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WHAT ARE THE CONSEQUENCES OF THE AWG-PROJECTIONS FOR THE ADEQUACY OF SOCIAL SECURITY PENSIONS?

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Executive Summary

Europe faces important demographic changes in the coming decades, changes that will have economic and budgetary consequences. The Economic Policy Committee (EPC) established the Ageing Working Group (AWG), one of whose tasks it is to assess the long-term sustainability of public finances in the long term. It does so by presenting a set of public expenditure projections for all member states, including on pensions. These projections are based on demographic forecasts provided by Eurostat and agreed assumptions on key economic variables.

To date, the projections that member states produce for the AWG include only a limited notion of pension adequacy, being the replacement rate. Other aspects, including the poverty risk among the elderly, and income inequality, are not considered. The assessment of adequacy of pensions is the work of the Indicator Subgroup (ISG) of the Social Policy Committee (SPC).

Even though the sustainability and adequacy of pensions are two sides of the same coin, the work of both committees is separated. This project aims to set a first step into integration by assessing the consequences of the AWG-projections and assumptions on the adequacy of pensions.

In the context of a European-funded sixth framework project called AIM, a dynamic microsimulation model MIDAS is being developed for Belgium, Germany and Italy. This is a joint effort by three institutions, the German DIW, the Italian ISAE and the Belgian FPB. This model simulates future developments of the adequacy of pensions, following wherever possible the projections and assumptions of the Ageing Working Group.

This paper starts by describing the model MIDAS in detail. It next presents and discusses some simulation results for Belgium, Germany and Italy. Finally, the simulation results of two alternative policy scenarios are presented and discussed.

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Contents

1. Introduction and overview of this report

Gijs Dekkers

1.1. Ageing and the sustainability and adequacy of pensions

Europe faces important demographic changes in the coming decades. These will have profound consequences on both the sustainability and adequacy of social security, including pensions. Traditionally, the assessment of these consequences on the European level was primarily concerned with the sustainability issues. Indeed, the long-term sustainability of public finances was considered an important part of the Stability and Growth pact. Already in 1974, the European Council decided to set up the Economic Policy Committee (henceforth EPC) to contribute to the work of the Council (ecofin), by focussing on structural policies for improving growth potential and employment. The Economic Policy Committee established the Ageing Working Group (henceforth AWG), one of whose tasks is to assess the long-term sustainability of public finances in the long term. It does so by presenting a set of public expenditure projections for all member states, including on pensions. These projections are based on demographic forecasts provided by Eurostat and agreed assumptions on key economic variables.

To date, the projections that member states produce for the AWG include only a limited notion of adequacy, being the replacement rate. Whereas the decision to set up the EPC was taken in 1974, it was the Amsterdam Treaty of November 1997 that introduced the fight against social exclusion as a field where Europe should not stand idle.[1]

However, the sustainability and adequacy of pensions are two sides of the same coin. It is becoming increasingly clear that the assessment of sustainability is not very meaningful without considering current or prospective developments in adequacy, and vice versa. This project aims to set a first step into integration by assessing the consequences of the AWG-projections and assumptions on the adequacy of pensions in Belgium, Germany and Italy.

But what does adequacy really mean? Even though safeguarding the adequacy of pensions is an important objective of the European Open Method of Co-ordination, the concept itself remains undefined. According to Lusardi *et. al.* (2008, 8), the notion of adequacy of pension systems embeds the prevention of social exclusion, the maintenance of living standards at retirement and the promotion of solidarity. They quote Holzmann and Hinz (2005) who define as *adequate* a pension system that provides benefits that are sufficient *to prevent old-age poverty* on a country-specific absolute level, in addition to providing a reliable means *to smooth lifetime consumption* for the vast majority of the population.

1 See EC (2008), article 136 and 137.

Lusardi et al. (op. cit) then define a pension system to be adequate when it provides means for individual consumption smoothing, and reduces inequality and poverty.

1.2. Why microsimulation, and why MIDAS?

In the context of the AIM project, a dynamic microsimulation model MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability') is developed for Belgium, Germany and Italy. The development of this model is a joint effort by three institutions, the German DIW, the Italian ISAE and the Belgian FPB, with the last also holding general management. The aim of MIDAS is to simulate future developments of the adequacy of pensions, following wherever possible the projections and assumptions of the Ageing Working Group. This way, a simultaneous assessment of the sustainability and adequacy of pensions and pension systems in Belgium, Italy and Germany becomes possible.

Technically speaking, MIDAS is a dynamic population model with dynamic cross-sectional ageing. This means that it starts from a cross-sectional dataset representing a population of all ages at a certain point in time, in this case the PSBH dataset for Belgium in 2002, the SOEP for Germany in 2002 and a compound dataset based on the ECHP, for Italy in 2001. From that starting year on, the life spans of individuals in the dataset is simulated, together with their interactions. So new individuals are born, go through school, marry or cohabit, enter the labour market, divorce, retire and, finally, die. All these main events in a life time are simulated by the model. During their active years, they build up pension rights, which result in a pension benefit when they retire. In the second chapter of this report, microsimulation models (henceforth MSMs) are classified, and the simulation properties of models in this classification are discussed. Then the above definition of adequacy and its goals are linked to the simulation properties of MSM's in general, and specifically of MIDAS.

