DEVELOPMENT OF MICRO-SIMULATION PENSION MODEL: LINKING THE MODULES WITHIN GRAPHIC INTERFACE

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Abstract

In this Working paper we summarized research activities undertaken during further development of the pension model. Substantial part of time was devoted to the completion of the pension module. With constructed matrix of the conditions for old-age retirement for both genders separately, the module enables simulation of the continuation of the reform of the existing pension system, which will be fully implemented by 2024. An additional sub-module was added that allows simulation of the system of notional accounts. The next very important step in developing the model was the integration of all developed modules into a single system that allows the use of dynamics. In parallel, developed graphic interface in practice links the modules into a microsimulation pension model as well as links the two models - pension model and model of generational accounts. At the same time, it allows independent work with each module separately, as well as the work with the basic data stored in a data warehouse.

Developed simulation platform enables elimination of restrictions on the applicability of the static micro-simulation model and generational accounts model arising from a static approach and the cohort level. It is in fact the result of the necessity to adequately adapt both tools to be able to provide a quality assessment of the proposed changes of the pension system. Developed simulation platform represents the first such tool and provides the first dynamic microsimulation pension model developed in Slovenia.

**JEL classification:** E17, E62, H55, J11

**Keywords:** demography, social security, pension system, microsimulation
1. INTRODUCTION

Within the first three phases of the project the following activities were concluded:

The system of linked databases has been successfully established and institutionalized. The system was included into the Yearly Program of Statistical Research of the Statistical office and will be regularly updated with the new versions every three years. Linked databases will be put at disposal through the remote access for any researcher or research team, as well as for different government institutions, for the research purposes. Despite a long period needed to come to the end of the preparation of these databases, we can conclude that a really important breakthrough in the field of linked administrative and statistical databases at the individual level was achieved.

For the calculation of disposable income of a particular individual within the sample, a special personal income tax module has been developed. It can be used as a particular programming package, which enables simulation of any scenario about the possible change of any of parameters within the valid personal income tax system, with the possibility to increase the number of income brackets, to change the rates of the employers’ and employees’ social contributions as well as to introduce any capping of the tax base for social contributions.

Development of demographic module was concluded. It is available and functioning as a particular programming package. Its main aim is to provide simple and quick preparation of demographic projections in a user friendly form. Module follows technical procedures of the LIPRO programming language, used for the preparation of the latest EUROSTAT projections. Therefore, the results obtained with the socio-demographic module are completely consistent with the EUROSTAT projections. The added value, however, lies in the graphic interface already developed and added with simple and quick implementation of alternative assumptions regarding the mortality, fertility and migrations and with the results obtained in a moment. As an important module within the model, it enables inputs for other modules, particularly for the pension module. This module is certainly a very useful programming tool which can be used also as an independent model in the field of demography. Linked with the pension module, it will enable introduction of dynamics into the model.

Development of the economic module has also been concluded. As is the case with other two modules, it is available and functioning as a particular programming package, but will finally represent a linkage between demographic and pension modules, using exogenous assumptions regarding some macroeconomic aggregates. Independent use of the module is at this stage possible, but it is a rather limited one, due to the use of the retirement rates obtained from the
generational accounting model. It uses inputs from the demographic module’s results (the number of population, split by gender and annual age cohorts) and calculates real growth rate of GDP taking into account exogenous productivity growth rate and the employment growth rate. Both variables are for the moment taken from the macroeconomic assumptions made by the EU commission, but can be arbitrarily changed.

Graphic interface, while underway, was still in the process of development. It was decided that graphic interface would be prepared as a broader tool, which would cover and link all modules in a consistent framework. The original plan in the project proposal was namely to prepare graphic interface separately for the individual modules of the project (this has already been done for the first three modules). In the process it was recognized that a more integrated approach to creating the graphic interface would have additional advantages for the users of the model. Final version will enable the user to work separately with each particular module as well as with the data stored in the data warehouse, and to run a dynamic pension model, taking into account any possible change of all parameters in all particular modules.

Pension module at the present stage of development is capable of identifying an individual who qualifies for an old-age pension and to calculate an individual’s old-age pension in accordance with the parameters set by the user of the model, but in the base year only. Individual data are in the model aggregated to national level. Design of the module allows an upgrade (which is in accordance with the plan of work scheduled for the next phase of the project) for the simulation of alternative pension systems, such as individual or notional pension accounts (NDC) and the points system.

In this Working paper we summarize research activities done on further development of the pension model. Substantial part of time was devoted for the completion of the pension module. With constructed matrix of the conditions for old-age retirement for both genders separately, the module enables simulation of the continuation of the reform of the existing pension system, which will be fully implemented by 2024. An additional sub-module was added that allows simulation of the system of notional accounts. The next very important step in developing the model was the integration of all developed modules into a single system that allows the use of dynamics. In parallel, developed graphic interface in practice links the modules into a microsimulation pension model as well as links the two models - pension model and model of generational accounts. At the same time it allows independent work with each module separately, as well as the work with the basic data stored in a data warehouse.
2. INCOME TAX AND SOCIAL SECURITY CONTRIBUTIONS MODULE

The first static version of the module was developed on the basis of the newly acquired linked database for the year 2007. With adequate adjustment of incomes, the module enables the calculation of the income tax in the year 2010 and the elaboration of the chosen scenario. The graphic interface is prepared and allows the user a simple preparation of the scenario, calculation and listing of the results for the purpose of entering them in the general equilibrium model or for the need of analyzing the consequences of a particular measure in the field of income taxation or social security contributions. User simply changes the necessary parameters within the sheet with parameters and runs the module. The results are automatically written into the sheet from where the user started the module. In the next steps (after some scenarios made) the user may prepare tables for the comparison of the results obtained.

2.1. Adding “time” and linking the module with the other modules

First version of the module was the static one, with parameters set only for the base year 2010. As the data were prepared for the year 2007, we adapted the module to work with the parameters valid for the year 2010. All incomes were therefore indexed with the average growth of wages in the period 2007-2010, and additionally, we had to take into account also all changes that occurred during this period in the area of income tax and social security contributions (differentiation of common tax relief, increase of the minimum wage, possible use of capping of the tax base for payment of social security contributions). This version of the module was programmed in STATA and used its own graphic interface developed in the Excel environment.

The new steps needed in order to include dynamics into the module were thus the following ones:

a) Adaptation of the programming code through introduction of time in order to be able to simulate income tax and social security contributions for each year within the observed period 2010-2060,

b) Preparation of special sheet with all parameters needed for performing simulations for the complete observed period 2010-2060 (see Figure 2.1),

c) Inclusion of this module within the new graphic interface platform with all necessary links with other modules through the use of input and output files (see Figure 2.2),

d) Testing the working of the module in the new dynamic environment as well functioning of all links with other modules within the graphic interface platform.
In the next steps, income tax module was thus linked with the other modules into the dynamic framework. From the pension module it gets data on new, due to the pension reform activated individuals, as well as data on changed pensions for the observed period 2010-2060. It is thus
possible to estimate also the change in government revenues (income tax and social security contributions) as an additional effect of the proposed pension reform. On the other hand, this module is linked also with the economic module, which uses data on income tax and social security contributions calculated within the income tax module, due to any change in the income tax parameters, demography or pension system. This means that this module is linked also to the demographic module, as changes in demographic projections, due to the proposed changes in fertility rates, life expectancy and migrations, influence weights and the structure and thus the number of employees and pensioners.

Within graphic interface this module can be executed also as an independent model in order to be able to simulate only the effects of changes in the income tax and/or social security contributions system. On the other hand, pension module can be executed only together with income tax module, as changes of the pension system affects also changes in the government revenues from income taxes and social security contributions.

The outputs of the income tax module are at the moment the following: volume of personal income tax, volume of social security contributions of employers and employees as well as of private entrepreneurs, average values of the variables – all split by gender, total amounts and split by 5-years age groups and one year age groups (Figure 2.3).

![Figure 2.3: Some results of the income tax module](image)

Interested reader can get more technical details on the use of the income tax module with the graphic interface platform in the chapter 7.
3. DEMOGRAPHIC MODULE

In the following paragraphs we present main characteristics of the demographic module. This module emerged from the need for the programming equipment that would enable simple and quick production of population projections in a user-friendly form. In this, it follows technical procedures as used in the programming equipment LIPRO, which had been used in the construction of the newest EUROSTAT projections. In this way results of projections of the demographic module are completely in line with EUROSTAT projections. Contrary to programming equipment LIPRO, alternative assumption concerning movements in mortality, fertility and migrations can be implemented very simply and rapidly. With the inclusion of this demographic module in other modules, on the basis of changed assumptions, results of projections can be calculated in real time, which enter in further calculations. Demographic module thus provides input data for further analysis within other modules, while the results of this module are also interesting as an independent final result.

Demographic module tries to be friendly to the user:

- In entering assumptions concerning future movements of fertility, mortality and migrations, needed for the population projections, as well as
- In presenting results of population projections.

When entering assumptions on fertility, mortality and migrations, parameters of the shape of transition curve are at disposal (“Oblika prehoda (lastna krivulja prehoda”) which allows quick and simple determination of the shape of transition from initial to final values (which are also set by the user). With low positive values (such as 1, 5, 10, etc.) the curve has the shape of a logistic function, but if a higher value is entered (say 100), the curve gets a concave form. With interim values we get some interim form of the curve. The shape of the curve is drawn immediately after the change of parameter, so that the user can check whether the shape of the curve is such as he wanted. In the line to the right of the figure, concrete values for all years up to 2060 are also written down. The user can also write these values by hand, if he wants to form the curves on movements of assumptions on mortality, fertility and migration completely by himself, as the shape, determined by the slider (upper frames) or according to EUROPO2010 assumptions (lower frames) may not suit him (see Figure 3.1).

At the same time, one has to be aware that assumptions on fertility, mortality and migrations are not uniquely determined already by the rate of total fertility, i.e. the number of children who are on average born by one woman during her fertile period (fertility), life expectancy at birth (mortality) or the number of net immigrants (migrations).
Figure 3.1: Entering assumptions on fertility, mortality and migrations

With all of the mentioned assumptions, in the background there is also the distribution by age groups. The same rate of total fertility can thus have a different age distribution of mothers, the same life expectancy at birth can be achieved by differing intensity of dying in different ages and the same number of migrants can be differently distributed by age. For the same number of live-born we could also assume different ratio between live-born girls and live-born boys, but in practice this ratio is rather stable. Behind each value of total fertility rate, life expectancy at birth and the number of net migrations, there is at least a distribution by age, and sometimes also by gender, which can change from year to year. In the basic version of projections, concerning these distributions we use Eurostat assumptions from the population projections EUROPOP2010. When changing parameters on the rate of total fertility, life expectancy at birth and the number of net migrations, there is at least a distribution by age, and sometimes also by gender, which can change from year to year. In the basic version of projections, concerning these distributions we use Eurostat assumptions from the population projections EUROPOP2010. When changing parameters on the rate of total fertility, life expectancy at birth and the number of net migrations, retaining age and gender structure as in EUROPOP2010 is assumed. The starting point of the demographic module is therefore projections of the Slovene population from EUROPOP2010, which have been produced in 2011 by Eurostat (Eurostat, 2011). These are also the projections whose use is required for calculations concerning ageing of the population in communication with the European Commission.

