statuses are modelled randomly according to the predefined transition probabilities. Different probabilities can be used for

- transitions **without an event**; the probabilities of transitions are given by input tables and typically depend on age, sex and potentially other attributes;
- transitions **caused by an event;** the event-related probability applies whenever an event occurs during current time step; the probabilities related to each respective applicable event are given by input tables.

Each model point in each time can be in (exactly) one of the following **secondary labour statuses:**

- Healthy
- Sick (= on sick-leave for employed primary labour status),

At each modelled time step, the participant can stay in current status or transfer to another status.

For more details about the labour statuses functionality see the Technical Specification.

### 5.4.4 Gross salary/income

The model internally projects both the employee salary and self-employed income in parallel during the whole individual's life, regardless whether the participant is employed anywhere.

This approach is necessary for modelling the potential growth of the salary or income. The nominal salary or income both represent the income the participant would have if he started to work.

For more details about salary/income modelling see the Technical Specification.

Once a year, the (potential) salary / self-employed income are both increased. The increase consists of the following two components:

- General salary growth (economy-wide wage inflation), and
- Career growth (specific for the individual, depending on age and sex)
    - Career growth is set in an input table CAREER_GROWTH_TAB, depending on age and sex; the growth may be also different for salary and for self-employed income
    - It is applied only if the person is employed and not on sick leave.

The career growth is modelled deterministically.

The truly earned amount of income (salary or self-employed income) is actively calculated, reported and used in further calculations only if the participant is employed or self-employed (based on the life status SELF_EMPLOYED – see Section 3.3.4 and based on labour status – see Section 3.4) in the following two variables:

## 5.5 Assumptions

Assumptions are inputs to the model, which are related to the expected future development. The following types of assumptions will be needed:

- **Economic**
  - Inflation
  - Development of average earnings in economy (wage inflation)
  - Career-linked growth of salaries
  - Interest rates – for the calculation of implicit debt, appreciation of funding in the second pillar, etc.
  - Macro-level unemployment projections
- **Portfolio / behavior**
  - Distribution of individual states (employee, retirement, …) and **all transfer probabilities**
  - Marriages/divorces distribution;
  - Child births distribution;
  - Mortality rates;
  - Disablement distribution; transfers between disability levels, recovery rates
  - Distribution of participant choices, like using the option to retire
  - All transition probabilities between various statuses.
- **Legislative:** assumptions on future values for parameters given by legislation
  - Parameters for pension benefits formulas, but also
  - Growth of minimum/maximum limits and other parameters in pension benefits formulas
  - Indexation of pension point value
  - Taxes and charges
  - Pillar I and Pillar II contribution rates
- **Population**
  - Population projections for constructing representative model points of future labour market entrants
  - Current population statistics by age, sex, etc.
  - Natality projections
  - Emigration/immigration distributions

## 5.6 Main Variables for reporting

### 5.6.1 Aggregate Reporting

The variables, specified in this section, will be reported by the model on the aggregate level for each projection month. It will be possible to introduce arbitrary modelpoint-level factors to determine the level of aggregation/granularity of the results (e.g.: cohort defined by birth year, sex, entry to the model, etc., CAEN code, special occupation etc.). However, the user must keep in mind two limitations:

- the product of the number of categories of the factors used at the same time (for example: if cohorts by birth year, sex and CAEN codes are used, then the multiple of all possible birth years × 2 genders × number of CAEN codes) must not exceed reasonable level (approx. 1000-10000) so that the results are processable;
- the factors must be based on information that is known at start of the model and does not change during the model run – for example, aggregation by birth year is possible, aggregation by age (which changes during the projection) is not possible;
- if a different aggregation is required and the factors are changed, the model needs to be re-run to produce results in the new aggregation.

Note that the Prophet model will report total values of variables (summed over relevant model points according to the level of aggregation). To obtain average (per person) values (e.g. average pension, average salary,…), the total values will have to be divided by the number of individuals during further processing of the results.

The variables will be produced for each month since start to end of the projection and will allow monthly, quarterly, semi-annual and annual reporting.

## CNPP pension expenditures

The model will report the development of the following variables:

- pension expenditures paid by CNPP per each month
    - by type of pension;
    - separately for new pensioners and for existing pensioners.
- number of pensioners and
    - by type of pension;
    - separately new pensioners and existing pensioners.
- average Pillar I pension benefits
    - by type of pension;
    - separately for new pensioners and for existing pensioners.
    - Gross and net of taxes and contributions
- average replacement rate
    - For old-age pensions
    - Gross and net of taxes and contributions
- dependency ratio (number of old-age and disability pensioners divided by the number of contributors)
- average number of accumulated points (per life, per year)

## CNPP pension revenues

This will cover

- contributions collected by the CNPP (decreased by the contributions to Pillar II)
- number of contributors
- average wage, average income.

### CNPP budget-balance

The monthly balance calculated as CNPP revenues less CNPP expenditures (summed over all cohorts and genders) will be reported. It illustrates short-term sustainability of Pillar I.

### CNPP cumulated debt/savings

This variable will contain accumulation of budget balances (positive or negative), increased each month by a predefined interest rate. This illustrates the long-term sustainability of Pillar I.

### Pension expenditures from state budget

This category covers the additional payments from state budget. The model will report

- pension expenditures paid from the state budget to the individuals and calculated in the main model, including:
  - state support;
  - plus state_support_widow;
  - plus artist_pension_bonus;
  - plus special_pension;
- number of beneficiaries of the additional pension from the state budget.
- Moreover, military pension expenditures (calculated in a separate military model) will be automatically added to the pension expenditures paid from the state budget in the reporting Excel spreadsheet.

### Pillar II cash-flows

As regards Pillar II cash-flows, the following variables will be reported

- Contributions to Pillar II funds;
- Payments from Pillar II funds
  - Annuities;
    - Gross and net of taxes and contributions
  - Lump-sum;
- Total value of Pillar II funds
- Average value of Pillar II fund
- Average annuity
- Number of Pillar II participants
  - In accumulation phase
  - In pay-out phase
- Average replacement rate for Pillar II annuities

## 5.6.2 Individual (Model point-level) Reporting

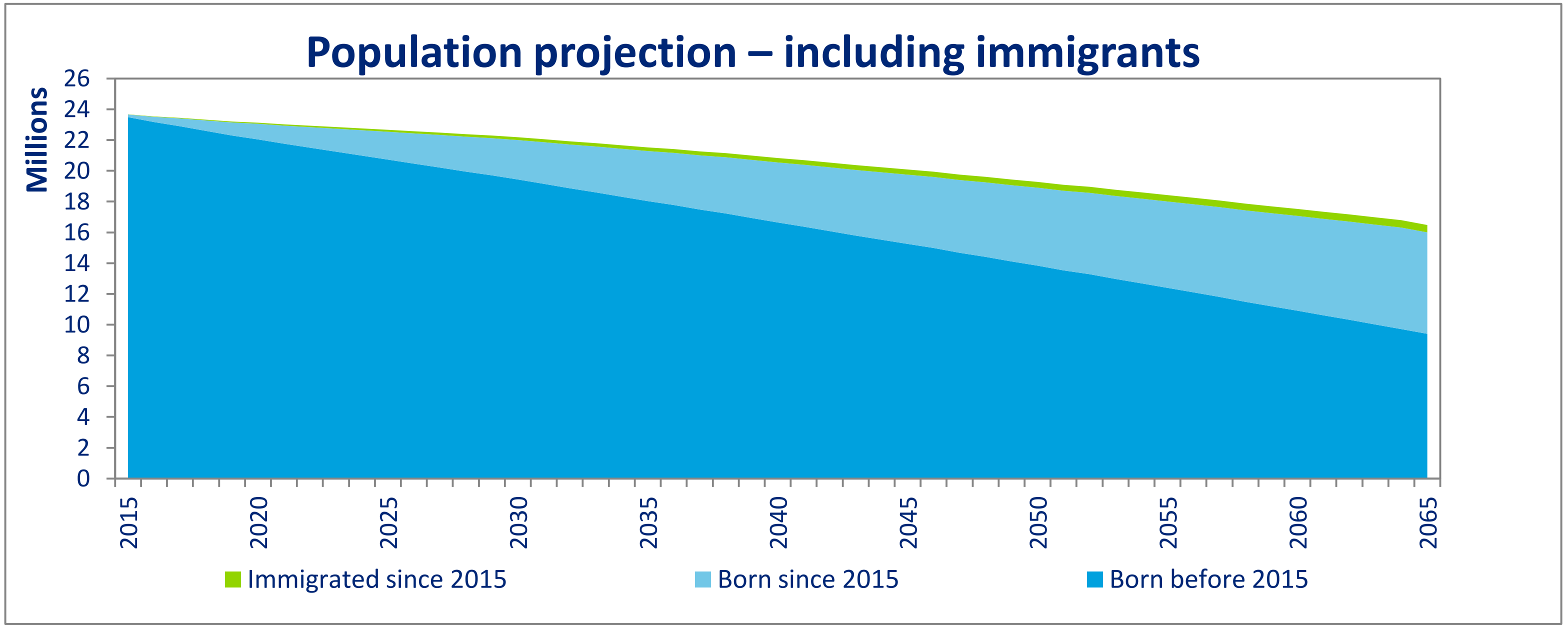
Results reported individually per each model point will cover

- Person's pension benefit at the moment of first retirement (or first pension of early retired people) and first disability
  - Disability pension;
  - Old-age and other pensions altogether;

- Person’s net income at the moment of first retirement (or first pension of early retired people);
    - Development of wages can be calculated from income and pensions if needed;
- Old-age pension at the moment of retirement (or first pension of early retired people)
    - before applying minimum pension (to assess the impact of minimum pension arrangement);
    - after applying minimum pension (OldAge_pension_person);
        - Gross and net of taxes and contributions
- Person’s replacement rate at the moment of retirement;
- Number of persons in the model point (if grouping will be applied).

# 6 Illustrative model results

## 6.1 Demographic evolution of population (2015-2065)

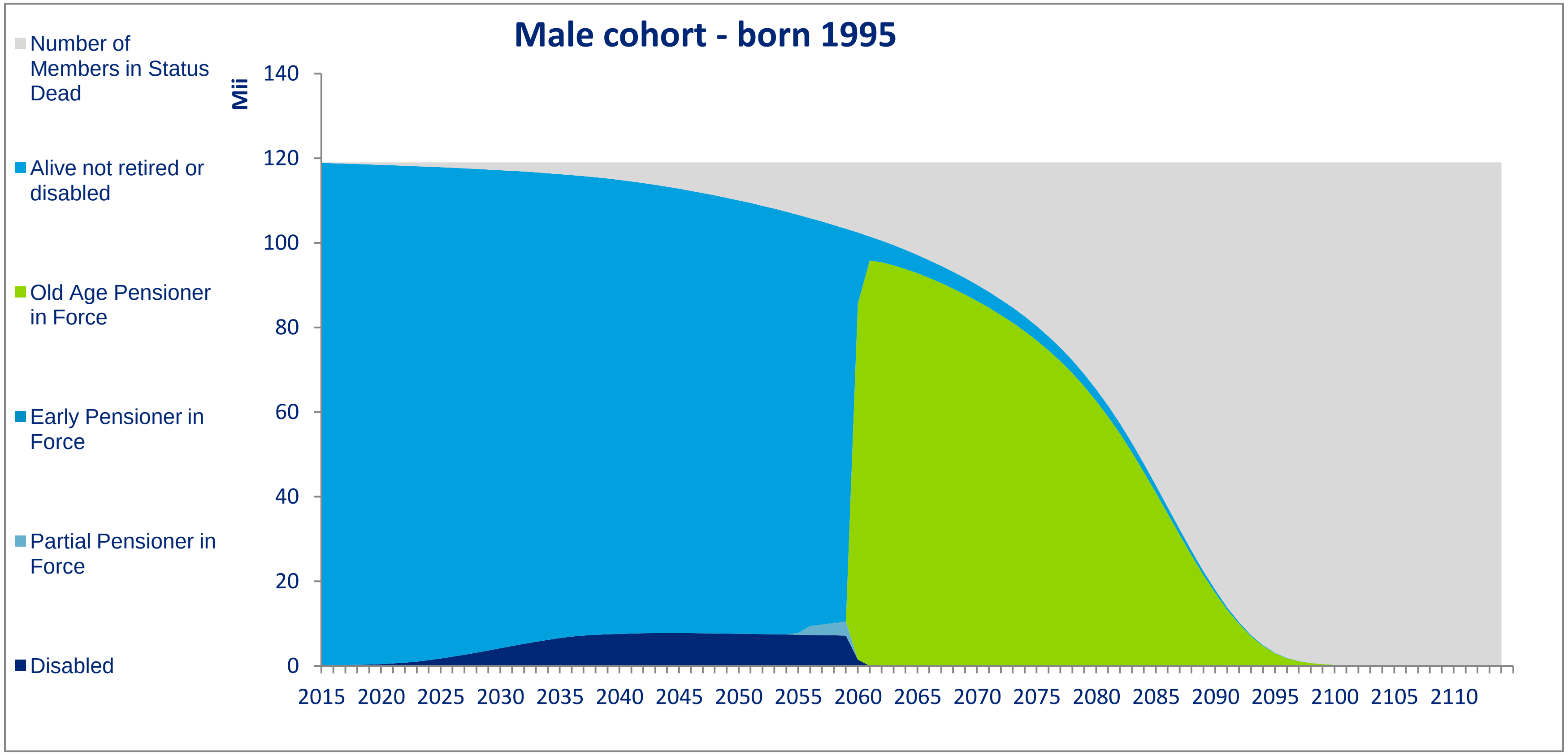



The projection presented above includes:

- Existing pension system participants (and their future evolution)
- Future new participants: new born and immigrants; artificial model-points, created on the basis of social-demographical hypothesis.