1.3. LIAM and its alignment properties

The model MIDAS is written in the programming language LIAM (the Life-cycle Income Analysis Model), which was designed for this purpose, and which was further developed by the FPB. It is a flexible computing framework designed to create a dynamic microsimulation model. The principle computing characteristics include the degree of modularisation, parameterisation, generalisation and robustness.

As said, the aim of MIDAS is to simulate future developments of adequacy between 2002 and 2050. It does so taking into account wherever possible the projections and assumptions used in the context of the Ageing Working Group. In order to do this, the LIAM language has one very important feature, and that is that it allows for 'aligning'. This ensures that aggregates from the micro model match macro aggregates. Chapter 3 of this report will discuss LIAM in more detail, and will also include an overview of the functionality added to it in the context of this project.

1.4. An overview of MIDAS

The microsimulation model MIDAS consists of different modules, being the demographic module, the labour market module and the pension module. The demographic module is for the three countries developed by the Federal FPB; the common labour market module is developed by the DIW and each partner is obviously responsible for the development of its own pension module. The fourth chapter of this report contains a general description of the three modules. Each description will be followed by a presentation and discussion of the estimation results of the behavioural equations in MIDAS. This will remain however rather limited. This is first of all because behavioural equations are not the main point of focus of this study, but serve only to describe and explain simulation results. Secondly, these estimations are often ad hoc and not driven by theory.

1.5. Results for Belgium, Germany and Italy

The fifth chapter of this report will be presenting and discussing simulation results of MIDAS. These start in 2001 (Italy) or 2002 (Belgium and Germany), and simulate up to 2050 using wherever possible the projections and assumptions of the AWG.

As these empirical results are obviously country-specific, this fifth chapter will be divided into three main parts, for each separate country. If possible, this chapter tries to explain these results using a technical or economic rationale. However, as with all microsimulation models of this type, MIDAS is subject to what might be called the "black box criticism". It can be very difficult to explain the development of variables that describe a certain state, and especially to relate the development of this state to certain causes. This is because a state is the result of inflow and outflow on the individual level. This in turn is the result of state-dependent logits, each with its own explanatory variables. For example, if we want to explain the proportion of workers having a fixed contract or tenure, then the inflow comes from two states (being not in work, being in work with a temporary contract) for men and women separately (so four states in total) while outflow is one state for men and women separately.

Furthermore and before discussing the simulation results of the model, it is important to realize that the information that the model uses -and therefore that it produces- is self reported information by the respondents. For example, whether or not an individual works in the public sector or not depends on his or her personal definition of what the public sector is. This may or may not be in conjunction with any formal definition of the word. Another situation where this may have its effect is in the difference between retirement, conventional early retirement (CELS), or unemployment. Formally, somebody who is a CELS-beneficiary is in unemployment. However, they might consider themselves retired as well, or neither of the two. This subjectivity in the data is not problematic per se, but makes it difficult to compare simulation results with exogenous official data.

1.6. Acknowledgements

This project has mainly been a joint effort of Gijs Dekkers, Raphaël Desmet and Frédéric Verschueren (Federal Planning Bureau of Belgium; FPB), Hermann Buslei, Johannes Geyer, Dirk Hofmann and Viktor Steiner (German Institute for Economic Research; DIW), and Maria Cozzolino, Paola Tanda, Michele Raitano and Simone Tedeschi (Institute for Studies and Economic Analysis; ISAE).

Furthermore, Cathal O'Donoghue (TEAGASC, Ireland), and his colleagues Stephen Hynes and John Lennon, have provided us with LIAM, and helped us in using it. Geert Bryon (FPB) has worked hard on the LIAM-code. He added important functionality to it, and removed some hard-coded 'Irish parts' of the software. Finally, the original idea and first setup of this project was developed in close collaboration with Jean-Maurice Frère (FPB).

All have been of invaluable importance in achieving the goals of this project, and I hold very good memories of our collaboration.

1.7. References

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2. A classification and overview of micro simulation models, and the choices made in MIDAS

Gijs Dekkers, Michele Belloni[2]

2.1. Introduction

As politicians have become more aware of possible consequences of demographic ageing, there has been a growing need for policy support and the evaluation of (potential) measures in pension policy. As a consequence, many types of models have been developed or have had a new lease of life in the research on pensions and pension systems. These types of models include overlapping generations models, so-called 'standard simulation models', option value models, and various other types of models.