In contact with the representatives of Eurostat who made the projections, they revealed to us the trends used in assumptions on age samples, so that the basic version of the results is completely equal to Eurostat official projections. At the same time, we also obtained algorithms for the calculation of age distribution of mortality in the case of a higher assumed
life expectancy. In this way, the user can also choose life expectancy higher than the one Eurostat assumed in the year 2060.

Concretely, we prepared distributions of the probability of survival by age groups for the distances of 0.01 years of life expectancy at birth. The user can thus use any values of life expectancy at birth for men in the interval from 74.00 to 93.00 years; and for women in the interval from 81.00 to 100.00 years.

3.1. Description of certain technical procedures in the population projections

In the population projections EUROPOP2010 Eurostat has used programming equipment LIPRO 4.0. This is a programming solution of the Dutch demographic institute (NIDI) which is aimed at population projections, but which beside basic population projections offers also some other solutions (multistate projections, projections of households, where different types of households and transition among them are taken into account). This is very flexible programming equipment, as far as the possibility of defining individual assumptions is concerned, but at the same time it is also very unfriendly to the user. The user must himself create all matrices, as mentioned, with time, age and gender dimension. Parameters, such as life expectancy at birth, are in programming equipment LIPRO 4.0 not input data, but LIPRO just provides them as a result. If we want to start from a given life expectancy at birth, the procedure for calculating mortality tables needs to be programmed independently, while assuming the age structure of the mortality rates and with for instance the function »goal seek” in the Excel calculating the probability of death, which results in the set life expectancy at birth, meaning that calculations in the reverse direction have to be made independently. In the demographic module all this calculation is automatic, starting from age distributions as assumed by Eurostat.

Technically speaking, population projections in the beginning of the next year are obtained by multiplying the Leslie matrix with the vector of the number of population by the age groups – separately for both genders. Leslie matrix for the female gender in the first line contains the probability of birth of a child according to the age of women. With the help of multiplying the first line in the Leslie matrix with the number of women in individual age groups, we get the number of new-born. Assumed ratio between live-born boys and girls is 0.515 to 0.485 – in other words, more boys are born and this ratio is fairly stable, both in time and among countries. Otherwise, both Leslie matrices have on diagonal, which begins in the second line, the probability of survival for individual ages. In this way, the number of live-born children (separately by gender) and the number of population in other age groups are generated.

Further, the assumed number of net immigrants by age groups is added. Technically, also mortality in an individual year has to be taken into account – for example, number of immigrants has to be appropriately corrected for the mortality, to which also immigrants are exposed, so that the number of population at the beginning of the next year in increased by
somewhat less than was the number of net migrations during the year, etc. At the same time, it is necessary to adequately derive the probability of death, as LIPRO uses projections’ for »period-cohort« probability of death, while statistical offices usually publish »age-period« probabilities of death. Some other technical details, evident from the mere connections in Excel data file are also needed. For more detailed descriptions of the procedures of calculation, used by LIPRO programming equipment, see Van Imhoff in Keilman (1999). In such a way we precisely reproduced Eurostat’s latest population projections EUROPOP2010.

3.2. Independent creation of population projections

As mentioned, at a start, assumptions from the population projections EUROPOP2010 are taken into account. For changing the assumptions in the independent creation of population projections the user has on the list with demographic parameters (»maDemografska gibanja«) at his disposal parameters for changing assumptions on the future movements of fertility, mortality and migrations. For each category under »krivulja prehoda« it is possible to select the option »lastna« or »EUROPOP2010« (this will be explained below), and further to change accompanying parameters.

First, the user selects the starting year of projections. In the start it is 2010, as Eurostat in 2011 prepared the latest demographic projections based on the actual data of that year. In the future, before Eurostat prepares other projections of the population, actual data for newer years will be available – those regarding the number of population by age groups and gender as well as those concerning fertility, mortality and migrations. For this purpose the user can himself enter the number of population by age groups and gender. At the same time, the user has to change parameter »Izhodiščno leto projekcij« from year 2010 to the year that the model should start from demographic projections (Figure 3.2).

![Figure 3.2: Determining the starting year of projections](image)
3.2.1.  Fertility

The user creates the assumption on fertility by setting the value of the indicator »stopnja totalne rodnosti« (total fertility rate), which shows the number of children born on average by one woman in her fertility age, on the assumption that all women live to the end of their fertility period.

If under »oblika prehoda (lastna krivulja prehoda)« the user selects the possibility »EOROPOP2010«, this means that he will define assumptions on the movements of fertility in the future as a multiplier of the increase with respect to Eurostat’s shape of the curve of the future movement of fertility. If the user determines factor 1, Eurostat’s assumption are used; if he chooses the value higher than 1, Eurostat’s curve will adequately »rotate« upwards, so that it will begin in the same point, and end on the higher level; if, however, the value will be under 1, it would rotate downwards – again it will begin at the same level and end on a correspondingly lower level. By the multiplier it is decided how many times higher the increase of total fertility should be in individual years compared to values assumed in projections by EUROPOP2010.

Determination of for instance factor 1.5 would thus mean that total fertility rate (TFR) would in the period 2010-2060 increase from 1.54 child to 1.7 child per woman (instead of 1.54 child as assumed by EUROPOP2010). In this case the increase of the number of children per women would in that period be 0.17 instead of 0.11 children per women, i.e. 1.5 times as much. Equally, also in all other interim years 50% higher increase of the number of children per woman compared to EUROPOP2010 would be assumed (see Figure 3.3).

![Figure 3.3: Changing base EUROPOP2010 assumptions regarding fertility](image)

If the user under »oblika prehoda (lastna krivulja prehoda)« selects the possibility »lastna«, this means he will create the shape of the curve on future movement of fertility by himself. In this case he has to determine:
- »Začetno leto prehoda« - year in which it is assumed that fertility starts to change from the initial level (if the user wants smooth changing, he will choose the first year of projections, which means one year after the base year – in other words base year +1)
- »Končno leto prehoda« - year in which it is assumed that fertility settles down on the final level. In the case that user wants smooth changing all the way to the end of the projections period, then this year will be equal to the final year of projections (2060).
- »Izhodiščna raven« - level of fertility (TFR) in the initial year of projections (actual value in the starting year of projections).
- »Končna raven« - level of fertility (TFR) in the final year of projections (2060).

![Figure 3.4: Preparation of own curve of transition from the initial to the final level of fertility](image)

3.2.2. Mortality

Entering parameters on mortality is analogous to entering of parameters on fertility (see previous section on fertility), except that it is necessary to enter parameters separately for men and women, while for fertility there was no gender dimension, as fertility is relevant only for women (Figure 3.5).

![Figure 3.5: Entering parameters on mortality](image)
3.2.3. Migrations

Equally, in creating assumptions on net migrations, the logic is the same as in creating assumptions on fertility and mortality. In the case of selection of »EUROPOP2010« both coefficients also this time determine how many times higher should be the number of net migrants in individual years, compared to values, assumed by EOROPOP2010. This time it is not about »rotating« the curve of assumptions from EUROPOP2010 projections, but about the shift (»rise« or »fall« of the curve). While fertility and mortality as a rule do not change from year to year with drastic jumps, for net migrations this is entirely possible and sensible.

![Figure 3.6: Entering parameters on migrations](image)

Other dimensions of the assumptions – age distribution of net migrations, distribution of total fertility by age with respect to the age of women and changing of mortality by age groups (while the user determines the movement of life expectancy at birth) - derive from the assumptions used in EUROPOP2010.

3.3. Results

All drawings of the used assumptions and input parameters are executed immediately when demographic assumption change. Results of the demographic module are, in comparison to other modules, also calculated very fast (in a few seconds).

For the moment we have included among the results the display of the age structure of population with the age pyramid and age structure of population (absolute and relative). Age pyramid is here interactive, so that the user selects in the cell any year of projections for which he wants that the age pyramid would display results. At the same time, in the form of structural bar graph and table, number and shares of basic three age groups, relevant from the economic point of view are displayed: young in the age 0-19, labor contingent (20-64 years) and old persons (65 years and more).
Figure 3.7: Some results of the demographic module

The module is undoubtedly an extremely useful tool which the user can use as an independent model in the area of demography. In the framework of the pension model it will enable us to dynamize the model. In the continuation of development of this module we have also added the possibility of calculating changing weights for individual age categories of the Slovene population with respect to the assumed movement of demographic structure in the period up to year 2060. And finally, the program was, because of better transparency and usability, separated from the data part, which of course called for adequate adjustment of the initial version of the program.

3.4. Development of the module for generating weights

In connection with demographic and economic module, results of the pension and income-tax modules are used for projections of movements of all aggregates (economic, fiscal, and demographic) in the future. This is the so-called static-dynamic ageing - projection of the existing population into the future - with the use of the appropriate system of weights. With the matrix of weights for individual dimensions (age and gender) we transpose the results of the existing population into an arbitrary year in the future (up to year 2060), which means that separately for each year we get the results at the individual level as well as the aggregates for the number of pensioners, amount of pension expenditures, income tax, social security contributions, etc.
In the process of weighting, we assign to individuals whom we have in the sample weights according to the actual state and aggregate projections of population by gender and age. In the base year, weights based on the sample reproduce the entire population, as far as the number of individuals by these two dimensions. Demographic projections, which enter the pension module from the demographic module, show that in the future the share of older population will increase. To such individuals from the sample, the procedure of assigning appropriate weights assign in the future higher weights, as they will represent or stand for the larger number of such population. With this procedure it is assured that with adequate adjustment of values of weights of an individual in the sample we reach actual aggregate values for the number as well as for the structure of population (by both dimensions) – both in the actual state in the base year and in the projected state in any year in the future which the model includes, obtained by demographic projections.

This very important module for generating weights which helps us to adjust the basic structure of Slovenian population to the future structure with the use of the sample of population in the base year represents an extremely complex procedure. In the first step we used program GREGWT which was developed at the Statistical office of Australia. In the next step we actually ran into an in fact completely practical trouble. Program works in the environment of the programming package SAS, which the users of the model would have to acquire and install. Exactly for this reason we decided that we would rather use a similar program that was however developed for the STATA environment and is therefore freely available to the users.