## 6.2 Population structure

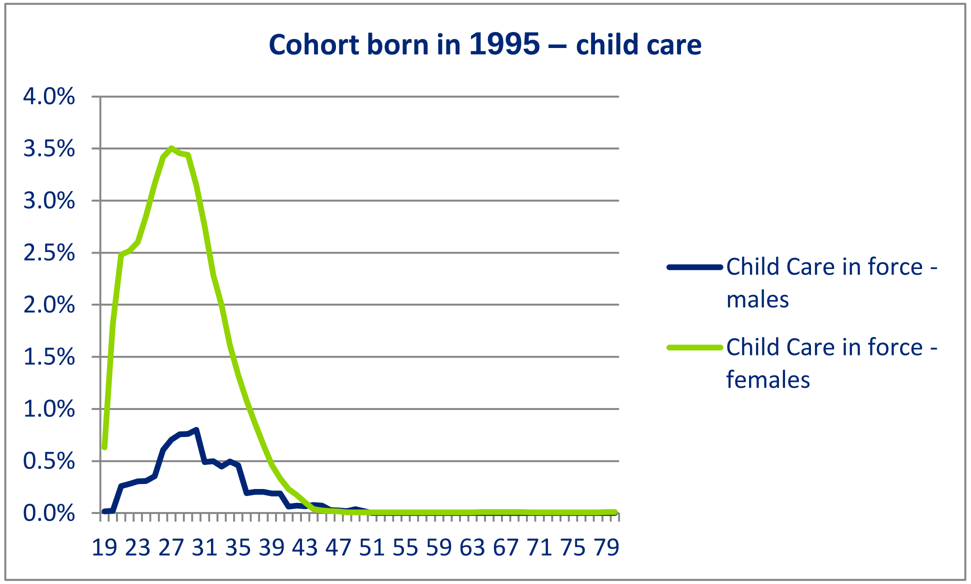
### 6.2.1 Public pension system beneficiaries – chorot of males born in 1995

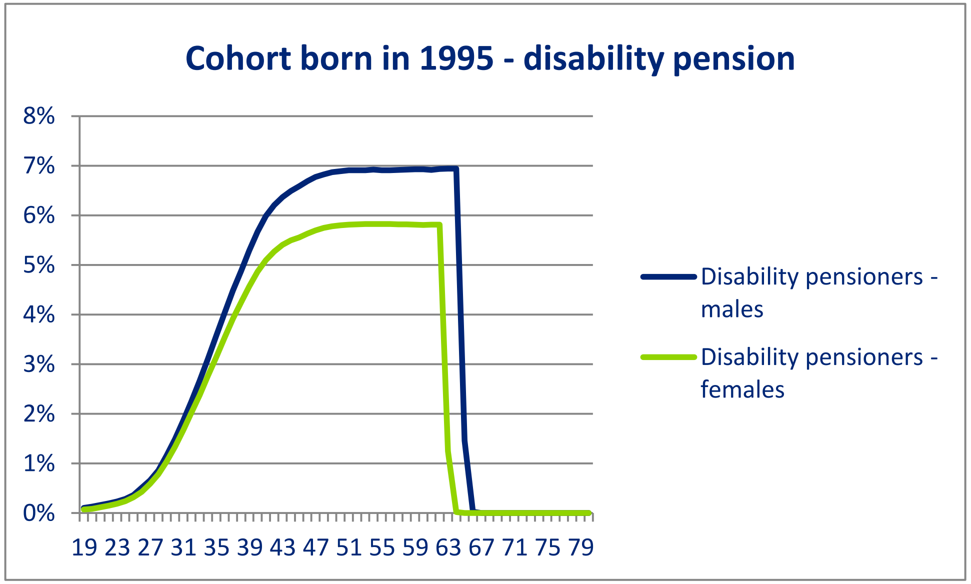



Cohort-level results are the most accessible way of testing the reasonability of the model population dynamics. The chart above shows the transition to old-age pension of the population, once it reaches standard retirement age.

### 6.2.2 Inactive population – cohort of males and females

The micro-simulation model allows for an analysis of inactive population by type of inactivity.

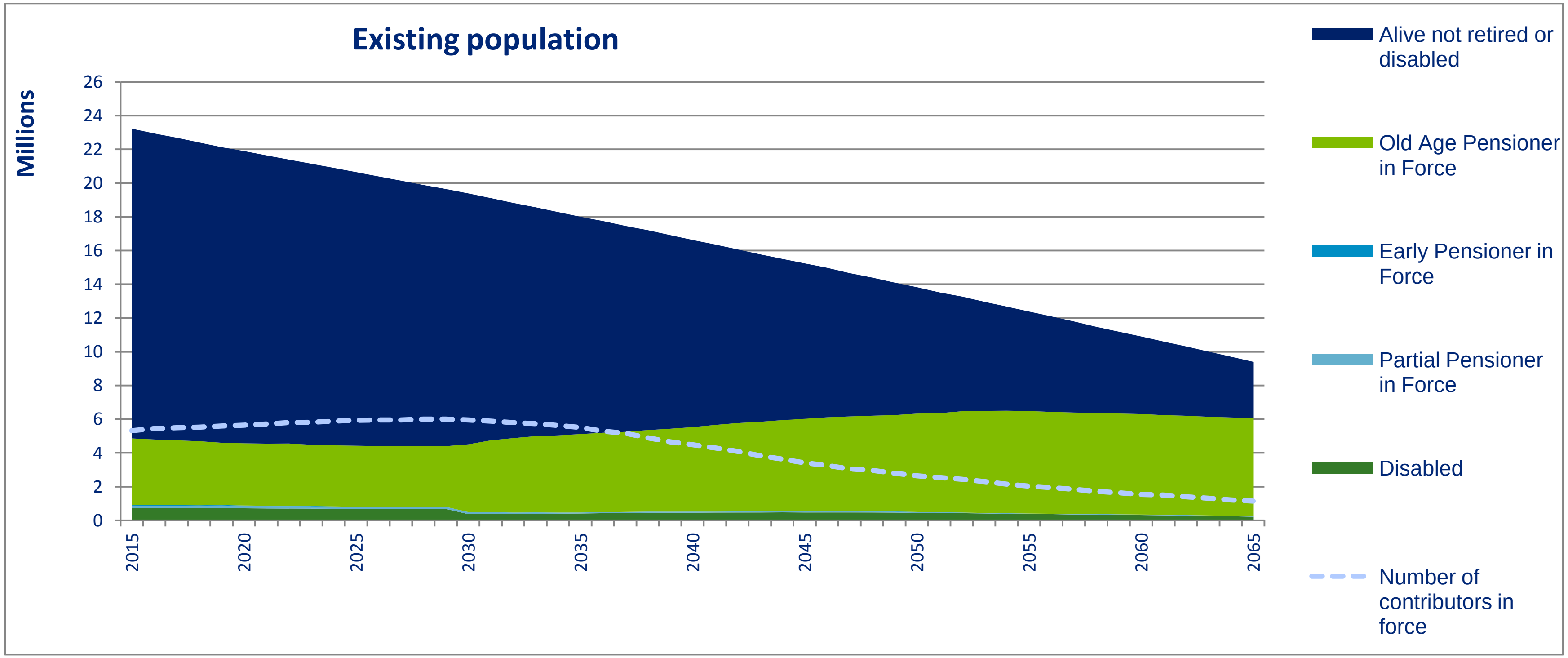



The graphs above present the evolution of a cohort of people born in 1995 from the perspective of the entry / exit of maternity leave and entry / exist from disability retirement status.

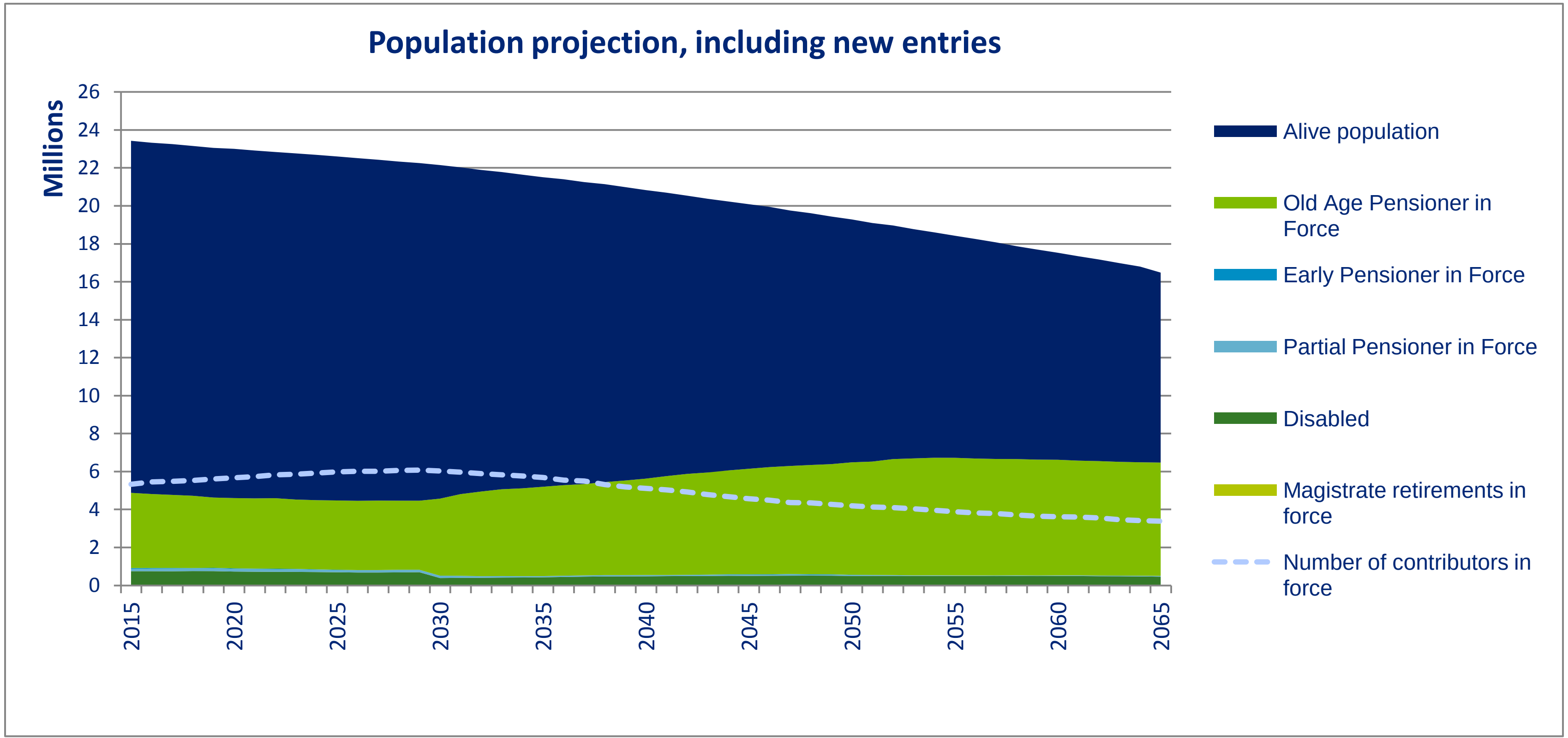
### 6.2.3 Public pension system beneficiaries – analysis of population evolution