As a result of this growing analytical tool-box, models with quite different simulation characteristics are often used to address a common set of research problems. Even for the specialist reader, it is often difficult to see what the consequences are of choosing one type of model over another, or to foresee how a model, once developed, can be expanded to cover new research problems in the future. This is all the more relevant, because developing a new model in this field typically involves several years' investment. As a result, model developers cannot remain idle until a politician comes by with a question for which a model is needed. Instead, public research agencies typically try to anticipate politician's future questions, and invest in the development of such a model, designed to cover the largest range of potential questions and problems. To make this choice, it is imperative that one has an understanding of the fundamental characteristics of various models available, including an appreciation of their respective pros and cons, and what kinds of questions and extensions they are suitable for.

In order to evaluate a government program one may look at its effects *between* countries, industries or groups of individuals without analyzing its effects *within* these entities. However, one may also look at its effects at a more disaggregated level, such as the individual, the fiscal-unit or the household. In order to perform this second type of analysis, in fact, one needs micro-data, in the form of repeated cross-sections or panels. Existing datasets often do not suffice, either because the period they cover is too short, or because simulated 'future' micro-information is required for a priori evaluation. One therefore might need a model that can generate this data, and these models are called Micro Simulation Models (MSM).

The first aim of this second chapter is to discuss advantages and disadvantages of micro simulation models over other models, particularly macro models and – within models focusing at micro level -

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standard simulation models (section 2). Secondly, in section 3, we discuss some of the discerning characteristics of various types of micro simulation models. This will result in a classification of micro simulation models that is based on the fundamental simulation properties that they share. Contrary to earlier papers, this paper will extend the classification to include standard simulation models. Furthermore, it will discuss at length the *order* in which individuals and time periods are simulated in dynamic micro simulation models. This will further clarify the pros and cons of various types of models. Next, some important dynamic microsimulation models currently in use in Europe, will be discussed. Finally, the dynamic micro simulation model MIDAS that is simultaneously being developed for Belgium, Germany and Italy within the project AIM, will be presented and discussed. It will be linked to the above classification, and its fundamental simulation properties will be confronted with its 'raison d'être', namely the simulation of the adequacy of pensions.

2.2. What are the 'simulation characteristics' of a model[3]?

Define 'simulation characteristics' as those characteristics of a model that have consequences for the actual or potential research problems that can be covered by a model, as well as the implicit or explicit assumptions that a model makes when handling a specific research problem.

The first part of this definition limits characteristics to those that are relevant in the light of the (potential) research applications. Whether or not the model developer is married with two children and loves cats, or that the computer used for development and maintenance is a laptop, are not simulation characteristics because they do not say anything on the range of (potential) research problems which the model can be used for. For example, suppose that we want to assess inference aspects of a certain potential policy measure. Then the choice of what model to use should among other things be based on whether or not a model can simulate distributional effects. This feature then is a simulation characteristic.

But the definition of 'simulation characteristics' is more subtle than a mere description of what research problems a model can handle. For this would imply that two models that are used in the same research problem, by definition have the same simulation properties. This of course is not true. In fact, there are no *a priori* reasons why two models that are inherently different could not be used in tackling the same research problem. So, the definition of 'simulation characteristics' needs to be expanded beyond the range of potential research problems, towards the implicit and explicit assumptions a model makes in handling these research problems. This is the second part of the above definition. For example, both microsimulation models (henceforth called MSMs) and some Computational General Equilibrium models (henceforth called CGE-models), such as the Adelman and Robinson (1978) model, can be used to simulate inference-aspects of policy, but the underlying assumptions are very different. Indeed, where the MSMs base the distribution of income on a sample of individuals, the CGE in this case assumes a constant distribution of income within household types, meaning that changes in overall inequality are the results of redistribution between household types.

3 This section is based on Dekkers and Legros (2006).

Also, it is relevant to discern technical characteristics from simulation characteristics. For example, the programming language in which the model is written is a technical characteristic, and not a simulation characteristic, for one may envisage two models that are otherwise the same, to be developed in two different programming languages. However, it is also possible that technical characteristics determine the simulation characteristics of the model. For example, suppose that the choice of the language has consequences on what the model can be applied to, for instance due to the way the language handles data. Then the language is not a simulation characteristic itself, but the *cause* of a simulation characteristic. But the opposite, where a simulation characteristic causes a technical characteristic, is also possible. For example, the more complex a model is, i.e. the more simulation characteristics it has, the longer it takes for the model to run or to converge towards a steady state, and the more efficient the programming language therefore needs to be.

Simulation properties can either be the result of the fundamental characteristics of a model, or of deliberate extensions added to a model. For example, a microsimulation model by definition can simulate inferences, whereas a standard simulation model cannot (van Mechelen and Verbist, 2005). When choosing what type of model to develop, the modeller starts from the anticipated future research questions, and matches them with the simulation properties of model types available. Once a choice is made and a model of a certain type is developed, simulation characteristics can be changed by making extensions to the model, but these extensions remain within the 'boundaries' of the model type. These boundaries represent the fundamental simulation properties of a model, whereas the extensions are non-fundamental simulation properties.