Quite some time was devoted to the preparation of the projection of the educational structure of the Slovenian population by gender and age. Appropriate weights were also calculated, which assure simultaneous adjustment to actual aggregate values by gender, age and education. Algorithm itself is, due to large number of dimensions which it must take into account, very complicated and calculation demanding, which on the other hand claims a »tax« in the form of time, needed for the calculation of new weights, as a consequence of changed assumptions in the demographic module and thus also new population projections. This was also the reason why weights in the system of linked modules are not calculated automatically at each change in the demographic module – program has to be specially started when for example the user is satisfied with the new set of assumptions and population projection.

Analysis of results of calculated weights, taking account of the structure of population by gender, age and additionally education, has shown an expected significant increase in the share of educated population, which would of course mean significant additional burdening of the pension fund in the long run. Dilemma with respect to the use of this, additional third dimension, was double. First, we do not have data on the movement of the structure of wages according to education in the next decades. However, we would expect that according to presented trends of increasing of the share of highly educated and lowering of the share of population with only the first degree of education, their starting ratio of wages would in time
diminish. Retaining the initial ratio of wages would in the long run most likely not be realistic and would overestimate the significance of wages of highly educated part of the population. As a clear presentation of the problem we can think of an (overstretched) assumption that all Slovenes in 2060 would have a PhD. degree. Would thereby all these Slovenes in this case have relatively such wages as doctors of science in the base year 2007? This is very improbable, as some of them would still need to cook in the hotel kitchens, clean the streets or the rooms etc.

On the other hand, we have estimates of the labor productivity growth for Slovenia, prepared by Eurostat. This can reflect also the increased share of highly educated population and taking account of both could additionally overestimate the significance of wages of highly educated part of the population. Unfortunately, we were unable to acquire information on whether increase in the labor productivity also actually contains assumptions on the increase of the share of highly educated population.

This is why we decided that it was better to skip the third dimension in the preparation of weights, as thus we would most likely make a much smaller mistake in our simulations of the movement of the share of pensions in GDP in the long run. Of course it is always possible to use one or the other weights and analyze gained differences in results. However, into the proper model we have for the moment built in the calibration of the number of population in the sample to the entire population only by gender dimension and age dimension.

Regarding weights we also had to solve the dilemma concerning the future movement of the share of active population, which was also estimated by Eurostat. Their estimations of successive raising of the share of active population in higher age groups is most likely based on the use of assumptions about successive raising of retirement age as a consequence of the currently ongoing pension reform. This is why moves for women are much higher than for men – all changes however end by 2024, i.e. until full implementation of the existing pension system. Eurostat thus assumes a shift in the average age at retirement of 3.8 years for women and 1.7 years for men.

If Eurostat therefore starts from the consequences of implementation of the present pension law, then this raising of the age at retirement in already built into our model in that part of the pension module, which reproduces functioning of the presently valid pension law. Nothing however happens in the next years and decades until 2060. Trying to calibrate the results of the base solution of the model to Eurostat values would thus impair the model itself.

At the same time we were also interested whether we can find significant differences in the beginning of entry in active age and in the density of employment for different generations of Slovene men and women. For this purpose we obtained from PIIIF data on wages histories also for all these persons from our sample, which in 2007 were still employed. Because of the limitations of data – data exist only from year 1970 on - we decided to compare generations
of 26-33 years old. In other words, we analyzed how many years of service a 26-33 years old person had in the base year 2007 and how many years of service the same generation had twenty years ago (1987) - which in 2007 is 50 years old and so we can expect that on average it would start retiring somewhere around the year 2018.

Results have shown important differences both within genders as well as among them. For men, this difference has in twenty years increased on average to 1.5 years, and for women even to 3.2 years. We can conclude that future generations will retire later than present generations, due to their later entry in the active period, as well as due to the lower density of employment, regardless to the pension law in force. These differences are even more pronounced if we prepare calculations also by taking account of the three levels of education. Therefore we have already built into the basic solution these calculations – such delay of course significantly affects lowering the pressure on the pension fund.

If we briefly summarize the main characteristics of this important module, they are the following:

- Module functions as an independent part of the pension model, which gets data on the structure of population in individual year from the demographic module;
- Module does not automatically calculate new weights as a result of the change in the assumptions of the demographic module, the command for the calculation of new weights has to be given explicitly, as the calculation is extremely demanding and lasts for more than an hour;
- In calculating weights, it uses two dimensions, gender and age;
- With weights we correct the base structure of Slovenian population and adjust it to future population projections in any year of the observed period 2010-2060;
- Results of the calculations of the module are new weights which are used in the pension module.
4. Economic Module

Economic module links:

- Demographic module,
- Pension module,
- Some exogenously given assumptions about the future path of macroeconomic categories. In the base variant we used the assumptions from the last set of macroeconomic assumptions of the European Commission (of 2011).

Economic module uses as input data the results of the demographic module about the number of population by gender and (one-year) age groups. Economic module calculates real growth rate of GDP. Growth of GDP is the sum of labor productivity growth and labor input growth. Growth of labor productivity enters the model as exogenous variable – assumptions of the European Commission of 2011 are used. Further, growth of labor input equals the sum of: a) growth rate of the employees in the age group 15-71, and b) growth rate of working hours per employee. This procedure of calculating growth rate of real GDP is used also by the European Commission. Growth of labor productivity is further calculated as the sum of growth of total factor productivity and capital deepening (increase of capital equipment of labor). In the model, these two components are not treated as endogenous variables: trends of labor productivity are taken as exogenous variable. Trends in the number of working hours per active person are also taken as exogenous variable. For the latter two categories, values from the set of macroeconomic assumptions of the European Commission are taken.

Employment rates enter the economic module from the pension module, where they are calculated on the basis of model linkages (based on the regulations of the pension system), detailed (individual) data, as well as assumptions (parameters) set by the user. In this way the pension module at the same time represents an alternative to the forecasts of the European Commission about the future trends of employment rates and the number of employees. The European Commission namely currently uses for the member states a simple model for the projections of the future trends of the employment rates, which does not take into account the number of years of retirement age and other information on individuals which in reality will in the future influence the number of employees. Consequently, some other macroeconomic categories related to this, such as for example growth of GDP, will be different.

Assumptions about the future trends of unemployment enter the economic module exogenously. Set of employment rates (by calendar year, gender and one-year age groups), as assumed by the European Commission in its latest set of macroeconomic assumptions, is considered here. Number of unemployed is calculated from unemployment rates (which enter the economic module exogenously) and the number of population (which enters the economic module from the demographic module). Absolute number of unemployed thus in addition to assumed movements of unemployment rates changes also due to changes in the number of
population. In the case of changes in demographic assumptions (where demographic projections are recalculated) the absolute number of unemployed - in total as well as by age groups – also changes accordingly. Unemployment rates cannot be changed, since in the income-tax-pension module they are not simulated.

Number of employees enters the economic module from the pension module. At the same time, from the employment rates and unemployment rates, while taking account of equations of interconnected statuses on the labor market, levels of activity – by (one-year) age groups and gender – are calculated. By multiplying levels of activity and the number of population, the number of active population by one-year age groups and gender is also calculated. Movements of population, number of active persons, number of employees, number of unemployed and number of pensioners are shown in summary.

Selected results are also presented in the form of graphs. For a chosen (by the user) year, age and gender structure of the number of population, employees, unemployed and pensioners for this particular year are presented. For this presentation the age pyramid is used, which is, due to technical limitations of Excel, lying to the right. If the graph is in mind rotated by 90 degrees counterclockwise, we thus get the age pyramid of the population, which in addition to the number of population also shows the number of population by individual economic categories: total number of population, number of active persons, number of employees, number of unemployed and number of pensioners. All mentioned categories are also shown separately by gender. Above the x-axis (in an upright standing age pyramid that would be on the left side, as it is usual in age pyramids) is a display for men – dominated by blue color; while the display under x-axis (which in an upright standing age pyramid would be on the right side, as usually) is a display for women – dominated by red color. All these results are also presented in the form of a table.

4.1. Explanation of individual parameters which are created by the model user

Labor productivity growth (in %): PAR-FAKTOR_G

This is a key variable which also enters the pension and income-tax module. Its values are entered by the user in this module, while the values entered in the other two modules are shown only informatively. In the basic version which the user can arbitrarily change, values as assumed in the European Commission's last set of macroeconomic assumptions are entered. For the period 2010-2014, actual values or projections made by Institute for macroeconomic analysis and development are used (Figure 4.1).
Figure 4.1: Preparation of parameters for the economic module

Interest rate on public debt

Interest rate remunerated on public debt – interest rate paid on public debt. Public debt is calculated as with the interest rate paid increased public debt from the past year, to which budgetary deficit of the current year is added.

HEALTH

Increase of health expenditures

Model allows the assumption that health expenditures increase with:

- Growth of GDP per capita – most often assumed in European Commission’s calculations
- Growth in labor productivity
- Labor input growth
- Employment growth
- Growth in hours worked pre employee.
Improving the health status with respect to increase in eO (in %)

Life expectancy at birth (eO) is increasing. In addition, the health of people also to some extent improves. Therefore, the curve of health spending by age moves to the »right«, that is to higher age groups. With this parameter the user specifies how much in % of increase of life expectancy at birth should be the shift of the curve of health expenditures to the »right«, i.e. to higher age groups. For example, Eurostat in its projections assumes that life expectancy at birth will from 2010 to 2060 increase by 6.5 years. If the user inserts the value of the parameter as 100, this means that from 2010 to 2060 the curve of health expenditures will successively shift to the right – each year so much as the increase of the life expectancy at birth (in total, 6.5 years).

Conceptually the value of this parameter represents:

- 0% - pure demographic scenario - which means that the population spends its extended life expectancy in poor health;
- 100% - constant health scenario – which means that the number of years that individuals spend in poor health is constant.

Elasticity of demand

In this vector the user determines assumed income elasticity of demand for health services in the future (for each year). Data show that in the past this elasticity should have been higher than 1. If the user in an individual year inserts for instance 1.1, the assumed increase of health care expenditures in that year will grow 10% faster than the category to which the growth of health care expenditures is linked (with what should health expenditures grow, is determined by the user in the economic module).

LONG-TERM CARE

Increase of health expenditures

Analogous to the category of the same name under »HEALTH«

Increase of health with respect to increase in eO (in %)

Analogous to the category of the same name under »HEALTH«

Elasticity of demand

Analogous to the category of the same name under »HEALTH«
4.2. Other parameters of the economic module

To which year should the detailed presentation of the labor market by age refer?