#### 6.2.3.1 Evolution of existing population at projection start



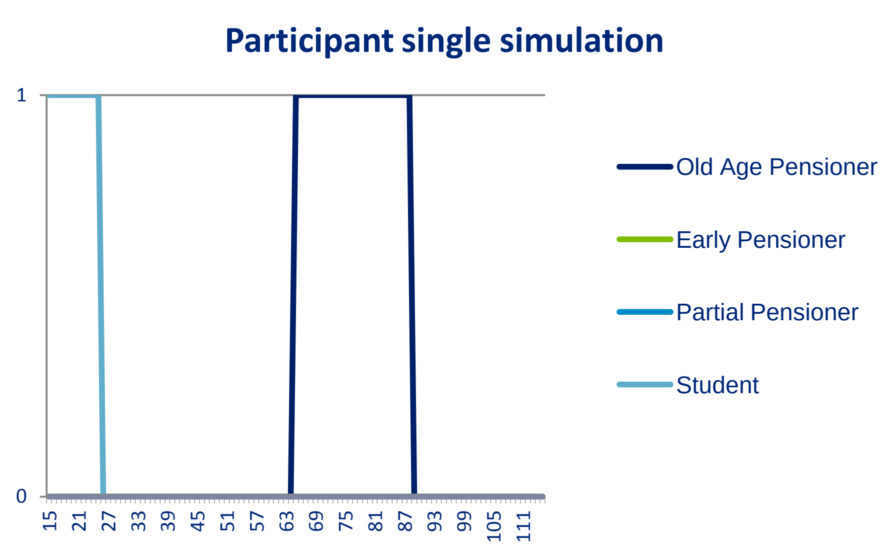

The graph above presents the total number of existing participants at the start of the simulation (born before 2015) by type of benefits they receive. Total existing population decrease by the end of the simulation due to the mortality rate. For comparison purposes, the graph shows an evolution of the number of contributors in the existing population.

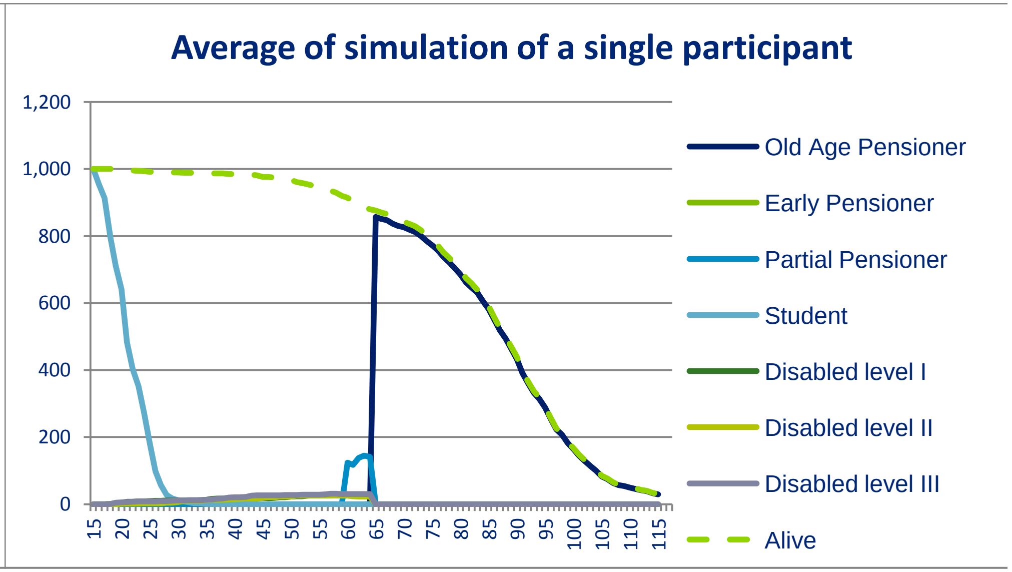
### 6.2.3.2 Evolution of total population




This population projection includes future new entrants (new born, immigrants). The graph shows the total population distribution in terms of retirement benefits and the number of contributors.

### 6.2.4 Beneficiaries – single participant simulation

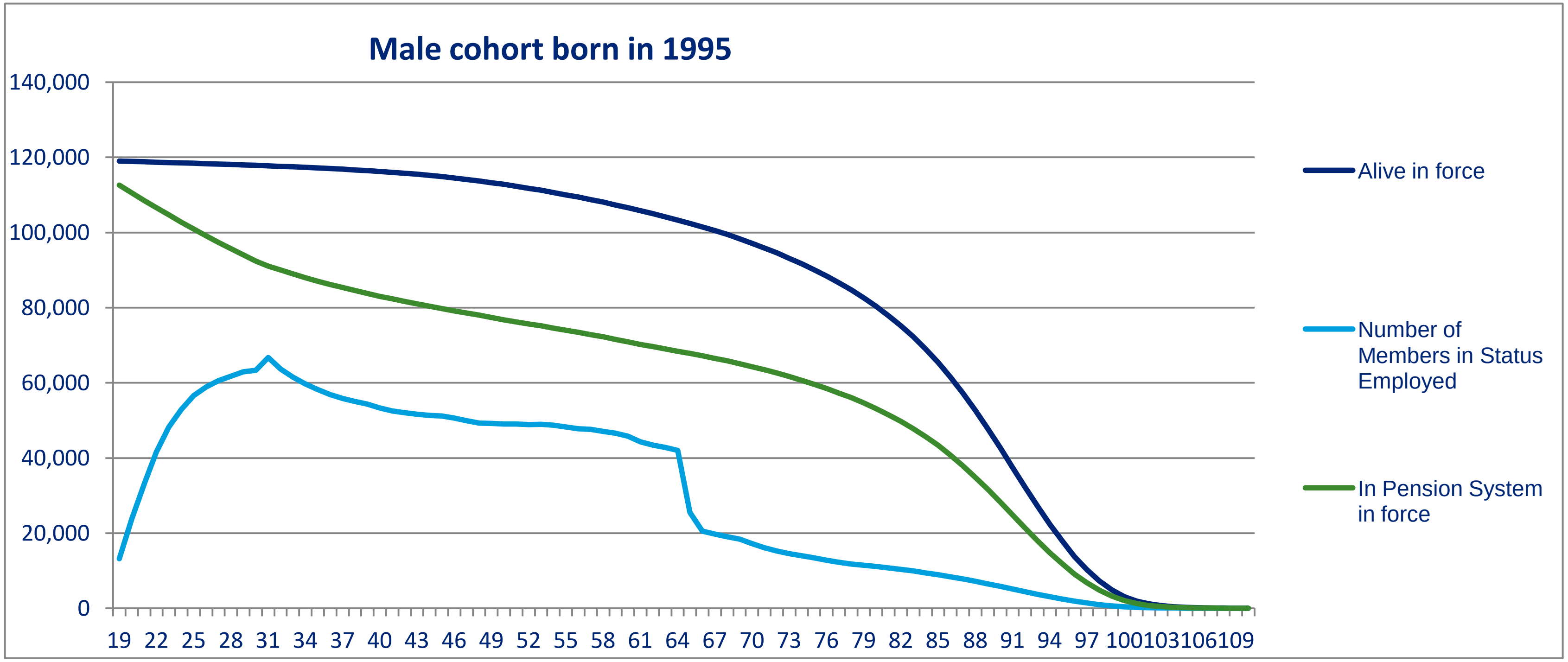



Individual level analysis allows for the check of a randomly chosen model point by analyzing its parameters dynamics and the transition between different modeled states (shown above is the transition to retirement pension).

By running multiple simulations on the same model point (eg. 1,000 copies of the model unit), the model generates several scenarios for the same participant, allowing analysis of the general behavior of the individual. Such results allow checking of modeled distributions of events (eg. the probability of becoming disabled by age and sex, etc.)

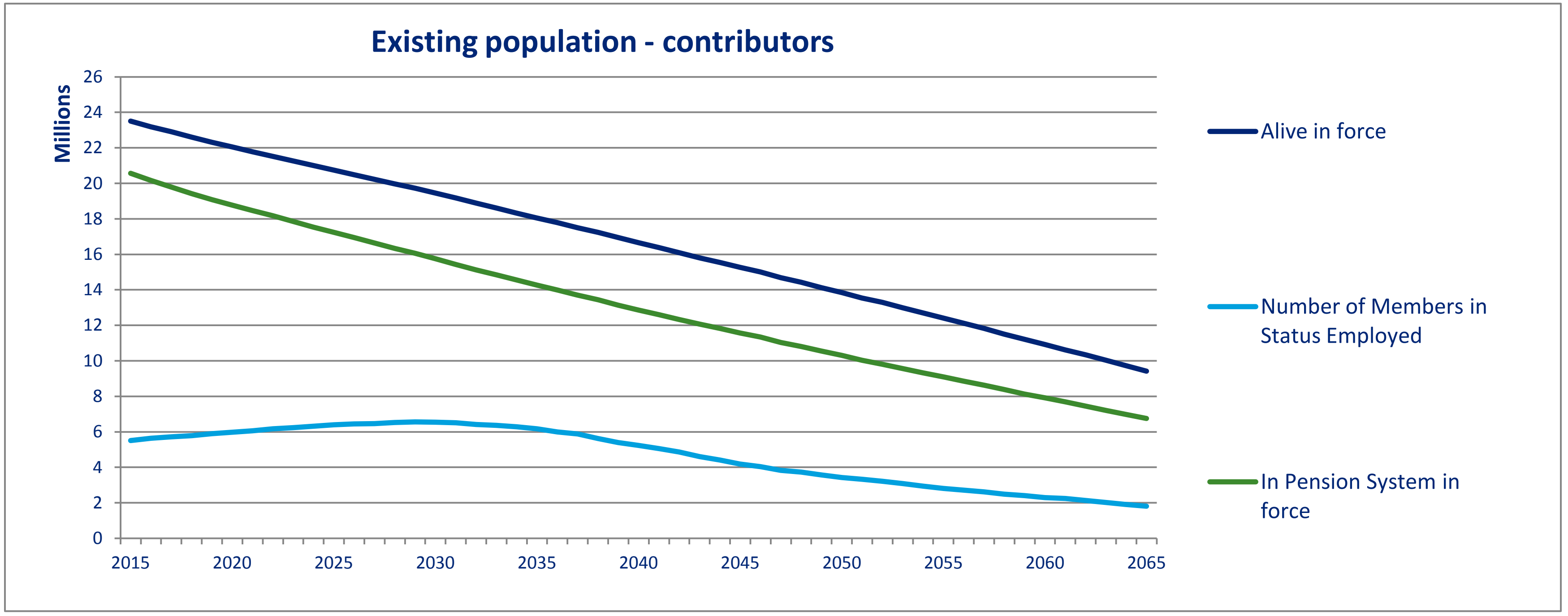
### 6.2.5 Evolution of contributors - cohort (male born in 1995)




The chart above shows the distribution of the cohort of men born in 1995 between those who are in the country, the total population of the cohort concerned and the number of participants in the public pension system being employed. The chart also allows of an analysis of the evolution over time of the distribution within the cohort throughout its life.