As an example of such an extension, one can imagine that a microsimulation model as well as a standard model can be extended by a gross-net trajectory, allowing the simulation of fiscal effects. This will however not change the fundamental differences between the two types of models, and the effects of fiscal policy will be simulated for a sample of individuals (in the case of the MSM) and for typical fictitious individuals (standard models).

Finally, note that the above definition also covers the difference between 'simulations' and 'projections' for the latter is simply a special case of the former, namely a simulation under the assumption of an unchanged policy environment. Hence, simulations can refer to the measure of a proposed reform on a given population whereas projections are simulations of no reform. As a consequence, for a model to be able to generate simulations, it must explicitly include simulation properties. By contrast, a simple trend, a regression equation or a vector autoregression (VAR) model can perform equally well in making projections than many complex models do. They however lack any simulation possibilities. So, if a model has the properties that allow it to simulate an exogenous effect on an endogenous variable, then it can by definition make a projection (simulate the ceteris paribus clause) of this variable, but the opposite is not necessarily the case.

Now that the notion of simulation properties has been defined, the fundamental simulation properties of micro-level models can be used to make a classification. Before doing so, however, the advantages and disadvantages of micro level models must be put in comparative perspective. This will be done in the next section.

2.3. Micro Simulation Models versus other simulation models

When comparing micro and the macro simulation approach, the former has several advantages, but also some problems (Emmerson et al., 2004).

An important advantage of micro simulation models is that the level of modelling is in line with the level at which policy takes effect, especially in terrains such as public pensions, health care and other aspects of public finance. So, where macro simulation considers averages, a micro simulation model can simulate at the individual level, and therefore report the effects of policy on the income distribution, as well as poverty (often a function of the location of specific groups within this distribution). So, where macro economic models are specifically designed to consider financial consequences of a certain measure or development for the population as a whole, or for some subgroups, micro simulation models focus on redistributive impacts, and the adequacy of a social security scheme (in terms of preventing poverty and loss of welfare).

Furthermore, macro economic models do not consider the dynamics below the averages. Therefore, questions like "which types of individuals or households move up or down the income distribution over time?" are not considered by macro models but are key element in micro-models.

Caldwell and Morrison (2000, 201) describe several examples of research issues for which microsimulation models are particularly suited. These include analyses of projected winners and losers, exploration at the micro-level of the operation of social security programmes, quantification of incentives to work, to save or to retire, and longer-term consequences of societal trends in marriage, divorce and fertility.

Problems associated with the micro simulation approach are, first of all, that the theoretical underpinning of many micro simulation models is often scarce at best, though improvements are being made. It will be discussed later that *longitudinal* micro simulation models often have an underlying structural model of at least one key process such as the retirement decision or saving, *cross-sectional* models often have empirical ad-hoc solutions to many processes. One might therefore argue that structural models are a better alternative[4].

Structural models however often simulate one or two key processes for a couple of representative agents (and are therefore to be classified as standard simulation models, cf. infra). In contrast, most dynamic cross-sectional micro simulation models have a complex framework of a large sample of individuals of different characteristics, such as age gender and labour market status, where all these characteristics are simulated, taking into account parallel (if possible) or serial interaction, both between characteristics and between individuals.