The results are basically shown at the aggregate level – as just one value for each year. However, the user can view previously described detailed demographic-economic structure of the population or the labor market in the selected year.

Up to which included year exogenously inserted projections should be taken into account? (Model will start »functioning« only after that year)

At the request of the user, the opportunity that up to the selected year exogenously inserted projections of individual categories are used is allowed. For some reason the user may want for some years first to use values from own projections, and only since then let the model simulate values. Technically, this is done so that the model for the last year of exogenous insertion calculates individual categories of incomes and expenditures and coefficients among inserted values and simulated values derived by the model. With these same coefficients also all simulated values for the future years are multiplied.

It should be noted that only aggregate values of categories which the user exogenously inserts are adjusted, but not the other values, which may introduce inconsistency in the model. If for instance the user will believe that the pension expenditures for the next two years will be lower than those simulated by the model, then simulated values for the next two years will be replaced by the inserted values, while for all future years up to 2060 simulated aggregate values, will be appropriately adjusted with the help of the calculated coefficients. At the same time, the number of pensioners and the number of employed persons neither in the next two years nor in the rest of the projections period will change. If it is assumed that exogenously inserted lower pension expenditures would be the consequence of for instance intervention law, this can be quite acceptable also from the conceptual view, as it would probably not cause significant changes in the number of pensioners and employed persons. If, however, it would be assumed that exogenously entered lower pension expenditures would be the consequence of later retirement, then exploiting this possibility of the model would not be appropriate. In this way, projections would all the time in the future show too high number of pensioners and too low average pensions (these would in the model be adequately lowered, to ensure exogenously lowered amount of pensions for the given number of pensioners). In this case it would be more appropriate to achieve a reduction of pension expenditures by changing the parameters in the pension module – where conditions for retirement would be hardened which would lead to lowering the pension expenditures.

The use of this function of the model would be controversial even if it was assumed that certain measure would be introduced somewhat earlier or later than assumed in the model. The model will namely calibrate its simulated values to the user's inserted values for the year
up to which the user will exogenously insert values. If the effect of a particular measure has up to this year already appeared (and the user has exogenously shifted simulated results, as he believes that it would appear later than assumed in the model), calibration will nullify it, so that the effect of this measure would never enter the results. And the other way around, if the user has in his exogenous projections already included the effect of a certain measure, which the model foresees only in the period after the last year of exogenously inserted projections, then the effect of this measure would be doubled.

When using this function we recommend caution and each time substantive assessment whether inserting own projections by the user is acceptable or not. Technically, the values are entered in the sheet "Eksogeni_vnos". Independently of this, it is necessary to determine the year by which the values of sheet "Eksogeni_vnos" are considered. Of course, exogenous values entered on sheet "Eksogeni_vnos" must be available up to the calendar year which the user selects within the parameters.
4.3. Generational accounts

Economics module includes also a sub-module that refers to the calculations related to the method of generational accounting. The method of generational accounting was presented in 1991 (Auerbach, Gokhale, & Kotlikoff, 1991). The term "generation" refers to individuals of a certain age (ie cohorts), the term "net payments" refers to the difference between public finance revenues of all kinds and all types of transfer payments by the government paid to the individuals.

The basis of generational accounts represents the inter-temporal budget constraint. For the base year \( t \) we can write:

\[
\sum_{s=0}^{D} N_{t,s} + \sum_{s=1}^{\infty} N_{t,s+1} + W^g_t = \sum_{s=t}^{\infty} G_s (1 + r)^{-(s-t)}
\]

The first term on the left side of the equation is the sum of the present value (of the future) net payments in the year \( t \) living generations, as we call generations, born before the base year or in it. The term \( N_{t,s} \) (\( s=0...D \)) is the current (discounted to year \( t \)) value of net payments made by the generations born in the year \( t-s \) in the rest of their lives to the government. In this sum, index \( s \) runs from age 0 up to age \( D \), which indicates the upper limit of life length. The first element in the sum is therefore \( N_{t,0} \) and means the present value of net payments of a generation born in the year \( t \); the last element is \( N_{t,D} \), therefore, the net present value of the remaining payments of the oldest generation, of which (some) members are still alive in year \( t \) (those born in the year \( t-D \)).

The second term on the left side of the equation is the sum of the present values of net payments of "future" generations, as we called the generation born after the base year. The first element is \( N_{t+1} \) and indicates the present value of future net payments of the generation born in the following year (compared to the base year \( t \)). The following items represent value for generations born in the still more distant future. Theoretically, it is a sum up to infinity, but in practice we stop at a sufficiently distant future, when the impact of so distant payments becomes negligible, due to discounting.

Term on the right side of the equation denotes the value of government consumption, discounted (through rate \( r \)) to the base year \( t \).

From the equation (1), the obvious feature is the zero-sum in the intergenerational fiscal policy. If you keep the right side of the equation unchanged (third term on the left is, according to the content, a constant), then the net increase in government payments to the existing generations (reduction of the first item on the left side of the equation) is

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1 Partially summarized from Sambt (2004)
compensated by an increase in the second item on the left side of the equation. This means that it will be necessary for future generations to impose higher net payments - either by reducing transfer payments to be received from the government to them, or to increase the obligation of their payments to the government.

Term $N_{t,k}$ (as a general record of $N_{t,2-\infty} ; s=0...D$ and $N_{t,2+\infty}; s=1...\infty$) is defined as:

$$N_{t,k} = \sum_{s=\max(t,k)}^{k+D} T_{s,k} P_{s,k} (1+r)^{-(s-t)}$$ (2)

Term $T_{s,k}$ means an average net payment, which will be in the year $s$ paid to the government by the representatives of the generation born in year $k$. When the average net payment is mentioned, it means the average payment of all members within the (living) generation living in the year $s$. Item $P_{s,k}$ indicates the number of living (or surviving) members of the cohort born in the year $k$ in the year $s$. As can be seen from the mathematical description, for the generation born before the year $t$, the sum starts in the year $t$. For generations born in the year $k$, when $k > t$, the sum starts in the year $k$. Irrespective of the year of birth, values are always discounted (back) to the year $t$.

Generational accounts are made separately for men and women. We did not write marks for gender in order not to additionally complicate mathematical expressions.

We thus get generational accounts with the help of application of projections of net taxes (by age and gender) on the population projections (also according to the age and gender), while all values are calculated (discounted) to the base year. Let's look at how to create forecasts of age-specific net (tax) payments. Average age-specific net tax payment in the year $s$ paid by people born in the year $k$ is broken down into:

$$T_{s,k} = \sum_{i} h_{s,k,i}$$ (3)

where $h_{s,k,i}$ denotes the average tax or transfer of type $i$ paid or received in the year $s$ by a person born in the year $k$, $s-k$ years old. If $h > 0$, it means that it is a tax paid, while $h < 0$ indicates received transfer.

It is assumed that all categories are increasing with a constant productivity - which is the assumption in the basic version of generational accounts - while in our model, we use labor productivity growth as it is assumed by the European Commission (or can be changed by the user). At the same time, the growth of certain categories is linked to other categories instead of labor productivity growth, if this is more appropriate for Slovenian example. In this way
we design projections on future average tax payments and transfer receipts to each representative:

\[ h_{s,t,k} = h_{s,t-(s-k)\text{yr}}, (1 + g)^{t-s} \]  

(4)

where \( g \) denotes the annual rate of productivity growth, which can be written in the equation as a constant in accordance with the basic version of generational accounts, although, as mentioned above, in our assumptions it changes from year to year. Equation (4) therefore in the year \( s \) assigns taxes and transfers to the person aged \( s - k \) years, which have been shared by persons of the same age in the year \( t \), increased with the assumed productivity growth in the intermediate period.

\( N_{t,k} \) is the aggregate of net payments paid by the members of each cohort to the government during the remainder of their lives. If finally this value is allocated to the number of members of each cohort in the base year, we obtain the average net tax payment that the (average) representative of each cohort will pay to the government in the remainder of his life. In short, we get the values of generational accounts:

\[ GA_{t,k} = \frac{N_{t,k}}{P_{t,k}} \]  

(5)

Now we can define the generational accounts also mathematically. A set of generational accounts is simply a set of values \( GA_{t,k} \), one for each generation.

With the obtained model we can determine how much should be the reduction of all transfers individuals are receiving, to ensure inter-temporal budget balance in the long run. Analogously, we can analyze how much would be needed to raise all types of tax (including contributions) to ensure inter-temporal budget balance. These two indicators are similar to the idea of the long-term sustainability indicator S2 developed later by the European Commission for the determination of long-term fiscal sustainability of the system.

For economic policy makers of particular interest is the possibility of calculating the impact of various economic policies on the improvement or deterioration of the situation of individual cohorts regarding net inflows in the public finance system in the rest of their lives. When simulating the effects of fiscal measures it is therefore possible to determine their impact on the individual age groups - who will be more and who less affected.
4.4. The results of the economic module

In the sheet with the results of the economic module, a summary projections of individual categories of public revenues and expenditures are shown. Furthermore, the movement of GDP, the wage bill, the number of active persons, number of employees, and the number of unemployed are also shown.

![Image of results of the economic module]

**Figure 4.3: Results of the economic module**

Indicators of the sustainability of public finance system, S1 and S2, are the next results presented. These indicators show the size of the required permanent adjustment of the difference between primary public finance revenues and expenditures in order to achieve the targeted gross debt. With S1, the target value of gross debt of 60% in 2050 is assumed. With S2, zero value of gross debt - and in infinity - is assumed. Since the indicators relate to differently long time intervals, the comparison between them shows the urgency of the necessary reforms (European Commission (EPC Secretariat), 2010) - for detailed technical explanations and mathematical expressions see this source and its Annex.

4.4.1. The results of generational accounts

Results of generational accounts are shown for each five-year age groups (cohorts) in the form of a table and chart format. Interpretation of the absolute values of generational accounts
is less relevant, as they are highly dependent on the assumed discount rate (a value of 3.5% per year was used). More relevant is the comparison of the results of generational accounts among various scenarios that show what impact the measures of a simulated scenario will have on each age category. Among the results, a discounted difference between revenues and expenditures (i.e. inter-temporal budget imbalance) is also provided. It is a standard indicator of generational accounts. Furthermore, the indicators of 1) required increase in any taxes or 2) reduction of transfers required for the establishment of inter-temporal budget balance are prepared.