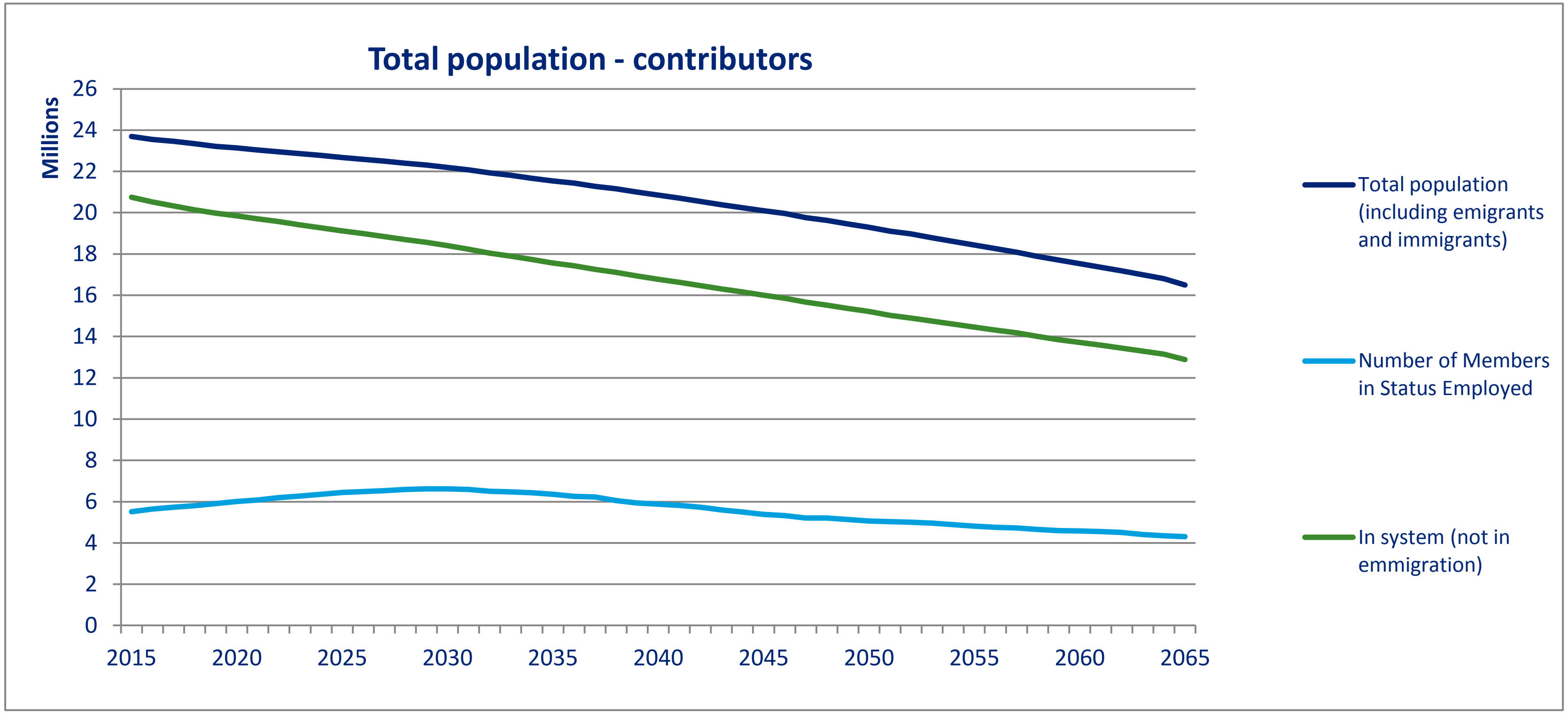
### 6.2.6 Evolution of contributors - population

#### 6.2.6.1 Evolution of existing population at projection start



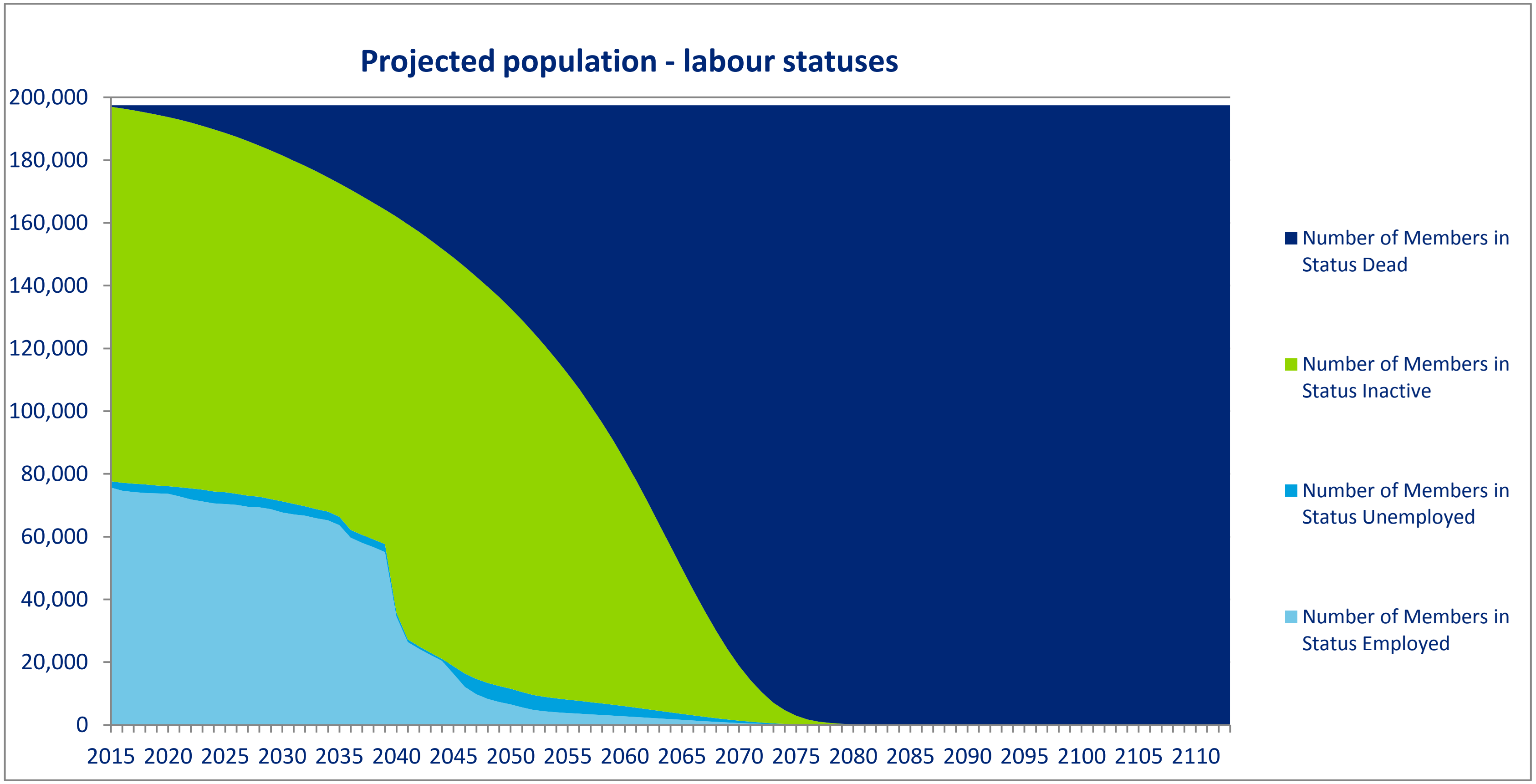

The model allows for a separate view of the evolution of the existing population alive at start of projection. Such an evolution is shown in the above chart which shows the difference between the simulated total population (including emigrants) and the population in the country at the beginning of the simulation (excluding emigrants). Over the years, these two variables vary by set probabilities of emigration by age and sex.

### 6.2.6.2 Evolution of total population




The chart above shows the simulated evolution of the total population (including emigrants and immigrants) and the evolution of the total number of employees participating in the pension system.

## 6.3 Evolution of employees - cohort (males born in 1995)

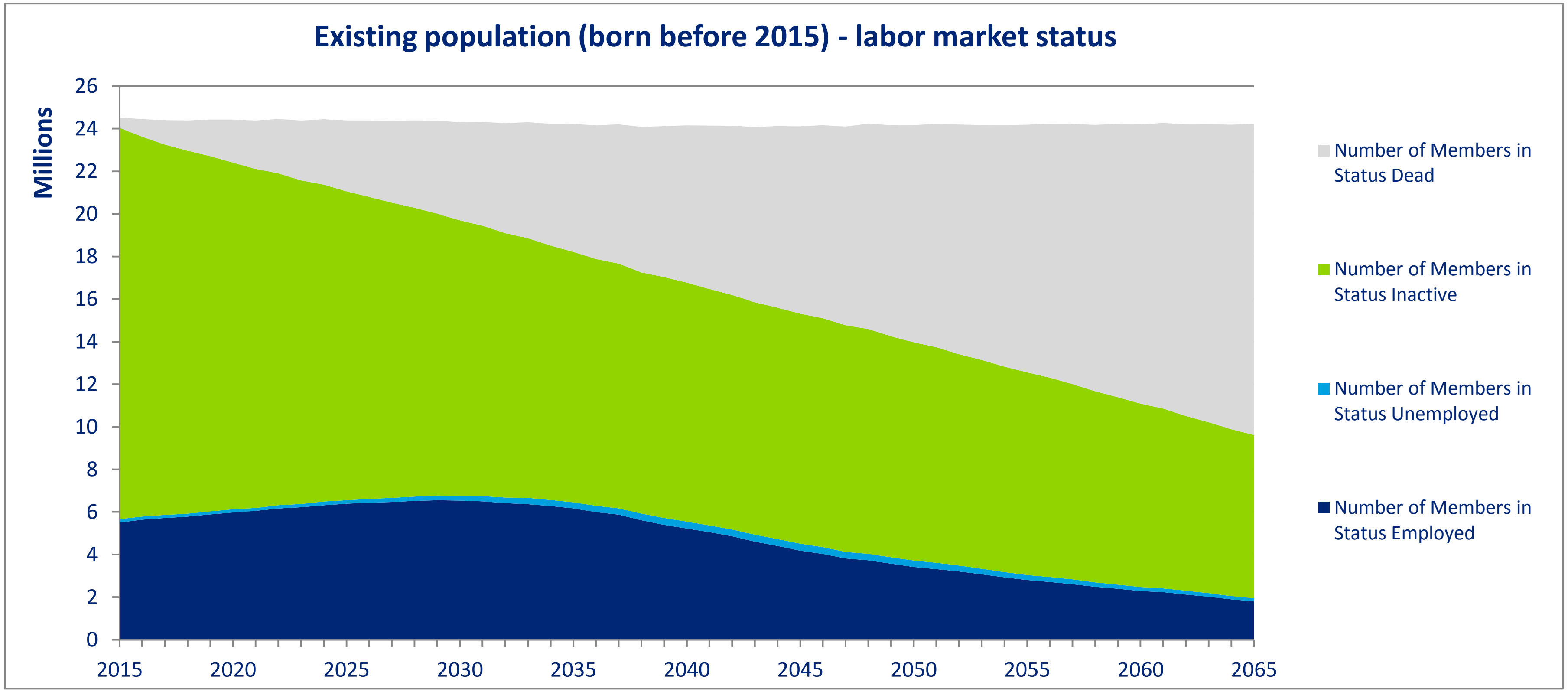



Also, at cohort level (in the above example, males born in 1995), the model allows for an analysis of the evolution of the distribution of participants by their labor market status. One can observe the transition from employee status to the status of pensioner around reaching standard retirement age - 65 years.