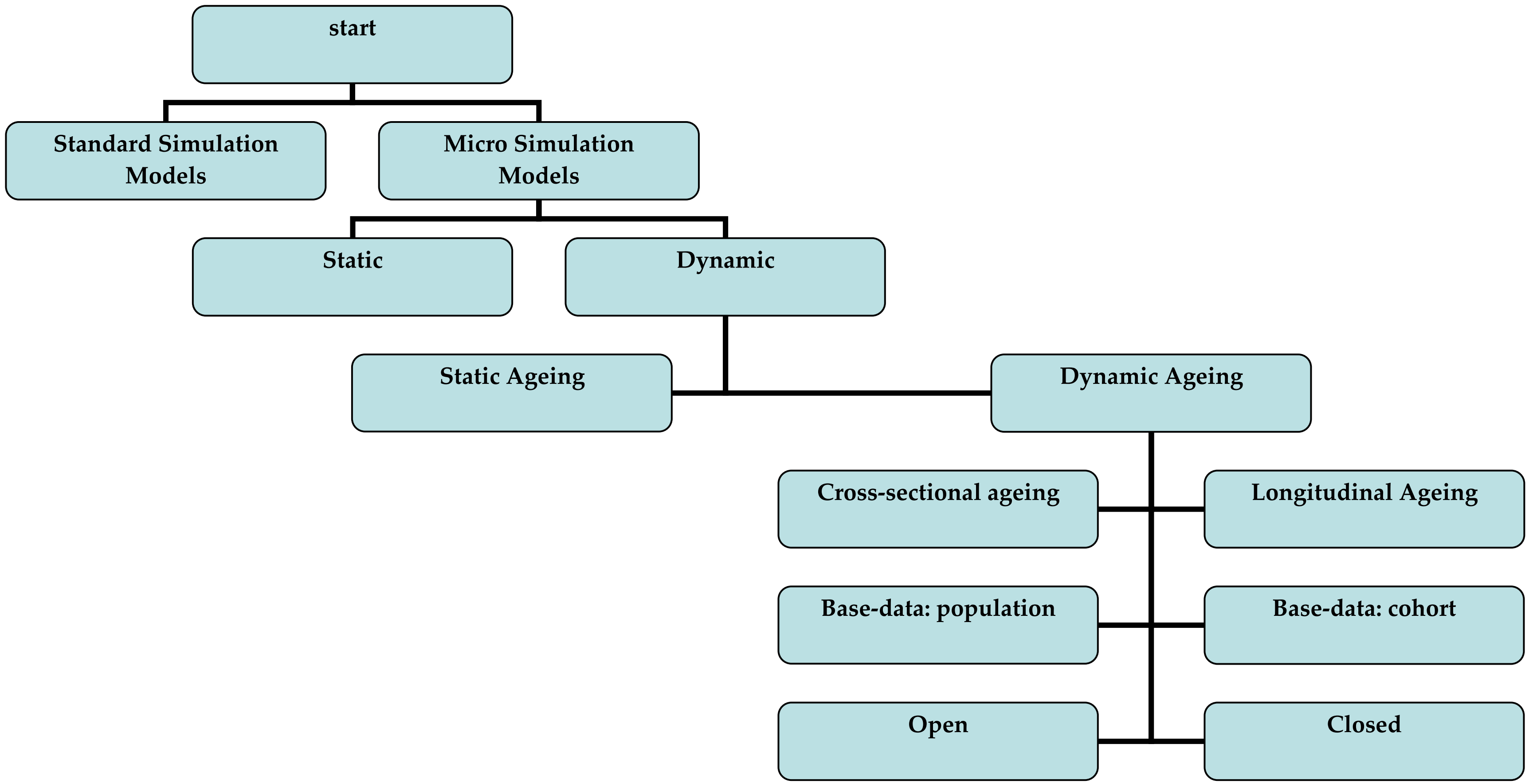
Furthermore, many underlying assumptions of structural models, such as the functional form of the utility function and what exactly adds to utility, or the development of the endogenous macro economic environment, often have important impacts and might not improve the fit of the model. Struc-

4 Emmerson et al. (2004) discuss this in more detail, and make an explicit comparison between the UK-model PENSIM II and a structural model. This section of the text draws upon their work.

tural models also are rather complex, especially when the number of processes increases. This has so far discouraged the development of a structural cross-sectional micro simulation model, at least to our knowledge[5]. This might however change, as we learn from the development of longitudinal micro simulation models, which traditionally have a larger 'structural component', and as new and more powerful computers become available. But even then, the challenges in terms of finding the balance between simulation stability and empirical fit of the model on the one hand, and theoretical soundness on the other, are enormous and one might even wonder whether the development costs will ever be worth the benefits.

5 The exception is the CBOLT model, where a structural life-cycle model was developed to model saving and labour supply (Harris et. al., 2005). It should however be noted that there is a promising development in linking CGE models with static microsimulation models (see Peichl, 2008), which may in the future be extended to dynamic models.

Figure 1: A classification of empirical micro economic models



The following discussion and classification will follow the outline presented in Figure 1. Within the group of microeconomic models, some authors (see Van Mechelen and Verbist, 2005 for a discussion) discern two broad categories. These are **standard simulation models** and micro simulation models. The standard simulation models simulate one or several – often synthetic- micro-unit, representing a category of micro-units. For instance, Dekkers (2006) simulates the effect of taxes and transfers on the expected future pension wealth of a single male or female blue or white collar worker. Micro simulation models by contrast simulate all micro-units in a representative cross-sectional sample of the population at a certain moment in time. So, they may simulate the effect of taxes and transfers on the level and distribution of income within the available dataset.

Standard simulation models are conceptually fairly simple –even though they can be technically complex- and there is no need for a large representative dataset of individual units. They are designed for the analysis of the 'mechanics' of a system of taxes, contributions and transfers. Given the characteristics of the synthetic individual, one may simulate income before and after implementation of a certain measure in the field of taxes, contributions and transfers, and simply compare the results. The drawback is that questions on the representativeness of the simulation results remain, for it is questionable to what extent simulations on one category of individuals can be used to draw general conclusions. Furthermore, given that one or several individuals are simulated, it is not possible to express the effects of policy measures in terms of changes of the sample moments of income. Put differently, it is not possible to simulate relative income poverty or inequality.

Micro simulation models start from a representative cross-sectional sample of the population, and then change this dataset to reflect an assumed future development, or the implementation of a certain policy measure, and so forth. Compared to standard simulation models, they usually are more complex, and therefore more expensive in terms of development and maintenance. They however are more representative for the population as a whole, and they are able to simulate poverty, income inequality and so forth. In the paragraphs to follow, the category of micro simulation models will be classified further.