![Figure 4.4: Results of generational accounts](image)

**Figure 4.4: Results of generational accounts**

4.4.2. The detailed structure of the population by age and gender in terms of labor market

For selected (by the user) year, a detailed age and gender structure of population, employment, unemployed and pensioners is displayed. The age pyramid, which is, due to technical limitations of Excel, lying to the right, is prepared. If you keep in mind the chart is rotated by 90 degrees counterclockwise we get the age pyramid of the population; in addition to population it also shows the structure of the population for each economic category: the total population, the number of active, number of employed, the number of unemployed and the number of pensioners. All these categories are presented separately by gender. Above the x axis (in the upright age pyramid this would be on the left side, as is usual in the age pyramids) they are displayed for men - dominated by blue color, while on the x-axis (which
would be in the upright age pyramid on the right side, as is usual) is a display for women-dominated by red color. All these results are also presented in the table form.

Figure 4.5: The structure of population by gender and age

4.4.3. Breakdown of the increase in pension expenditure into the individual components

The total increase in pension expenditure can be broken down into its individual components (in accordance with the methodology of the European Commission):

\[
\begin{align*}
\text{Pension Exp.} & = \frac{\text{Dependency Ratio}}{\text{GDP}} = \frac{\text{Population 55+}}{\text{Population 15–64}} \\
& \times \frac{1}{\text{Employment Rate}} \times \frac{\text{Coverage Ratio}}{\text{Working People}} \times \frac{\text{Number of Pensioners}}{\text{Population 55+}} \times \frac{\text{Average Pension}}{\text{GDP}} \times \text{Working People}
\end{align*}
\]

The results for each calendar year up to 2060 show the contribution of each of these components to the overall growth of pension expenditures to the GDP.
4.4.4. Questionnaire ("Vprašalnik")

The model is linked to a table or questionnaire, which had to be completed in order to fulfill the purposes of reporting to the European Commission. Categories that can be calculated by the model are related to the model itself, so that at each simulation results are automatically recorded in the table. This will alleviate the preparation of this table.
5. PENSION MODULE

Pension module, which is by far most extensive and important part of the project, called for close cooperation with the representatives of the Pension and Invalidity Fund, Ministry of Finance, Ministry of Labor, Family and Social Affairs and Statistical office. This was already reflected in the preparation of adequate still missing data on pensioners in the sample. Without cooperation and also understanding of all these institutions it would be impossible to successfully overcome already the first serious problems – preparation of appropriate data on individuals which were retired in 2007 and are in the sample of households. In addition to substantive issues, also purely technical or legal problems concerning preparation, transmission and linking these data with the data in the sample had to be resolved. With these successfully undertaken activities we actually made additional step forward in linking statistical and administrative data at the level of individuals.

In the continuation of work on the development of the pension module we first developed the static version of the pension module. Because of the way of developing the model, already the static version of the module allows practical implementation – preparation of different possible simulations with discretely changing parameters on meeting conditions for old-age retirement as well as the level of old-age pension. Because of different conditions for men and women, and also because of different length of the period of successive implementation of current reform of the pension system, the module allows separate treatment by gender and is designed so as to enable simple upgrading of alternative pension systems. In the following chapters, we briefly summarize the research activities carried out in the framework of the third phase of the project.

5.1. Preparation of databases

Pension module represents one of the basic elements (modules) of the entire micro-simulation model and means substantial continuation of previous modules (demographic, economic, income-tax). Primarily it is based on data base with pension micro data for the period 2000-2007, which was prepared by Pension and Inability Insurance Fund. For the sample of old-age pensioners data base contains data on the level of wages, different periods (retirement qualifying period, insurance qualifying period, insurance period without bonus, special qualifying period, added qualifying period, years of service, purchased period), assessment of pension, gender and age. On the basis of these variables for each individual from the sample we first »reproduced« his old-age pension at the time of the retirement; this means that from
the data we calculated individual's pension rating base, day of retirement, accrual rate or the level of individual's pension.

Data on pensioners who are in the sample of households in the new base year 2007 and have retired in the period 2000-2007, enable us to de-activate old-age pensioners due to the extension of age at retirement for up to eight years. They will also serve us for the estimation of the correction of pensions for all old-age pensioners who have retired already before 2000 and are included in our sample of households.

Because of the changes in the structure of employees in time (mostly lengthening of the time of entry into an active period for younger generations), Pension and Invalidity Insurance Fund prepared also data base on wages histories for all employees in 2007, who are in our sample. On the basis of these data we could estimate the lag in retirement of the younger generations in the future years, as we expected that individuals would retire at the higher age regardless of the valid pension law, due to later entry in the active age as well as lower density of employment in a given year. Significant delay in the preparation of data for the development of the pension module which consequently led to the delay of planned activities in the framework of the project, is in the first place the result of the fact that these data were in fact for the first time prepared at the individual level for the selected sample of households and for individuals within them. Despite absolute willingness of representatives of both PIIF and Statistical office to do this, in practice quite some technical and legal barriers had to be overcome, which all required their time and foremost much patience of all those involved. Additional complication was due to considerable extension of the sample base of linked data. With always new variables included in the elementary database, the likelihood of detecting individuals in the sample rapidly increases. Consequently this means significant and growing necessary hiding of problematic variables, which leads to the impoverishment of the base and the loss of information. Searching the appropriate solution which would satisfy legal restrictions regarding the use of individual data as well as at the same time enable the use of data for the research purposes, thus represented a parallel, but very important activity which engaged all three groups: Statistical office, as a custodian and an authorized institution which can link various databases on the level of the individual, users - different ministries, and other government institutions, interested in the use of modeling tools, based on individuals, and researchers - who on the basis of linked databases develop, maintain and also use modeling tools.

Undeniable fact is that an outstanding work in the area of linking administrative and statistical databases has been done, which finally had its confirmation with their inclusion in the Annual program of statistical research of the Statistical office. After two linked databases for the sample of households for years 2004 and 2007, in May 2012 we acquired also the third with
data for 2010, to which some data on the monthly level have been added (employment, unemployment, pensions), as well as data on real estate. For health data we will have to wait for some time because of the prior adjustment of identification numbers of individuals in different databases which will first have to be interconnected. There is an agreement with the Statistical office that database for the sample of Slovenian households is to be prepared every three years, which coincides with the planned administrative census survey.

Constantly repeated fact that we have to deal with activities of obviously infrastructural nature (regular maintenance and development of both databases and modeling tools) unfortunately does not help with necessary transition of the manner of financing these activities towards regular funding. This is exactly why the new database for the year 2010 is not used on the new server in the Statistical office, as there is no new project forthcoming.

5.2. Pension module

Due to different conditions as well as different transition periods we organized the pension module in the following way: We separately treat old-age pensioners by gender and at the same time also divide the module into a static and dynamic part. Although we have available data for the base year 2007, year 2010 was taken as the base year with conditions for acquiring the entitlement to old-age pension as were in force in that year.

5.2.1. Static part of the pension module

Static part of the pension module reproduces the pension law in force in year 2010. Conceptually, it is divided into two parts according to the gender of the individual. This is due to different conditions of retirement applicable to men and women. Within each part the following sections are defined:

1) Conditions of fulfillment of the pension qualifying period and age. There are three basic combinations of fulfillment of the pension qualifying period and age, since according to the present system, men can retire when he fulfils:

- A: 40 years of pension qualifying period and 58 years of age;
- B: 20 years of pension qualifying period and 63 years of age;
- C: 15 years of insurance period and 65 years of age.
Similarly this is also true for women, except that boundary conditions are somewhat different:

- A: 38 years of pension qualifying period and 58 years of age;
- B: 20 years of pension qualifying period and 61 years of age;
- C: 15 years in insurance period and 63 years of age.

(These values for women are in force after the end of the transition period).

In the computer code itself the boundary conditions (A, B or C) are written in the form of variables, so that the user of the model can himself determine their level and combination. Let us add that in the phase of preparing the report we also started with practical implementation of the pension model for the needs to prepare the assessment of the effects of the new proposal of pension reform, as well as of several possible versions which emerged in the framework of negotiations with the social partners. Accordingly, we have intensively adjusted also the basic version of the model, which despite the generalized nature of its recording, could not capture some of the proposed variants of corrections. So we added the fourth condition (condition D), which enables additional flexibility of the pension model.
2) **Length of the period or the number of consecutive best years of completed years of service**, which are taken into account when calculating the pension rating base. The model allows choice of from one to forty best consecutive years (in present system, 18 best consecutive years are used) in the form of parameters, so that the user can choose any number of best consecutive years for the calculation of the pension rating base. According to the newest proposal of the reform of the pension system, which foresees the possibility of excluding one, two or three worse years, we completed the model code also with this possibility. In this way we can now combine any number of best years between 1 and 40, while also at the same time possibly excluding one, two or three worse years, for any year of the observation period 2010-2060.

3) **Micro-data about an individual** contain detailed information on pension qualifying period, insurance period, insurance period without bonus, added qualifying period and purchased period. All these periods are properly taken into account in the model, when we calculate pension base with the choice of the number of best consecutive years.

4) **The pension formula.** In the existing system the calculating accrual rate is the following one: for men 35% for the first 15 years, and then it increases by 1.5 accrual points for each additional year of pension qualifying period. For women it is 38% for the first 15 years, and then it increases by 1.5 accrual points for each additional year of pension age. (These values are valid for women after the end of the transition period). In the module’s program code the pension formula is written in the form of parameters, so that the user of the model can himself set the accrual rate to be used for an individual. The model also has transition periods built-in and special module is constructed which calculates sums of accrual rates, taking into account period before 1999 and after that year, of course by taking account of the accrual rates for individual years, which were still valid in the pension law in force before 2000. In the end, new procedure was also added for the calculation of accrual rates, as this was proposed in the latest reform proposal.
5) Pension formula is inseparately connected with bonus/malus system, which is the result of an early retirement or later retirement. Both of them are taken into account in the pension formula and are in the program written in the form which allows exclusion because of the new pension reform proposal. Extensive testing of the functioning of the model have shown that the model in the case of worsening conditions for retirement still works correctly, but can technically retire an individual who does meet conditions for an early retirement, but not also conditions for regular retirement and can thus, because of just one month, acquire a permanent maximum malus, which in practice most likely will not happen. Model could though be corrected so that it could allow retirement with maluses only to those persons who have actually already retired with maluses, however, this could be done only for men. For women, in the pension law presently valid, maluses still have not entered in force (this should happen in 2014). Taking into account all these considerations and the fact that both bonuses and maluses were in practice very rare (on average, the accrual rate was higher/lower up to 0.1 percentage point), we decided that otherwise modeled bonus/malus system should not be included in the model, as this would lead to a considerably smaller error. This at the same time means that we implicitly assumed that individuals would retire at the moment when they fulfilled the conditions for regular retirement without maluses.