# 6.4 Revenues and contributions of participants

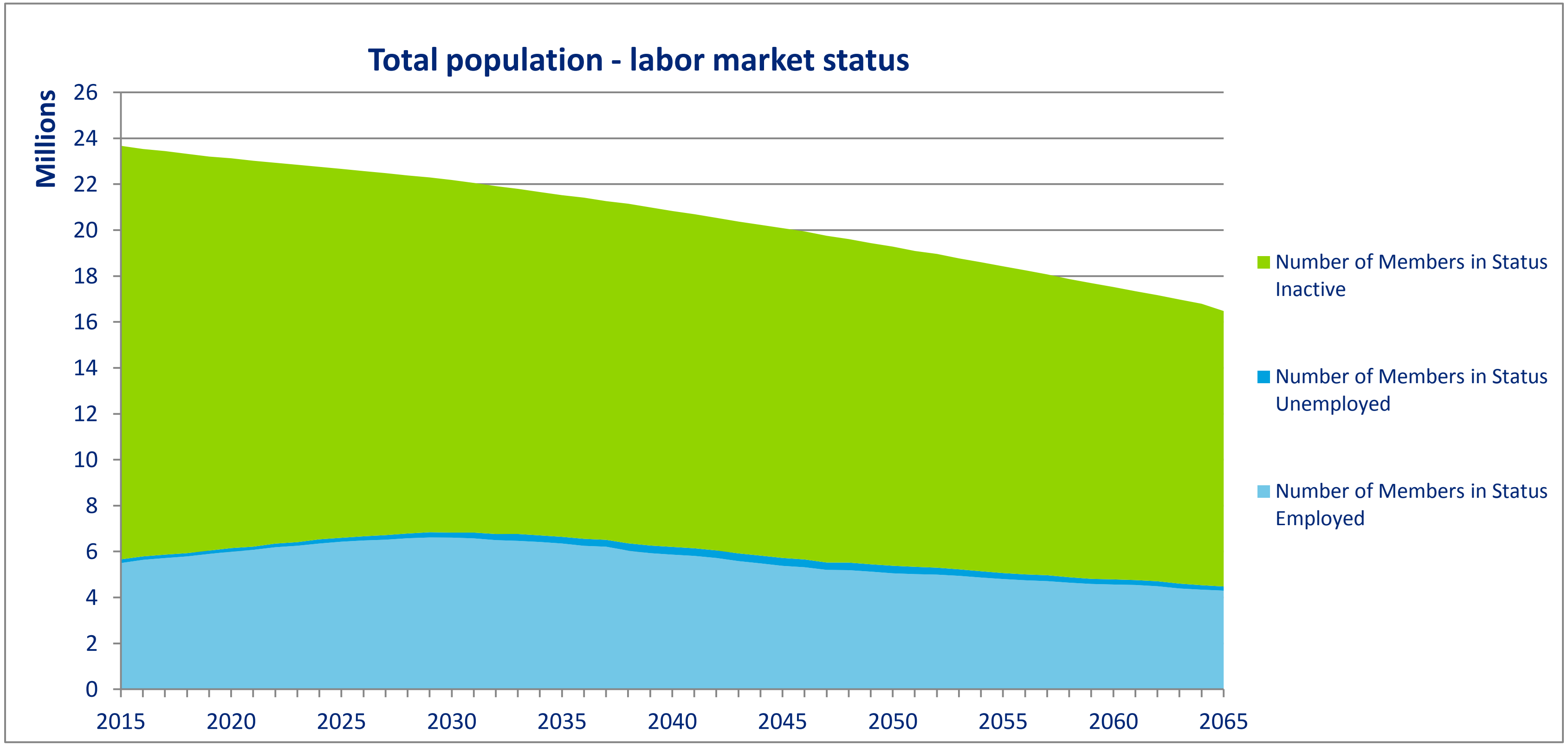
## 6.4.1 Population

### 6.4.1.1 Evolution of existing population at projection start



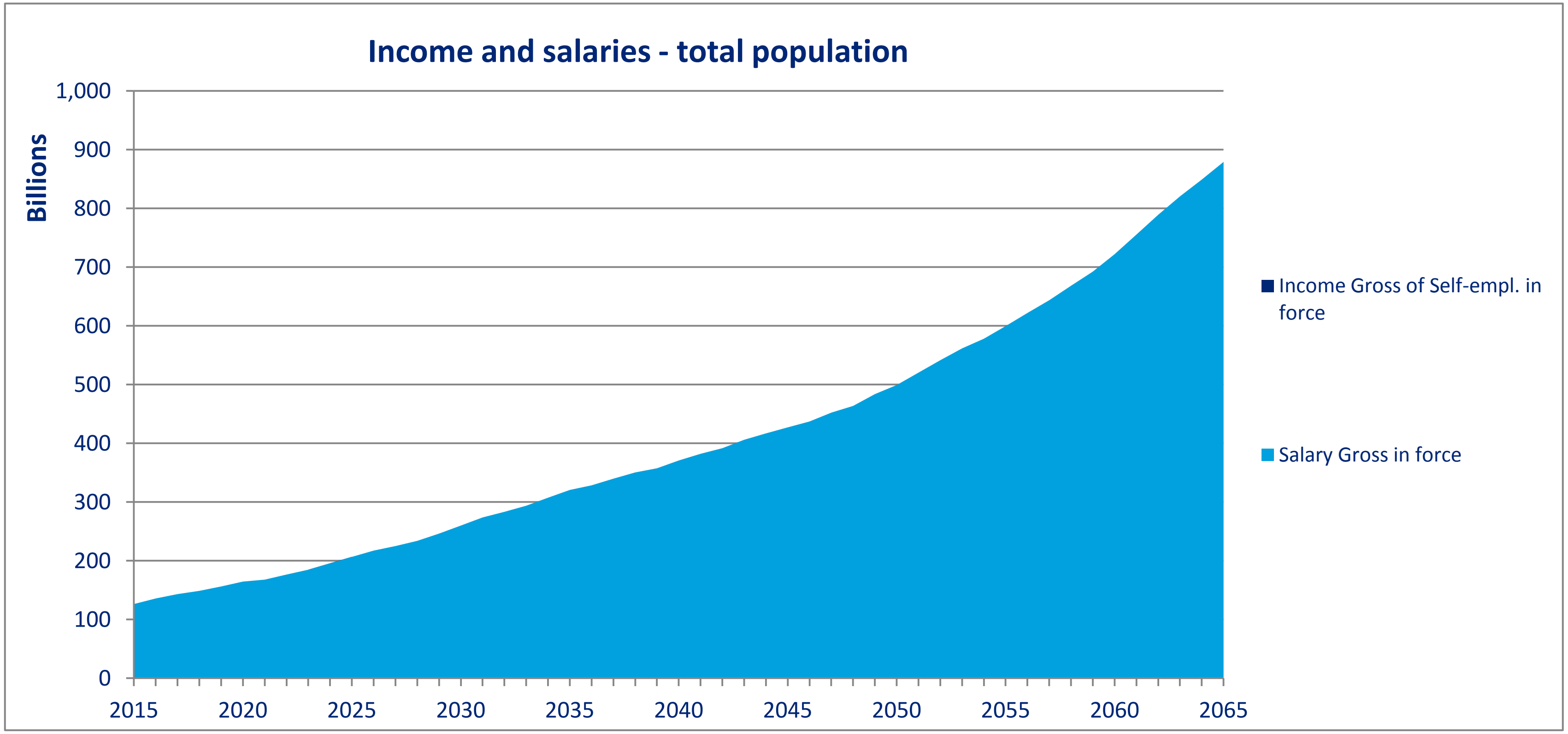

The above chart shows the evolution of existing population at projection start by labor market status.

### 6.4.1.2 Evolution of total population



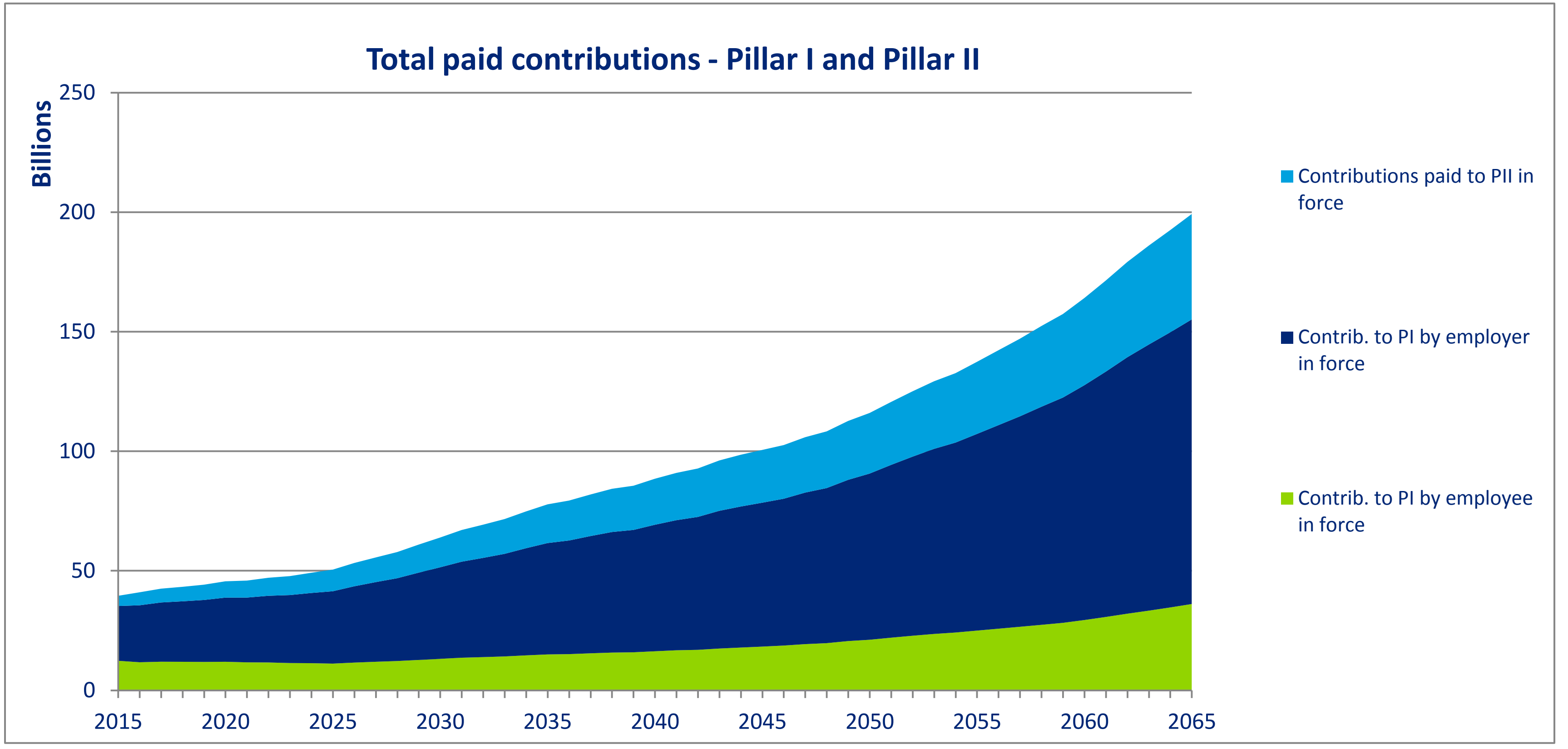

The above chart shows the evolution of total population (including emigrants and immigrants) start by labor market status

### 6.4.1.3 Evoltion of revenues and salaries at total population level – nominal values



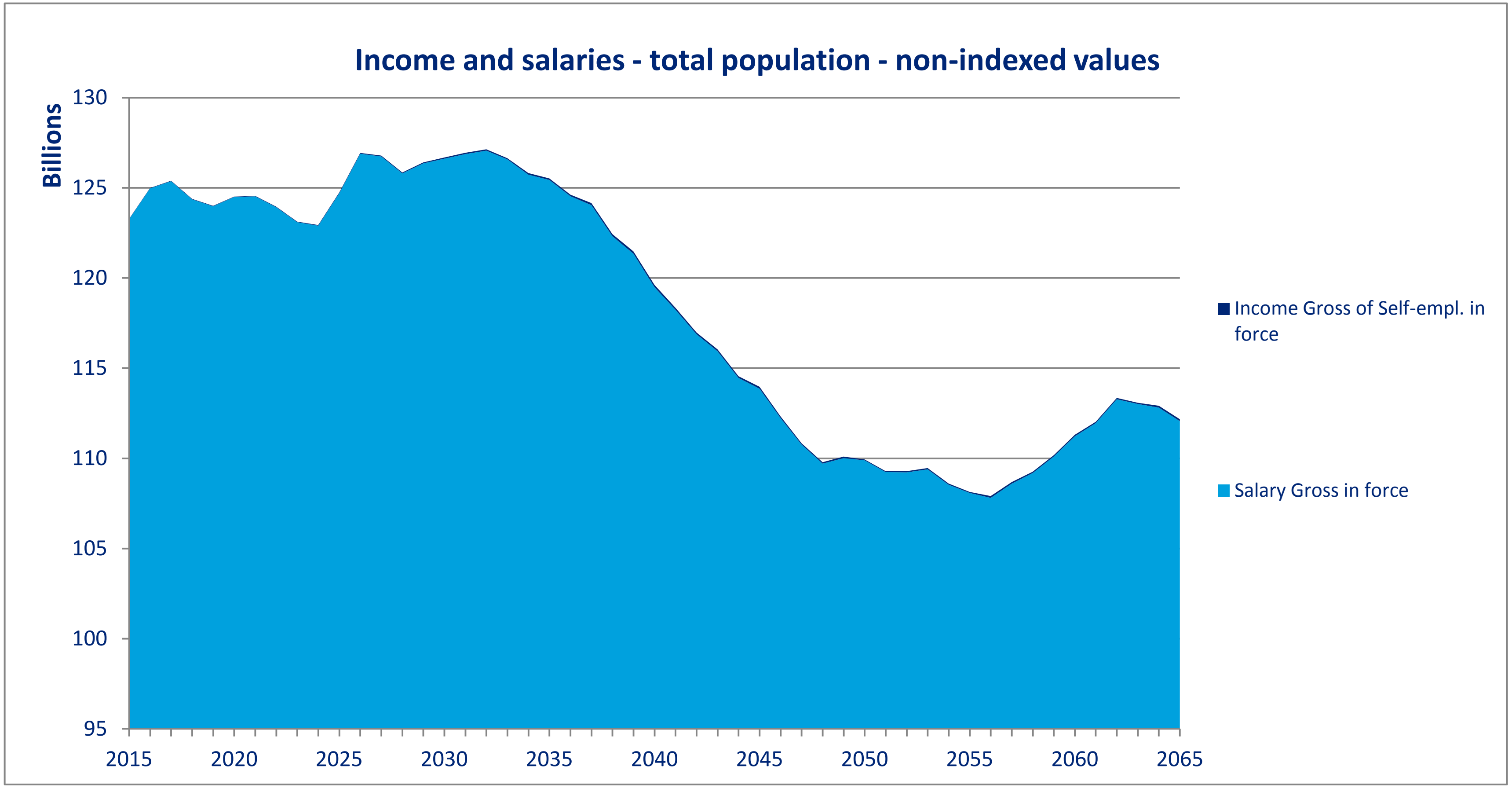

The chart above presents the evolution of revenues and salaries for the total population during the period 2015 - 2065. The values shown are nominal.