2.4. A classification of microsimulation models

2.4.1. Static versus dynamic microsimulation models

The primary classification of MSM is based on whether and how they model time. Is the cross-sectional dataset simulated to reflect an assumed future development? If so, how? *Static* models do not include time, and therefore only simulate overnight effects of a change in policy. If time is not modelled, then the model is valid only for the cross-section data period (Merz, 1993, 4, 1994, 6). In several static models, however, the dataset that is the point of departure of the model is 'aged' to bring it up to date (Sutherland, 1995, 3). This will be discussed at length in the next section. The most well known European static model nowadays is EUROMOD, developed by an international group of researchers in the context of the fifth European framework. This model covers 15 pre-enlargement member states of the European Union, and its latest version has been extended to 4 new member states: Estonia, Hungary, Poland and Slovenia. EUROMOD is freely accessible[6] and "has been used for a number of policy-related exercises, ranging from studies of the relationship of public spending on social benefits to poverty and the implications of a common European minimum pension, to the impact of welfare benefits on work incentives and the consequences of non-indexation of taxes and contributions" (Sutherland, 2001, 1). Sutherland (1995) discusses static models in Europe; Merz (1994) also discusses models developed in the US, Canada and Australia.

Dynamic models do include time, and the simplest ones are those where time is simulated indirectly, via the reweighing of the units dataset to mimic a process of demographic ageing. These models are referred to as dynamic MSM models with 'static ageing'. Basically, the technique used to update static models now becomes the way to mimic time. Instead of changing individual characteristics over time, dynamic models with static ageing use exogenous future aggregate data to adjust the sample (Merz, 1993, 4, 1994, 6). This process is described in Harding (1996, page 3 and further) and consists of two basic steps. The first step is *reweighing*. This involves changing the weight attached to each individual record in the micro data, usually to reflect demographic ageing i.e. the change of the relative size of the cohorts in the sample. The structure of the sample itself is therefore not modified. The second step is *updating*, where monetary values within the dataset are adjusted to meet exogenous future projected developments. An example of a simple model where both techniques are applied is STATION (Dekkers, 2000, idem, 2003). This model was designed to simulate the effect of full or partial linkage of pension benefits to the development of wages on poverty and inequality among pensioners in Belgium.

We now turn to dynamic micro simulation models with 'dynamic ageing' (henceforth referred to as *dynamic* MSM). In opposition to models categorized so far, dynamic MSM do not reweigh, but alter the contents of the dataset itself. It involves "updating each attribute for each micro-unit for each time-interval" (Caldwell, 1990, in Harding, 1996, 4). Taking a certain dataset, individuals face certain probabilities of a change in each of their attributes. In the modelling process, this is simulated by chance. The number of variables that can be modelled this way depends entirely on how much information on transition probabilities or risks are available (Dekkers, 2003, 183). A dynamic model builds up complete synthetic life histories for each individual in the dataset, including data on mortality, labour market status, retirement age, savings and so on (Emmerson, et al., 2004, 3).

[6] A downloadable version can be found at http://www.iser.essex.ac.uk/msu/emod/

Before discussing a classification of dynamic micro simulation models, let us take a quick look at the question what type of model to choose for what reason. If one is interested in the overnight effects of policy changes, or simulations that pertain only to the dataset used as a point of departure of the model, then one might choose a static model i.e. one without ageing. If one is interested in simulation results that can be analysed using cross-sectional analysis of current and 'future' simulated data, one might choose a dynamic model with static ageing. Finally, if policy analysis involves a panel data analysis, i.e. if it requires that the simulated units evolve over time, then one might opt for a model with dynamic ageing. On the more practical level, one needs to weigh complexity against applicability. Static models are less complex than dynamic models, which means that they take less time to develop and require less maintenance effort. On the other hand, the scope of dynamic models is much wider than static models, which means that the potential applicability of dynamic models exceeds that of static models.

2.4.2. A classification of dynamic models

Several characteristics can be used to classify dynamic MSM[7]. A first fundamental difference pertains to the dataset that is taken as the point of departure of the model. The dynamic *population* models involve the ageing and adjustment of a cross-sectional sample of an entire population. So, the point of departure is a dataset consisting of individuals of many age groups or cohorts. Dynamic *cohort* models, by contrast, age only one cohort and this from birth to death (Harding, 1996)[8]. A consequence of this difference is that the population model "will produce also many micro units with an incomplete life-cycle; some micro units are still living or have died in an earlier simulation" period (Merz, 1994, 9). Of course, since cohort models simulate just one cohort of individuals, cohort models cannot directly simulate demographic ageing, which after all is a change of the relative size of cohorts vis-à-vis each other.