6) The pension formula takes into account the number of children. In the present system for the first child retirement age is reduced by 8 months, for the second child by 12 months, etc. Number of children or in fact »old-age bonus« which they represent for
an individual, is in the program written in the form of a parameter, so that the user of
the model can set its value himself.

Figure 5.4: Decrease of retirement age because of children and limitations of this
decrease

7) Health care contributions for pensioners. In the present system contribution for health
insurance of the pensioners amounts to 5.96% from the so-called »gross« pension.
Percentage of this contribution is written in the program in the form of a parameter.

Final result of the static part of the pension module is the identification of an individual who
fulfills conditions for acquiring old-age pension, and the calculation of his old-age pension in
line with the parameters, set by the user of the model. Individual data are in the model
aggregated to the national level with the help of appropriate weights for the base year 2010.
They are represented in the form of aggregate amount of pensions, total number of pensioners
and total number of insured and employed persons.

Of course this part of the model primarily serves us, developers of the model, so that we could
on one year test correctness of the program code and solve potential problems and possible
mistakes. In the continuation of work, we made a step forward with dynamisation of the
pension module.
5.2.2. Dynamics in the pension module

Already developed demographic and economic modules and module for calculating weights enabled us to develop dynamic version of the pension model. In the demographic module we thus prepared appropriate projection of population for the observation period 2010-2060. Then we run the module for calculating weights, which allowed us to adjust the structure of population that we had in the base year to the structure and the size of population in any year of the observation period. By using weights we can thus bring in dynamics to the proper model, which allows us to simulate the consequences of population ageing on the long-term sustainability of the public finance.

Technique used is called »static ageing« of the population from the base year with the use of weights (Harding, 1993, p. 19). This technique in fact represents the so-called »cold-deck« imputation of the missing variables (Kalton, 1983). In the literature for this kind of models the term »static microsimulation models« is used, which can mislead uninformed readers, since we nevertheless deal with dynamic models, because of the inclusion of »time«, which is reflected in changing demographic circumstances (Dekkers, 1999, p. 12-13).

Essential difference in comparison with fully dynamic models is that individual data remain unchanged, while just weights are adjusted to changes in the number and structure of population in the future. These models are technically simpler (of course in comparison with fully dynamic models), as we can directly simulate just one chosen year without having to simulate also all the years between the base year and the chosen year. On the other hand, they have also disadvantages compared to fully dynamic models, namely, in the absence of flexibility and in the fact that they do not have »memory«. For example, we cannot calculate the income of an individual in the course of his life-cycle, as in this kind of the model an individual is not born, grows old and dies. In addition, simulation calculations for certain year do not affect calculation for any other year, as both of them are calculated directly from the data of the base year (Dekkers, 1999, p.14).

Adjusting the basic model

Essential question even before preparing the project proposal was: What type of model should be developed for the purpose of assessing the consequences of the foreseen pension reform? External adviser, who advises us on the project, suggested that in the circumstances of lack of time and resources we should follow the usual logic of developing tools in steps. Therefore, from the classic static model we should continue with the next phase of the model and use static ageing of the population. Of course, we were constantly aware of the problem of transition periods of the present pension system as well as of expected new transition
periods of the proposed reform of the pension system. We adjusted the pension module accordingly.

Given the fact that we start from the base year and that basic data factually do not change - only weights change and some used macroeconomic aggregates which are either exogenously given from outside the model (growth of labor productivity) or are partially dependent also on the model itself (growth of GDP, which is beside the growth of labor productivity dependent also on the growth of employment) - we carried out some adjustments of the classic model with static ageing. These adjustments enable increased flexibility of the model and thereby help solving the problem of changing conditions of retirement in time.

Adjustment of retired in 2000-2007

For this adjustment we had to prepare appropriately supplemented basic database. For individuals who were included in the sample of the base year 2007 and have retired in the period 2000-2007, we acquired their wage histories and other data which would enable us assessment of implications of rising the age/pension qualifying period of up to eight years. Basic logic we followed was that if individuals remain »captured« in the base year, we can at least virtually move them in time, by bringing to them conditions for retirement from some arbitrary year and in the next step check whether with this new values of parameters they still fulfill conditions for retirement or not. If they do not, they lose the status of pensioners and become active again – thereby causing a reduction in the number of pensioners, in the costs of the pension fund, as they get their wages, start paying social contributions and contribute additional sources to the budget by paying income tax. If, on the other hand, they fulfill them, we calculate their pension anew according to new conditions.

How can we solve the policy measure of, for example, raising retirement age for three years? Considering the fact that most people retire as soon as they fulfill the minimum conditions for retirement, the consequences of such raising of retirement age would not be correctly assessed, as we only have available pensioners in the base year. However, it should not be forgotten that in the base year we have data also on pensioners which retired in the 2000-2007 period. They cannot be shifted, but we can adequately correct individual variables from the year of retirement (say 2003) into the base year 2007 – we recalculate what values of variables a person would have in the base year (age, years of service, pension qualifying period, insurance period) and see if he could still be retired according to conditions in force in 2007. The more they are further away with their actual year of retirement from the base year, the lesser is the likelihood that they would not fulfill conditions for retirement. With such corrected base now we can carry out scenario of raising retirement age for three years and the
estimation of the number of activated retirees would now be more precise, since we adjusted for eight generations of old-age pensioners their retirement values to the base year 2007.

Next problem which needed to be solved, due to using just old-age pensioners from the base year (and remaining old-age pensioners from the period 2000-2006) was the question of reality of the assumption that future old-age pensioners would be by their characteristics similar to those of today. We tried to solve this with the use of wage histories of individuals who were in the base year 2007 still active. We analysed if the same generations of men and women have in time similar number of years of service. Given the limitations of data on wage histories for the period up to 1970, we could with sufficient quality identify possible differences in working period for old-age pensioners, who were in the base year 2007 between 26 and 33 years old and the same generations before 24-17 years (thus being 50 years old in the base year). Results have shown that present generations of 26-33 years old have on average 1.5 years (men) or 3.2 years (women) less years of service. Because of later entry in the active age and lower density of employment, younger generations will in the future retire at higher age than generations that will retire already in the next ten years, regardless of the pension law in force. These calculations were therefore directly built in the pension module, so that we successively lowered for male and female old-age pensioners pension qualifying period, insurance period and insurance period without bonus in the period of twenty years with the beginning moved ten years from the base year. After thirty years the reduction remains unchanged.

Taking into account transition periods and changing of parameters in time

An important shortcoming of the pension model with static ageing is its inability to take into account transition periods or start of reforms in a particular year of the observation period (Dekkers, 1999, p. 27). By appropriate adjustment of the basic version of the model this problem has been solved, so that in the model we can also take into account both transition periods and changes of individual parameters in any year. We have already developed above mentioned procedure of »shifting« in time eight generations of old-age pensioners (retired in period 2000-2007) and identifying whether an individual still fulfills conditions for old-age retirement or not. If he fulfills conditions which should be in force in certain year, say 2020, we calculate his new pension assessment base, accrual rate and the new pension.

By comparing total amount of pensions of old-age retired in the particular year and the total amount of pensions of the same retirees, which would otherwise be valid in the same year and all other unchanged conditions (this means under conditions of the present pension law), we in the next step calculated average change of the old-age pension in the given year. This change was subsequently used for the correction of pensions for the remaining old-age
pensioners, who have retired already before 2000 and for who we did not have data on their wages histories. Correction was done with the use of the so-called »main diagonal«, by which we - on the assumption that an old-age pensioner retires on average at the age of 59 (women at the age of 54) – searched for the distance of an individual from the average retirement age with respect to his age in the base year. In this way we defined the year whose average change in pensions due to pension reform we then used for the correction of pension for the old-age pensioner retired before 2000.

For disability and survivor pensioners this procedure was carried out separately. We started from the fact that assumed increase in the retirement age or extension of the pension qualifying period does not affect this type of retirees. At the same time, changes of parameters which affect the level of pension (increase in the number of years for the calculation of the pension assessment base, change in the level of accrual rates, indexation of pensions, etc.) also affect the change in the level of these pensions.

**Adjustment of pensions in time and calibration**

In the next step we also had to carry out adequate adjustment of pensions in time which is in effect dependent on the assumed indexation of pensions. This adjustment had to be executed again with the use of the so-called »small diagonal«, as we in a way had to take into account retirement of the future generations of pensioners, whose wages will until the moment of retirement grow by a certain rate (for instance by the rate of labor productivity growth), and after retirement the pensions will adjust by the rate which could be lower than the growth rate of the labor productivity. With adjusting the number of active years and years after the retirement, we actually simulated generating of new generations of pensioners in the environment of the pension model with the static ageing.

![Figure 5.5: Indexation of wages and pensions](image)

Results obtained for the base year 2010 were finally compared to the actual values with the purpose of calibrating the model. We followed the principle that we do not calibrate the number of insured, employed and retired separately, as the use of weights takes care of that itself. Comparison of the number of insured persons and pensioners with the actual values has shown that model results do not completely match the reality, but the differences were in fact very small. If we deduct from the total number of insured persons (PIIF, Annual report for
year 2011, Table II.1. p.10), unemployed persons which were not modeled, the difference with the actual number of insured persons is just 0.2%. On the other hand, the difference to the total number of pensioners is +0.7%, but we have to take into account that we have included also pensions that are sent abroad.

With such minor differences in the number of pensioners, a rather small difference in the total amount of pensions was also expected. In the comparison we took into account the latest data which have been sent by the Ministry of Finance – the aggregate contains data on the total amount of pensions for all types of pensions, together with the annual supplement, but without state pensions. Factor for the calibration of total mass of pensions in the base year 2010 was just a good percentage, as total amount of pensions calculated by the model was just 30 millions € lower from the actual amount of pensions of 3,973 million €.

5.2.3. Results of the pension module

Final version of the pension module enables reproducing the pension system presently in force, including with taking account of the remaining transition period of the current reform until the full implementation in year 2024, with simulating the functioning of the system till 2060. At the same time, with the use of parameters it enables preparation and execution of any chosen scenario of changes in the pension system presently in force. Additionally, we have built in the possibility of implementing proposed changes in the pension system (ZPIZ2), which required additional adjustments of otherwise generalised version of the pension module. Reform can be started in any chosen year, while up to that year the pension system currently in force is taken into account.