### 6.4.1.4 Evolution of contributions at total population level – nominal values



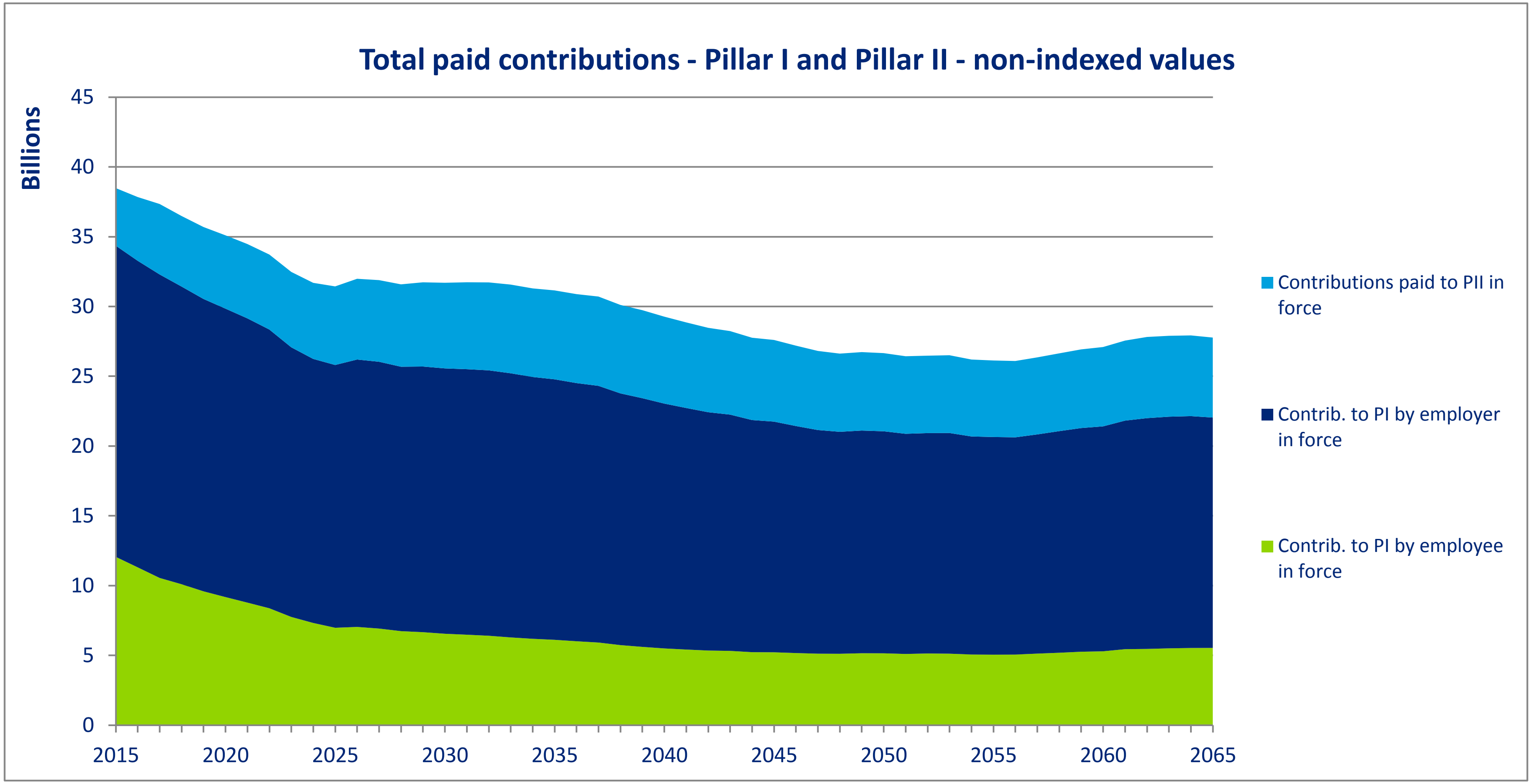

The chart above presents the evolution of contributions for the total population during the period 2015 - 2065. The values shown are nominal.

### 6.4.1.5 Evolution of revenues and salaries at total population level – non-indexed values




The above chart presents the evolution of income and salaries of the total population for the period 2015 - 2065. The values are non-indexed, allowing for an analysis of the demographic impact on income levels and wages recorded.

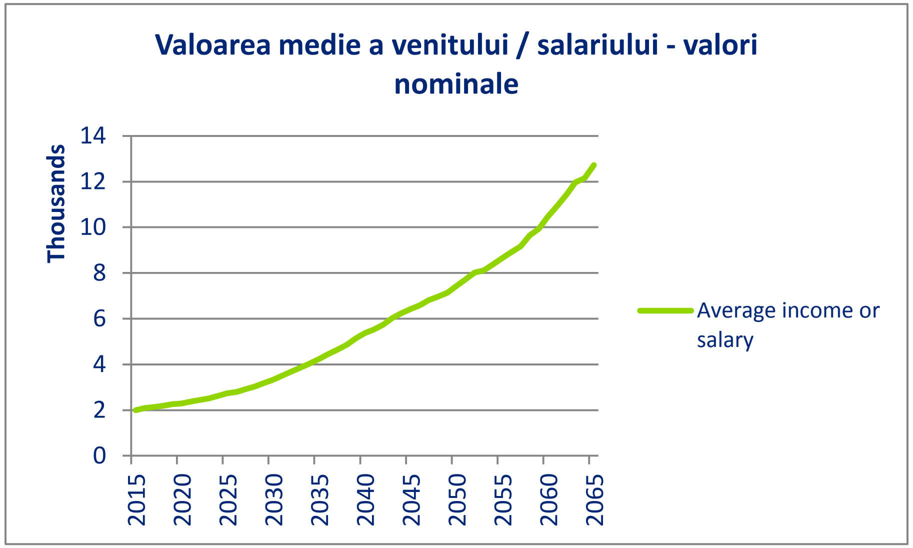
### 6.4.1.6 Evolution of contributions at total population level – non-indexed values

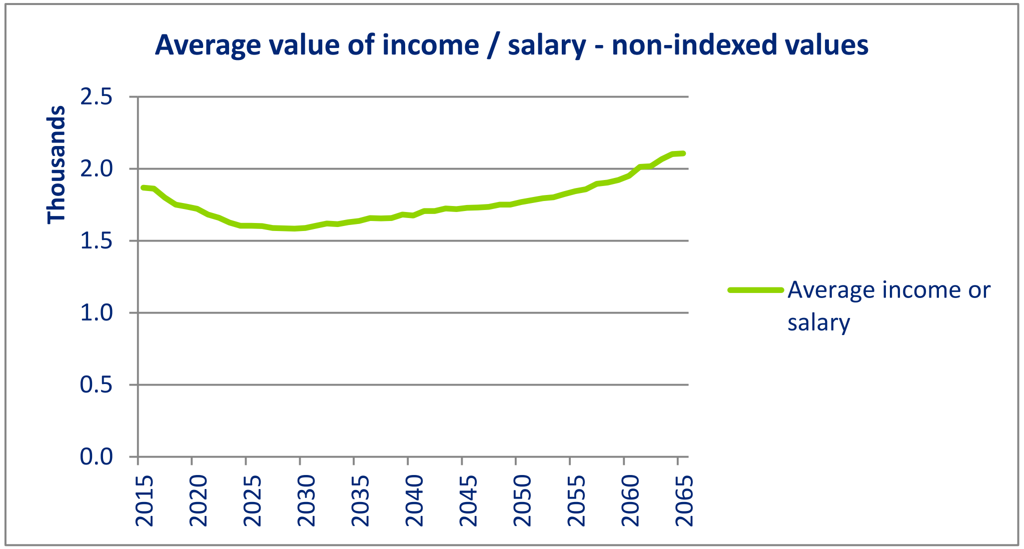



The above chart presents the evolution of contributions of the total population for the period 2015 - 2065. The values are non-indexed, allowing for an analysis of the demographic impact on income levels and wages recorded.

## 6.5 Evolution of average income

### 6.5.1.1 Evolution of average income – nominal values and non-indexed values

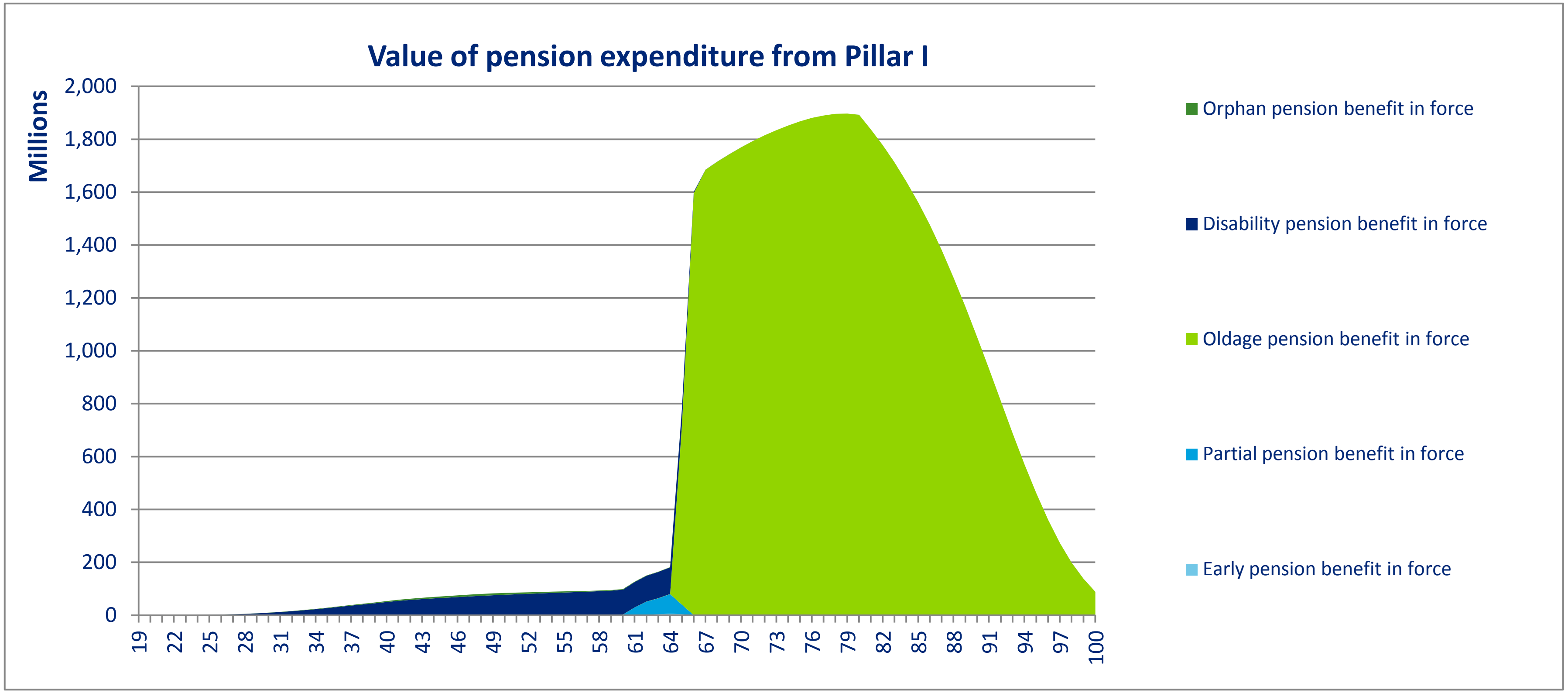



Previous charts show the evolution of average wage or income both in a simulation performed using indexing assumptions and a simulation conducted without the use of indexing assumptions.