A second characteristic has to do with the order in which individuals are simulated over time. This is the difference between *cross-sectional* models and *longitudinal* models. Suppose a model that is to simulate *N* individuals from periods 1 to *T*. In cross-sectional models, *all* individuals are simulated for *one* year. In the first period, all *N* individuals are simulated from period 1 to 2. Next, all individuals are simulated from period 2 to 3, and so forth. By contrast, longitudinal simulation models simulate *one* individual for *all* years. So, individual 1 is simulated from birth to death. Then, the same is done for individuals 2, 3, up to *N*.

The difference between the two types of models may seem trivial, as the result of both models is the same: a simulated data set of *N* individuals for all *T* years. However it has some important

[7] A comprehensive and exhaustive overview of the characteristics of micro simulation models can be found in O'Donoghue (2001).

[8] This is why they are sometimes referred to as "dynamic life-cycle models", whereas the population models are called "cross-sectional models" (Merz, 1994, 9). This latter appellation may cause confusion with the typology based on the simulation order which is to be discussed next, so it is not used in this paper.

empirical consequences. A first consequence is that cross-sectional models allow for micro-interactions, i.e. interactions between individuals. If, for example, an individual experiences a certain change (he or she dies, to name one quite important change), this in real life affects the situation of other individuals (the partner becomes a widow/widower). In a cross-sectional model, this is easy to do. In a longitudinal model, this is more difficult since all individuals are simulated independently from each other: when the simulation of individual *y* starts, the simulation of individual *x* is ended, so that his or her whole future is already set. This however has as an advantage that the (future) life span of an individual is affected by a limited number of potential events, and this makes it possible to introduce forward-looking elements in the behaviour of the individual (see Sefton and van de Ven (2004) for an application). This makes the model theoretically appealing. A drawback of models with longitudinal ageing relative to those that use cross-sectional ageing, is that the former do not allow for the simulation of household income, whereas the latter do. As most measures of poverty risk are based on (equivalent) household income, models with cross-sectional ageing are the more useful when it comes to simulating poverty, (re) distribution and inequality. They however are less developed in terms of theoretical underpinning.

A second difference relates to the ability of both types of models to include ’life time decisions’ such as savings. Both types of micro simulation models make it possible to model these decisions. However, longitudinal models simulate lifetimes separately, and this future is then ‘frozen’. Hence, they are more suited for these kinds of decisions than cross-sectional models, which do not necessary simulate an entire life span of an individual. As a consequence, the theoretical foundation of longitudinal models usually is better developed than that of cross-sectional models, which concentrate on applicability and strengthening their policy-supporting role. In practice, therefore, one often sees that longitudinal models are developed for academic purposes, where cross-sectional models often have a policy-supporting role to play.

So far, a difference has been made between *population models* and *cohort models*, referring to the dataset they use as a point of departure, and between *cross-sectional* and *longitudinal models*, referring to the simulation order of the individuals in the dataset. This two-dimensional classification has been rarely considered in the literature so far. A possible explanation is that, to our knowledge, the combinations *population-cross-sectional*, and *cohort-longitudinal* are by far the most common, while the others are a minority. This may be why Harding (1993), O’Donoghue (2001) and others use a one-dimensional classification, The difference between the two types of models then becomes, in the words of O’Donoghue (2001, 17) “A cohort model is simply a model that ages a sample of unrelated individuals aged zero, while a population model ages a sample of individuals of different ages, some of whom are related”. Space for our finer classification can be however found in the words of Harding (1996, 5), according to whom dynamic cohort models use exactly the same type of ageing procedures. We are aware that the usefulness of the two-dimensional classification is primarily on the theoretical ground. However, models that do not fit the one-dimensional classification (population-longitudinal and/or cohort-cross-sectional models) exist already today, as will be shown below. Our classification might gain empirical relevance in the future, as more of such models are developed. Furthermore, separating these characteristics improves comprehension of the characteristics of a specific micro simulation model.

Another classification can be based upon whether the models are open or closed. This has to do with how marriage of individuals is modelled. A *closed model* generates new individuals in the case of birth or immigration only. So, when somebody in the model 'becomes eligible for marriage', his or her spouse is selected from the other living individuals in the dataset. In an *open model*, a 'synthetic individual' is created and linked to our marriage candidate. This of course is necessary when individuals are simulated independently from other individuals in the dataset, which is the case in cohort/longitudinal models. In population/cross-sectional models, however, pulling additional synthetic individuals out of a hat is unnecessary, for the simulation method allows for relations between existing individuals. Existing individuals therefore are often matched via a 'marriage market module' of some sort.

Another discerning factor between models has to do with how time is modelled. Here, *discrete* models stand in opposition to *continuous* models, a difference pertaining to the difference between discrete and continuous time hazards used in these models. Continuous models include continuous time hazards, defined with reference to a period of time (and not a probability) after which a certain event will occur. Discrete models by contrast include discrete time hazards: a probability that an event will occur in an interval of time. Emmerson et al. (2004, 10) explain the difference by saying that dynamic micro simulation models can simulate relevant life events either "year-on-year for the (starting) year *t*, *t+1*, *t+2*, in discrete time, or by starting at *t*, and predicting a life-event at (*t+n*), where n is positive and possibly non-integer (continuous time)". For a more elaborate discussion, the reader is referred to O'Donoghue (2001); we limit the discussion to that most models to date are of the discrete type, and one of the reasons for this is the lack of continuous data for the processes to be simulated.