Figure 5.6: Additional parameters for the proposed pension reform (ZPIZ2)
Obtained results are written down for each year of the observation period separately and are the following: total number of pensioners, total number of insured persons, total number of employees, average amount of the pension, total amount of pensions and share of pensions in GDP. At the same time the module in a separate data file writes down new values of wages of employed (indexed by the rate of growth of labor productivity), which includes also possibly newly activated pensioners, due to the proposed policy measure in the area of the pension system, and the newly calculated pensions. These two variables are inputs into the income-tax module of the pension model and thus enable the assessment of the changes in income tax and social contributions due to the changes of the pension system.

Figure 5.7: Final results of the pension module

Figure 5.8: Results of pension module for income tax and economic module
5.3. NDC scheme

Pension system allows for modeling of all boundary conditions which are used for the old-age pension, i.e. for the identification of entitlement to the pension as well as for calculation of the amount of individual's pension. Module separately treats both genders and can be used for the estimation of the impact of the changes in the present pension legislation. At the same time, mere design of the module enabled upgrading for the simulation of alternative pension systems, such as the system of individual or notional pension accounts (NDC) and the point system.

With this in mind in the framework of the pension module we developed a special sub-module which allows for simulation of the system of notional accounts. In the NDC scheme each individual has a specific "account" opened, which precisely records his paid contributions, which on this "account" also virtually earn interest. Notionally, because the money “paid” to the "account" does not remain there, but is spent for the pensions of currently retired generation. When one retires, it is checked how much is recorded on his "account" and on the basis of this amount his pension is determined.

![Figure 5.9: Parameters for NDC scheme](image-url)

This system takes into account also some other parameters, such as gender and age. Functioning systems with NDC scheme are in practice extremely rare and very complex, with a series of well-defined parameters prescribed by the relevant pension legislation in these
countries. In modeling NDC schemes, we followed their basic logic. Model for an individual calculates net present value of his contribution on the day of his retirement (with the user setting the discount rate himself). From the amount thus calculated the model calculates a lifetime annuity or the pension, taking into account individual's age and the discount rate (which may be different from the discount rate used to calculate the net present value of contributions). Other parameters on which any eventual Slovenian system could be based are not known, and can be programmed when they will be communicated to us.

5.4. Linkages with other modules

The next and very important step in the development of the model is the presentation of linkages of all developed modules and connecting them into a single system, which enabled the use of dynamics. In this step, the process of appropriate calibration of variables to exogenously given aggregate values was particularly difficult, but also of key importance for ensuring adequate quality of the model.

Pension module is thus both on input and output side linked with other modules of the entire system. Linked modules form the pension model which itself is additionally linked to the model of generational accounts, built in the economic module. Linkages among modules which are presented on Figure 5.10 are the following: a) demographic module generates projections of the population of Slovenia by gender and age for the observation period, b) on the basis of population projections appropriate weights are calculated for each individual in the sample. With their help we can reproduce the structure of population by gender and age in any year of the observation period 2010-2060, c) weights enter the pension module and enable dynamization, i.e. treatment of changes of the pension system and their consequences in time, d) pension module calculates the amount of pensions, number of pensioners, insured and employed persons by gender and one-year intervals, which are themselves an important input for the economic module (and model of generational accounts), e) at the same time it provides data on gross wages and pensions to the income-tax module which can calculate the consequences of changes in the pension system also for the revenues of the budget – income-tax and social contributions, an finally, f) income-tax module provides data on paid income-tax and social contributions to the economic module.

In the framework of graphic interface we have linked individual modules among themselves and thus constructed the pension model which is at the same time also linked to the model of generational accounts, set in the environment of the economic module. For an easier organization of the essential databases, those generated in the process of performing individual modules, as well as those with the results of particular scenarios, a special data warehouse was developed.
Figure 5.10: Scheme of linkages among individual modules
6. GRAPHIC INTERFACE

6.1. Basic concepts

Simulation environment Microageing is used for preparing, carrying out and checking the results of simulations. Environment unites different microsimulation modules; with their combinations, analysis of different kinds can be performed. Beside programming modules themselves, environment also includes datasets which are the basis for the preparation of calculations.

6.1.1. Simulation modules

Environment is composed of the following elements:
- demographic module;
- module for the calculation of weights;
- pension module;
- income module;
- economic module.

For an easier work, modules are united into a unified environment with which the user communicates through users' interface. With its help, values of parameters for the execution of simulations are prepared, simulation experiments carried out and results checked. Groups of values of model parameters (such as for the area of demographics) can be stored for the later use in the data warehouse. Linked database is also stored there.

6.1.2. Work with the user interface

The basis for the work in the Micro-ageing environment are the so-called scenarios. A scenario is an Excel table which contains in advance prepared sheets, whose form and content is prescribed. Sheets can be of various kinds:
- Sheets with basic settings of the experiments (»Osebnaizkaznica«, Figure 6.2.),
- Sheets with the model parameters,
- Sheets with model results,
- Ordinary sheets.

Before carrying out simulation experiment, most important are the sheets of the scenario which contain model parameters. Values of model parameters can be changed by the user. For the better transparency, parameters are divided by their content into several blocks, i.e.
policies. Individual policies are represented with a list in the table. Scenarios envisage the following types of policies:

- demographic movements (sheet maDemografska gibanja),
- economic assumptions (sheet maEkonomskePredpostavke),
- income tax arrangements (sheet maDohodnina) and
- terms of retirement (sheet maUpokojevanje)

**Figure 6.1: Sheets with types of policies**

Beside these sheets/policies, a special sheet with the name Identity card (maOsebnaIzkaznica) is available (Figure 6.2). It contains the basic parameters of the simulation experiment which the user himself can set. On this list the type of simulation model and the most important parameters for the individual types of the model can be chosen.

**Figure 6.2: (Osebna izkaznica) - Identity card**

After the simulation experiment is performed, results of the simulation are written on a new sheet, named according to the type of the chosen model, but it has always the preposition »Rez«. The structure of the presented results depends on the type of the chosen model.
Simulation environment allows for copying policies among individual scenarios (in the technical sense copying sheets with parameters among different tables), but it contains also the so-called data warehouse, where individual policies can be deposited or from where they can be included in the newly performed scenario. In the next section it is described how this is done.

6.2. Work with scenarios and policies

Production of the new scenario

When starting simulation environment, a scenario with adopted values of parameters opens. If we want to make a new scenario when simulation environment is already opened, we choose the command Microageing / Nov scenarij (New scenario).

In practice, this can lead to three different situations:

a) If we chose the command when the usual Excel table is active, Excel asks whether we want to add sheets with policies to the table. If we choose »yes«, sheets with policies will be added to the table (such an adjusted table has to be saved with the command Microageing / Shrani kot scenarij (Save as scenario). If we chose »No«, Excel will create a new, empty table, furnished with policies sheets.

b) If we choose the command when the table which already contains sheets with policies is opened, Excel asks whether we want to create a new table with policies. If we choose »yes«, Excel will create a new, empty table, furnished with policies sheets. If we choose »no«, Excel does nothing.

c) If we choose a command, when we do not have any opened table, Excel will create a new, empty table, furnished with policies sheets.
A new scenario behaves like a usual table, but it contains special sheets (as described in the section Basic concepts). If we have at the same time opened several scenarios, we switch among them as we switch among several simultaneously opened ordinary Excel tables.

**Opening of the existing scenario**

A scenario, saved in a dataset system can be opened so that we choose the command Microageing / Odpri scenarij (Open scenario) and find the scenario in the addresses book.

**Saving a scenario**

A scenario is saved as a file of the type '*.ma.xlsm' so that we first chose him as active (for instance View / Switch Windows) and then use command Microageing / Shrani kot scenarij (Save as scenario). With the chat window which opens, we define into which addresses book we want to save the scenario, as well as the name of the file.

**Copying an element into another scenario**

If we want to copy an active scenario into some other scenario, the latter must be open beforehand. The procedure is the following:
- We check if the scenario into which we want to copy the policy, is open; if not, we have to open it first (see the section Openning of the existing scenario);
- We activate the scenario which contains the policy we want to copy (say with the command View / Switch windows);
- We display the policy we want to copy (say with Microageing / Prikaz elementov (Presentation of elements) /<chosen policy>);
- We choose the command Microageing / Kopiraj te elemente v drug scenarij (Copy these parameters into another scenario);

Figure 6.6: Choice of the command Microageing / Kopiraj te parameter v drug scenarij (Copy these parameters into another scenario)

- In the chat window we choose the scenario into which the policy should be copied and click OK.

Figure 6.7: Chat window Kopiraj parameter (Copy the parameters), in which we choose the scenario into which we want to copy the sheet with parameters

**Warning:** Sheet with parameters which we copy will run over the existing sheet of the same kind in the targeted scenario (if we for instance copy income tax parameters, these will be in the targeted scenario substituted with those from the baseline scenario. Retrieving is not possible if such a changed targeted scenario is then saved on a disc.
6.3. Data warehouse

Data warehouse is a special memory unit on the disc, where we can deposit individual sheets with parameters or from where we can include them in a scenario if we want so. Data warehouse thus enables production of type of policies which can be saved and reused in some other scenario. A shorter description or metadata can be added to individual saved sheets.

6.3.1. Saving the elements in the data warehouse

If we want to save certain policy from an active (currently opened and displayed) scenario into data warehouse, we first display it (for example with Microageing / Prikaz elementov (Presentation of elements) / <chosen policy>) and then choose Microageing / Dodaj parameter v skladišče (Add the element into the warehouse). A chat window is displayed where we define the name of the element which can be descriptive (we can use various alphanumerical symbols). It is desirable that a description should be added to the element, which more precisely defines the content of the element (description should be added to the field Opis elementa (Description of the element)). The field Vrsta elementa (Type of element) explains which policy is in question and it is not possible to change it.

![Figure 6.8: Choice of the command Microageing / Dodaj parameter v skladišče (Add the parameter into the warehouse)](image)

After we press the OK button, the policy is stored in the data warehouse.
6.3.2. Use of the stored elements

If we want to use the element stored in the data warehouse, we activate the scenario in which we would like to use the element and choose Microageing / Odpri skladišče (Open the warehouse). In the chat window displayed we first chose “Vrsta elementa” (Type of element - demographic movements, incomes profiles, etc.), on the lower sheet mark the desired element and click the button “Uporabi element” (Use the element). Before that, we can check the description of the element which is displayed in the central part of the chat window for the chosen element.