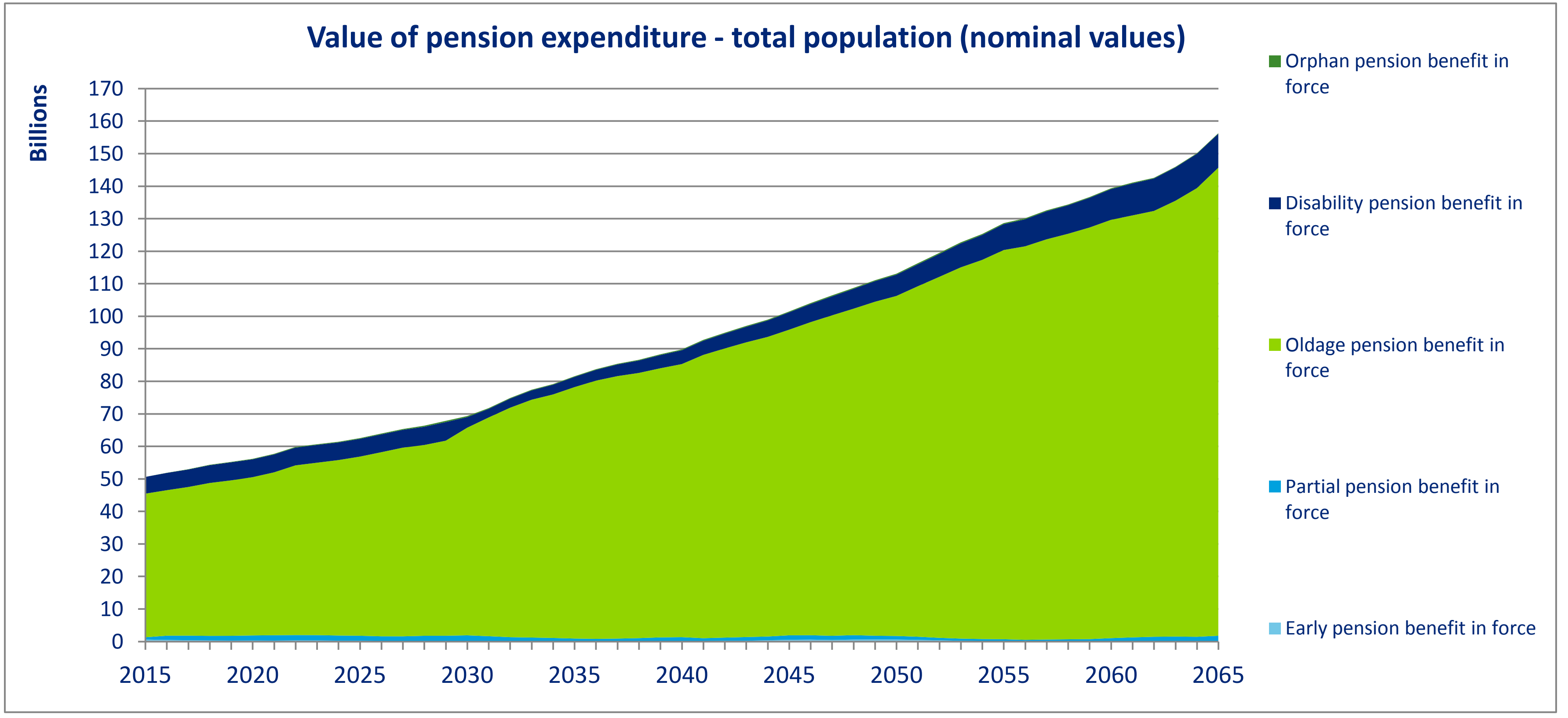
## 6.6 Value of pensions paid from Pillar I

### 6.6.1 Evolution of cohort (males born in 1995)



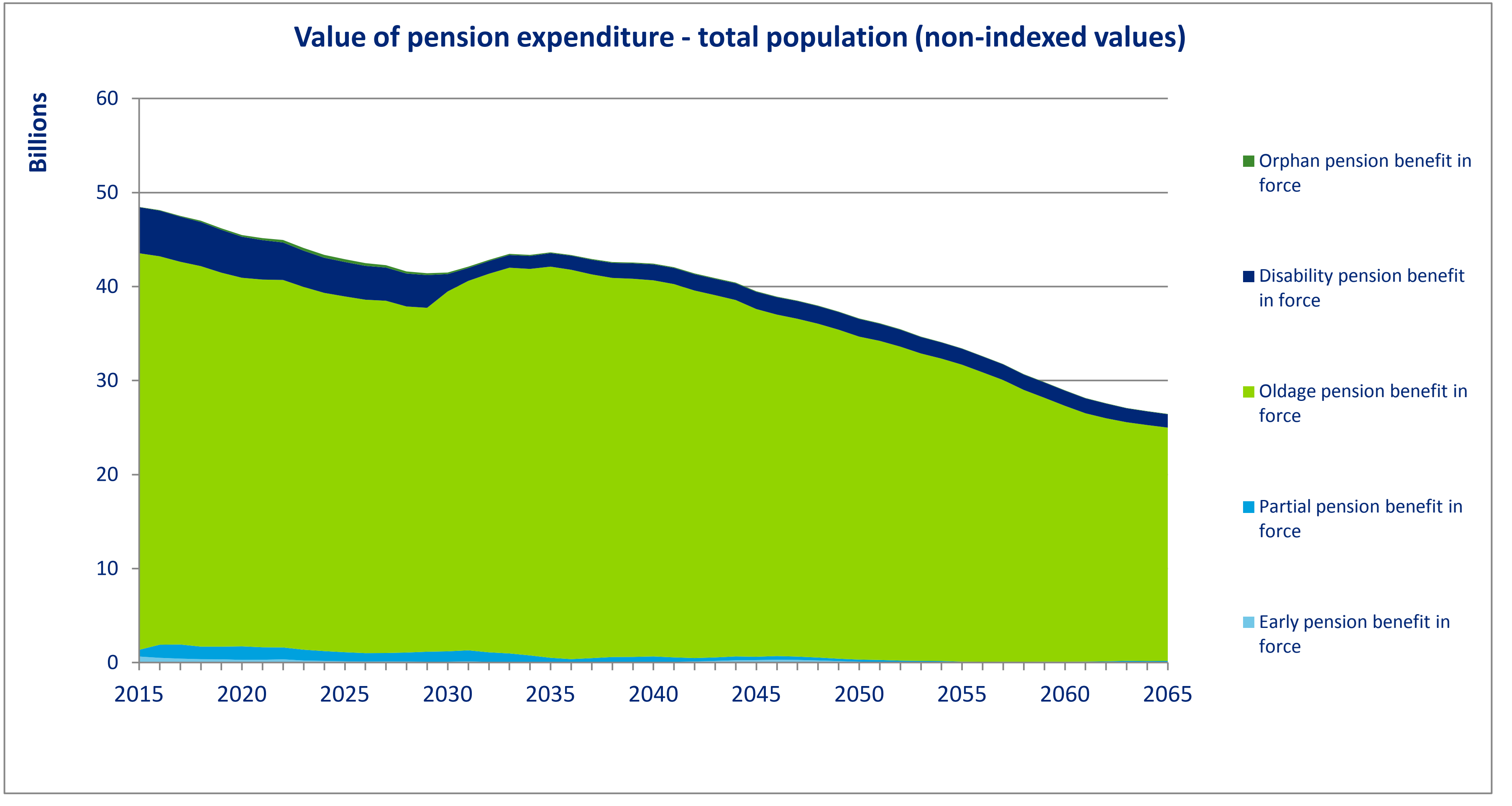

The results provided by the micro-simulation model allows for a distribution analysis of the cohort (in the above graph - cohort of men born in 1995) in terms of value of pensions paid by type. The chart shows the transition to old-age pension from disability pension and partial and early pension, once the population reaches standard retirement age.

### 6.6.2 Evolution of population – nominal values



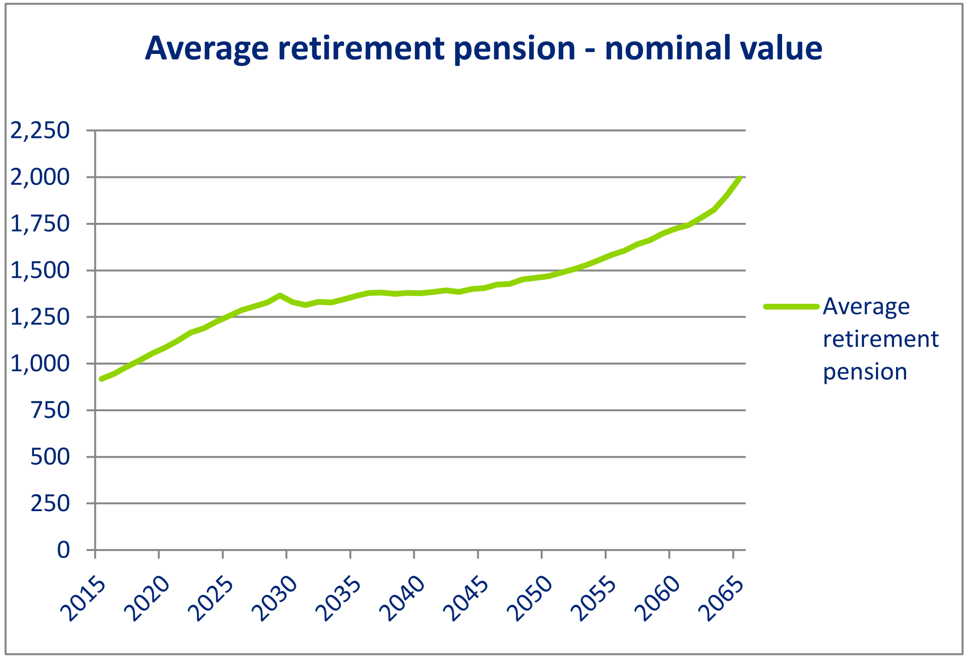

The above chart presents the evolution in nominal values of pension expenditure for the period 2015-2065, depending on the type of benefit.

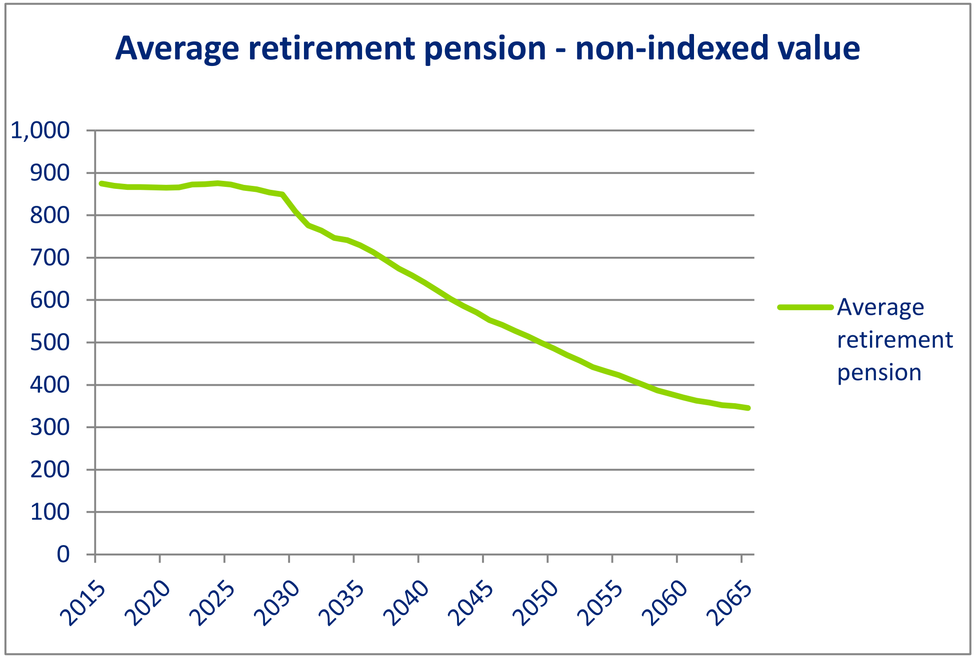
### 6.6.3 Population evolution – non-indexed values




The above chart presents the evolution of non-indexed value of pension expenditure for the period 2015-2065, depending on the type of benefit.

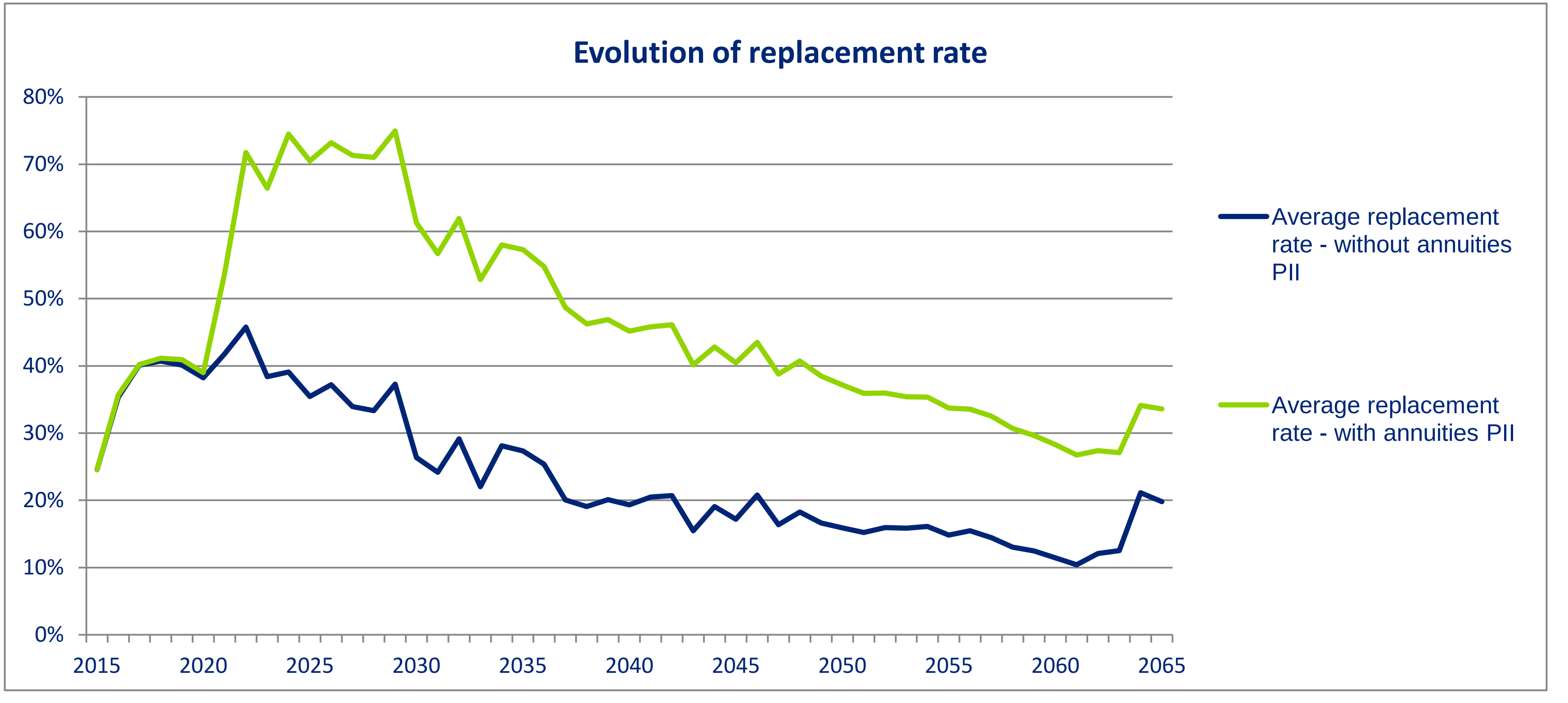
### 6.6.4 Average old-age pension – indexed value and non-indexed value




The results provided by the micro-simulation model allow for the calculation of average values for the main benefits from Pillar I. The charts above show the average pension amount at the entire population level, indexed values and non-indexed values.

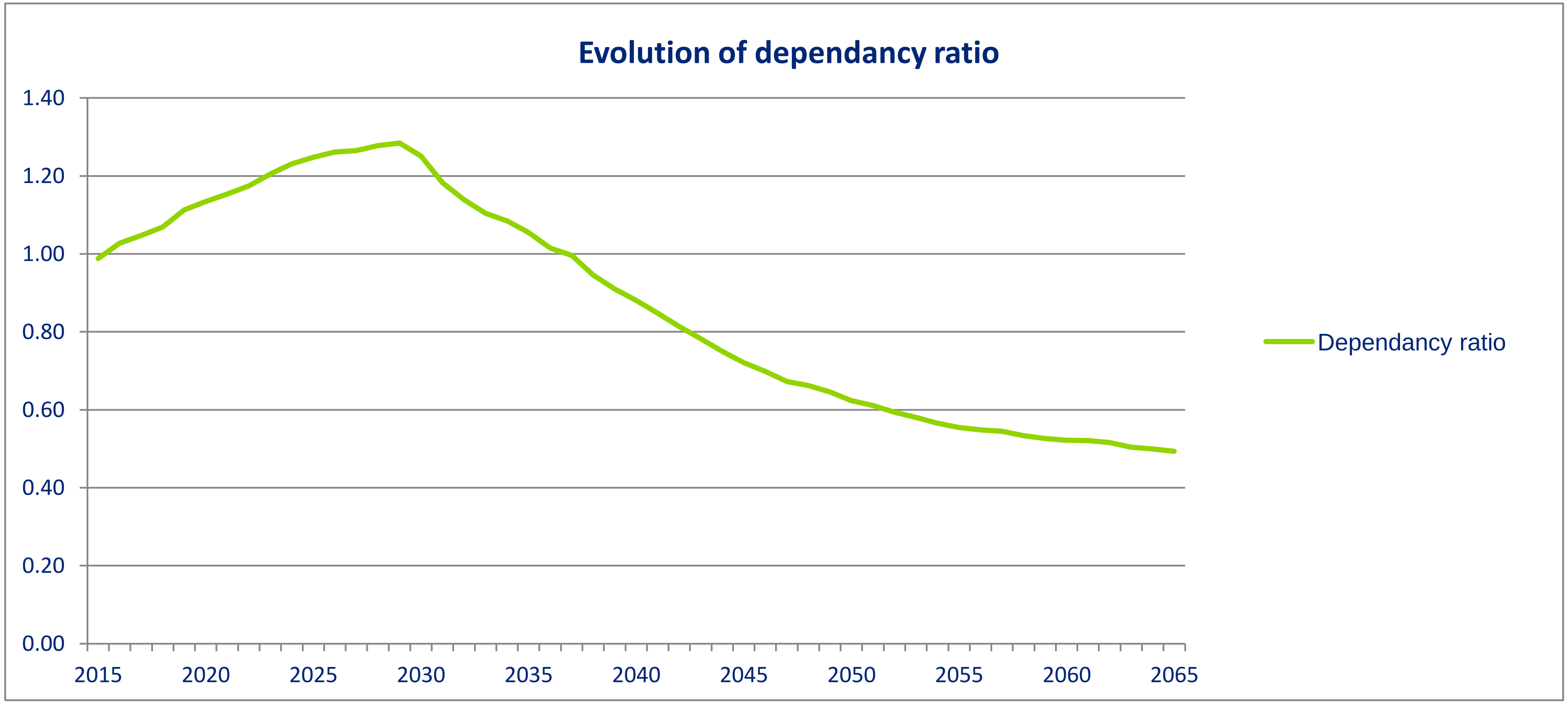
## 6.7 Average replacement rate including annuities from Pillar 2 and without annuities from Pillar 2




The above chart presents the evolution of average replacement rate in two separate scenarios:

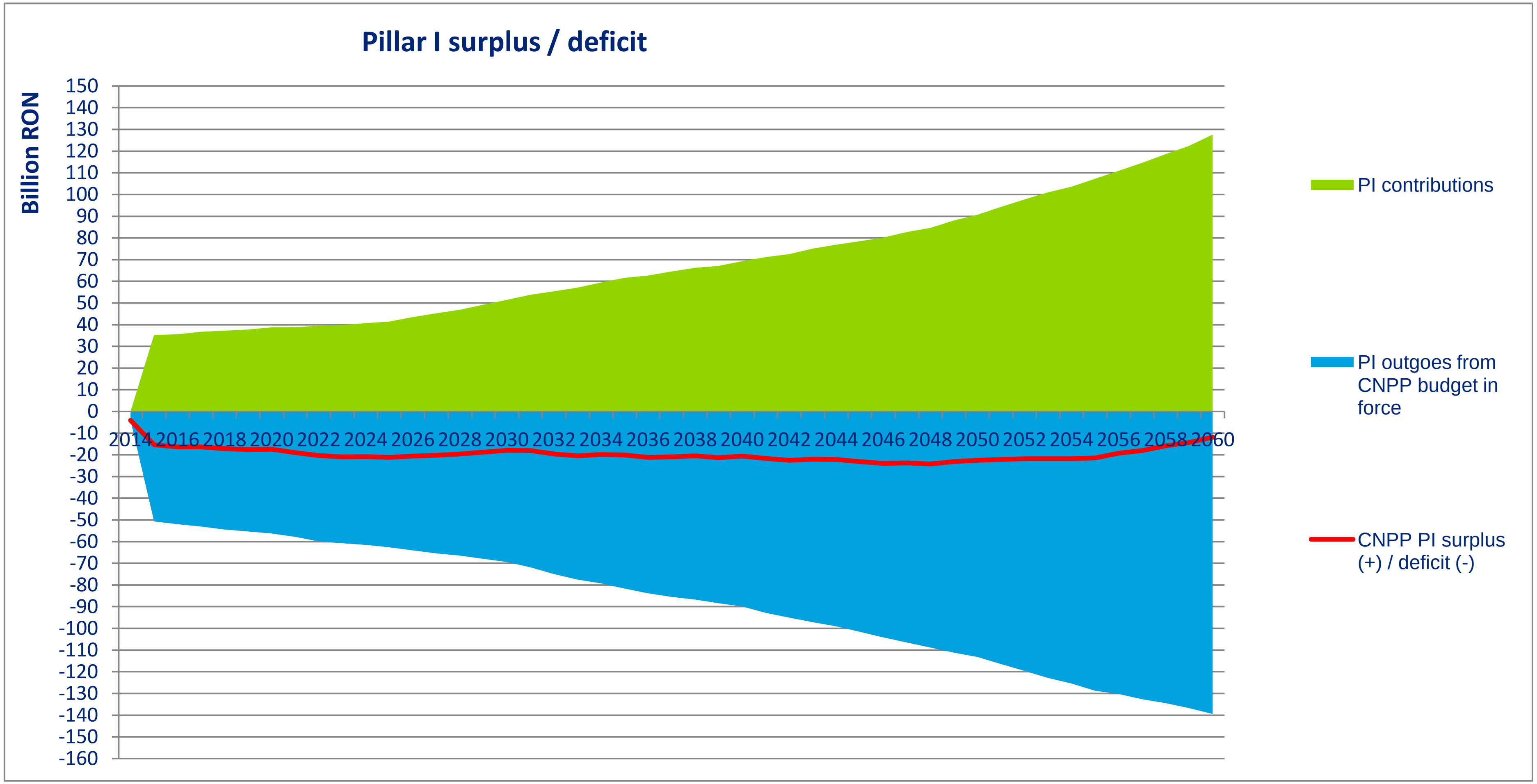
- Hypothetical scenario in which annuities are paid from Pillar II at retirement for main types of benefits (except for disability retirement);
- Hypothetical scenario in which the contribution rate starting with 2015 to Pillar II is 0, the pension will be fully paid from Pillar I.

## 6.8 Dependency ratio




The above chart shows the evolution of the dependency ratio between contributors and pensioners for the period 2015-2065.

## 6.9 Deficit / Surplus of Pillar I



**Raport is based on the Phase 5 report issued by Deloitte Consultanta**

*European Commission*

*This publication is supported by the European Union Programme for Employment and Social Solidarity-PROGRESS (2007-2013)*

*This programme is implemented by the European Commission. It was established to financially support the implementation of the objectives of the European Union in the employment, social affairs and equal opportunities area, and thereby contribute to the achievement of the Europe 2020 Strategy goals in these fields.*

*For more information see: http://ec.europa.eu/progress*