6.3.3. Changing the names and descriptions of elements in the data warehouse

The name and description of an element in the data warehouse can be corrected so that we choose Microageing / Odpri skladišče (Open the warehouse). In the chat window displayed we first choose “Vrsta elementa” (Type of element) - demographic movements, income profiles, etc.-, on the lower sheet mark the desired element and click the button “Uredi element” (Edit the element). In the chat window we can complete the name and description of the element. After clicking OK button the changes are stored in the data warehouse.
6.3.4. Deleting elements from the data warehouse

An element from the data warehouse can be permanently deleted by choosing Microageing / Odpri skladišče (Open the warehouse). In the chat window displayed we first chose the “Vrsta elementa” (Type of element) - demographic movements, income profiles, etc. -, on the lower sheet mark the desired element and click “Briši element” (Delete element) button (see Figure 6.11). Chosen element is permanently deleted from the data warehouse. If this element has ever been used in the production of some scenario, it will still stay there unchanged; it is deleted only in the data warehouse.

6.3.5. Displaying and hiding elements of the scenario

Figure 6.12: Menu for quick switching of presentation of individual sheets with parameters
For the better transparency, simulation environment allows for temporary hiding and displaying of the chosen elements of the scenario. If we do not determine otherwise, the new scenario displays only the “Osebna izkaznica” (Identity card) element. Other elements can be displayed by choosing command Microageing / Prikaz parametrov (Display of parameters) / <chosen policy>. All elements at the same time can be displayed with the command Microageing / Prikaz parametrov (Display of parameters)/ Prikaži vse (Display all). Elements can be hidden with the command Microageing / Prikaz parametrov (Display of parameters)/ Skrij vse (Hide all).

6.3.6. Performing simulation experiments

Simulation experiment is made in several steps:

- We produce a new scenario or we open the existing one;
- We set the type of simulation model in the identity card;
- We complete its policies or reuse some policies which were beforehand stored in data warehouse; policies can also be copied from some other scenario;
- We choose command Microageing / Poženi simulacijo (Start the simulation).

![Image](image.png)

**Figure 6.13: Choice of the command Microageing / Poženi simulacijo (Start the simulation)**

After calculations are done, the sheet with results of the experiment is displayed. The table is not saved by itself, so it is recommended to save it.

A scenario can be completed and the calculations can be restarted. In this case the sheet with the original results will not be copied with new ones, but the new sheet with the preposition 'Rez' will be created.

The sheet with the results can be quickly displayed with the choice of Microageing / Prikaži rezultate (Display the results). If in the scenario we have several sheets with results, consecutive use of this command cyclically displays sheets with the results. It is recommended to delete sheets we do not need at the end of work with specific scenario – thus
we will have the scenario results and all the parameters used in the new (or old, but rewritten) file.

![Figure 6.14: Choice of the command Microageing / Prikaži rezultate (Display the results)](image)

### 6.4. Inputs and outputs of individual modules

For proper functioning the modules require parameters, which can be determined by the user on policies sheets, basic sample database on data files and results of the other modules, which are in data files or in results sheets.

#### 6.4.1. Demographic module

For its functioning, the demographic module needs a reasonable set of parameters on the sheet “maDemografska gibanja” (Figure 6.15). Modul is started so that on the identity card we choose “Demografski model” (Figure 6.16) and select Microageing / Poženi simulacijo (Start simulation). After the execution of simulation, results will be shown on the sheet named RezDemogr.
6.4.2. Module for calculating weights

Module for calculating weights needs results from the demographic module for its functioning. In addition, we need to determine which data file with basic micro data it should
take as the basis. We also have to define the name of the data file on which newly calculated weights should be written. These three things are determined on the “Osebnaizkaznica” (identity card) sheet (Figure 6.17).

After we set inputs and outputs of the module, on the “maOsebnaizkaznica” (identity card) sheet we select “Uteževanje (Weighting)” as a type of simulation model and press button command Micro ageing / Poženi simulacijo (Run simulation).

6.4.3. Pension-income-tax module

Pension-income-tax module for its functioning needs data file with basic micro data, data file with weights (as the result of the module for calculating weights) and a reasonable set of parameters on sheets “Maupokojevanje” and “maDohodnina” (Figures 6.18 and 6.19). Before the execution of simulation, we have to set which regulation (ZPIZ-1, existing pension system or ZPIZ-2, proposed new pension system) the pension module should take into account in calculations (Figure 6.20).
Figure 6.18: Preparation of parameters for the income tax module

Figure 6.19: Preparation of parameters for the pension module
After we have set inputs and outputs of the model, we choose “Pokojninski-dohodninski” as a type of the simulation model and press button command Microageing / Poženi simulacijo (Run simulation).

6.4.4. Income-tax module

Income-tax module for its functioning needs data file with basic micro data, data file with weights (as the result of the module for calculating weights), data on statuses of individuals, which is prepared by the pension module, and a reasonable set of parameters on the sheet “maDohodnina” (Figure 6.18).

After we have set inputs of the module, on the “maOsebnaizkaznica” (identity card) sheet, we chose “Dohodninski” as a type of simulation model and press button command Microageing / Poženi simulacijo (Run simulation).
6.4.5. Economic module

Economic module for its functioning needs results from the demographic module, results of the pension-income-tax module and a reasonable set of parameters on the sheet maEkonomikskePredpostavke (Figure 6.22).
Figure 6.22: Preparation of parameters for the economic module

Results of demographic and pension-income-tax module are on the sheets REzDemogr and RezPokDoh. These can be obtained so that before the economic module we run demographic and pension-income-tax module. We can obtain them for example from data warehouse or from other scenarios (or tables for already executed simulation experiments). Names of these sheets must be defined on the “maOsebnaizkaznica” (identity card) sheet before running the economic module (Figure 6.23).
After we have set inputs of the module, on the »maOsebnaizkaznica” (identity card) sheet we select »Ekonomski« (economic) as a type of simulation model and press the button Microageing / Poženi simulacijo (Run simulation).

6.4.6. Interdependence of the modules

As is evident from the descriptions above, the modules are interdependent, as they exchange data through data files with micro data (weights and status) and results sheets (demography, pension-income-tax aggregates). The basis for most modules is the basic micro base. All modules, except for the module for calculating weights, require setting input parameters on policies sheets. Before performing calculations according to particular module we must on the »maOsebnaizkaznica” (identity card) sheet define from where the module obtains data and where it writes them to. Interdependence of the modules is presented in Figure 6.24.

**Figure 6.23: Preparing the results of demographic and pension modules for the economic module**
<table>
<thead>
<tr>
<th>Micro bases</th>
<th>Modules</th>
<th>Results on sheets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Demographic</td>
<td>RezDemogr</td>
</tr>
<tr>
<td>Weights</td>
<td>Weights</td>
<td>RezPokDoh</td>
</tr>
<tr>
<td>Status</td>
<td>Pension</td>
<td>RezEkonom RezDlgVzd</td>
</tr>
<tr>
<td></td>
<td>Income tax</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Economic</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6.24: Interdependence of modules
7. CONCLUSIONS

In this Working paper we summarized research activities undertaken during further development of the pension model. Substantial part of time was devoted to the completion of the pension module. With constructed matrix of the conditions for old-age retirement for both genders separately, the module enables simulation of the continuation of the reform of the existing pension system, which will be fully implemented by 2024. An additional sub-module was added that allows simulation of the system of notional accounts. The next very important step in developing the model was the integration of all developed modules into a single system that allows the use of dynamics. In parallel, developed graphic interface in practice links the modules into a microsimulation pension model as well as links the two models - pension model and model of generational accounts. At the same time, it allows independent work with each module separately, as well as the work with the basic data stored in a data warehouse.

Developed simulation platform enables elimination of restrictions on the applicability of the static micro-simulation model and generational accounts model arising from a static approach and the cohort level. It is in fact the result of the necessity to adequately adapt both tools to be able to provide a quality assessment of the proposed changes of the pension system. Developed simulation platform represents the first such tool and provides the first dynamic microsimulation pension model developed in Slovenia.

With the pension model that uses the concept of static aging, an important step forward towards the introduction of full dynamics in the microsimulation model has been made. In the process of development of the model we have successfully resolved some important limitations of this type of dynamic models and developed the final version of the model, which allows the user to carry out scenarios with transition periods and change the parameters in any year of the observed period 2010-2060.

Research activities within the project represented a logical continuation of the work on the development and maintenance of the existing microsimulation model, by adding time dynamics and the possibility of building a new pension microsimulation model. It allows, in addition to more accurate assessment of the effects of the proposed reform of the pension system, research in the areas of income tax system, social security contributions and demography, health and long term care systems, as well as of long term sustainability of public finances.

Main realised results of the project are the following:

a) Established system of linked statistical and administrative data bases (households and relations among the members, education, activity status, income statements, real
estate, social transfers and subsidies, pensions, health) for the sample of 40,000 households with about 115,000 individuals;
b) Developed new dynamic framework for the existing static microsimulation model;
c) Developed new pension module linked with the other modules (income tax, demographic, and economic) into the pension microsimulation model within the graphic interface;
d) Use of the new model for the assessment of the effects of proposed pension reform;
e) Delivery of the simulation platform to the relevant ministries to enable its use for a more efficient decision making in the areas of demography, personal income tax and social security contributions, the pension system, health and long term care systems, and long term sustainability of public finances.

The results obtained provide quality inputs also for other developed analytical tools, such as dynamic CGE model, which is used to assess the complex effects of the proposed reforms in the areas of taxes and social security. As the proposed research activities are of the infrastructural nature, they should continue also after the end of the project.

And last but not least, graphical interface connects the individual modules in the user-friendly environment that allows the use of the individual modules as separate models, as well as now two linked models – microsimulation pension model and the generational accounts model. With this and added data warehouse it represents an effective simulation platform in the areas of demography, income tax and social security contributions, pension, health and long term care, long-term sustainability of public finances and the analysis of the effects of actions on a particular generation.

The existing use of the static version of the microsimulation model in practice has certainly demonstrated the great usefulness of this tool. Its usefulness increased further with the development of the dynamic model framework and the so far missing pension model. The tool allows an active participation of the policy makers in the preparation of proposals of policy measures or reforms in different already mentioned areas as well as the estimation of the consequences of proposed measures. Together with the computable general equilibrium model of the Slovenian economy, we will thus be able to answer the question what are the macroeconomic consequences of the proposed policy measures. The usefulness of the generational accounts model, now linked together with the pension model, will be significantly increased and will allow for the preparation of high-quality simulations of long-term public finance sustainability of the pension system as well as of the system of health and long-term care in the context of the Stability Program.

Necessary follow-up work on the construction and updating of the microsimulation model as a tool of infrastructural nature (development module for health and long-term care, education, adaptation of existing modules to a new dynamic framework, regular maintenance and further
development of the model) would for many ministries enable rapid and effective monitoring of the effects of particular proposed policy measures or proposed reforms at the micro level – on the situation of an individual or any group of typical selected individuals or families - as well as at the macro level.
8. LITERATURE AND SOURCES


Sources

#Further_Eurostat_information

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