2.5. A focus on some relevant models

In this section we provide an introductory description of some dynamic MSM's. We concentrate on the countries with more experience in microsimulation modelling and more specifically on the models which are more innovative or/and more relevant for pension issues. We choose MINT for the US, Pensim2 for the UK, and DYNAMITE for Italy.

The **MINT** (Modeling retirement Income in the Near Term) model (Panis and Lillard 1999, Butrica et. al. 2001, Toder et. al. 1999, O'Donoghue 2001) has been developed in the US by the Social Security Administration (Office of Research, Evaluation, and Statistics), with substantial assistance from the Brookings Institution, the RAND Corporation, and the Urban Institute. The model projects the retirement income (social security and pension income, but also asset income and earnings of working beneficiaries) of individuals at their retirement age. The simulation period ranges from 1997 to 2031. The model has been applied to simulate several policy scenarios. Between them there are the analysis of the effects of social security benefits reforms on the level of benefits, retirement income and poverty, and the analysis of cohort differences in the sources of retirement income. Its detailed demographic component allows also simulating economic well-being in retirement.

MINT is a population model. Its base population – 113,000 individuals born between 1926 and 1965 – is obtained merging files coming from multiple sources. In particular, demographic information and marital histories come from the Census Bureau's Survey of Income and Program Participation (SIPP, years 1990 to 1993), while earnings come from the SSA Summary Earnings Record dataset (SER, years 1951 to 1996).

Transitions into marriage and divorce (and to death) are modelled using a continuous time hazard specification. Using the estimated coefficients, the expected dates of these events are determined. Therefore the model is, at least with respect to these occurrences, continuous. Marriages are simulated in two steps. For each marring candidate, the characteristics of the 'ideal' partner are first defined. Then, spouses in the sample are matched by means of a statistical matching algorithm which minimizes a 'distance function' defined in terms of individual characteristics. When the 'ideal' spouse is not found in the sample, because there is nobody with the desired characteristics, a 'synthetic' one is created. MINT is thus a mixed open and closed model.

The age of retirement, for those eligible to OASDI benefits, is determined by estimating a logit model. The probability of receiving social security benefits is explained by a set of individual characteristics like age, education, gender, race, marital status, earnings and non-housing wealth. Earning profiles are estimated using a fixed-effects specification (run separately for each gender and education level). The individual effect is also estimated, in order to predict earnings for out-of-sample years. MINT thus fully exploits the advantages of its panel data, when estimating transitional probabilities in the demographic module as well as in its economic modules. It fully takes into account that social security benefits depend not only on the pensioner's earning history, but also on his marital histories and on the earnings history of his spouses(s). Earnings of the spouses are obtained in a different way depending on whether the spouse is in the sample. If the spouse is in the sample, they are predicted from the estimated earnings lifetime profile. If the spouse is 'synthetic', they are instead determined by first imputing a spouse from a pool of eligible donors, and then assigning her earnings to the main pension beneficiary.

Pensim2 (Emmerson et. al. 2004, Zaidi and Rake 2001) is the second version of the microsimulation model built by the British Government's Department for Work and Pensions to analyze the distributional impact of pension policy reforms in the UK. The level of accuracy of many of its modules makes it also suitable to quantify the effects of tax and benefits interventions, as well as tuition fees for higher education.

Pensim2 is a population model. It exploits information of several administrative and survey databases. Between them, the Lifetime Labour Market Database (LLMDB), the British Household Panel Survey (BHPS) and the Family Resource Survey (FRS) are the most broadly exploited. The model is *discrete* (many life events are modelled with a probit or a logit equation; some of them with nested logits) and runs up to the year 2050. The model is furthermore closed. The partnership module governs several events: new marriages, changes from cohabiting to married, new separations and custody of dependent children after it, divorces from separations. The matching process between individuals is determined by the 'order of decreasing differences' algorithm.

Pensim2 simulates occupation by first ranking the individuals according to the probability to be at work (using the BHPS), and then calibrates the transitional probabilities in BHPS using LLMDB. Labor supply is modelled in the household framework, although it is not jointly determined between the spouses. Decisions to work are in fact assumed to be taken in a sequential order: first the man decides and then the woman decides taking into account the choice of the man. Man's work status is therefore estimated without considering the work status of the woman, while woman's work status is estimated including as explanatory variable the man's one. Earnings are estimated using a random-effects specification and exploiting the BHPS panel. This specification has been preferred to a fixed-effects one, because it allows both to impute an individual effect for new entrants into the labour market and to quantify the effect of education on earnings.

A relevant modelling effort, within the pension module, has been dedicated to the attribution of public and private pension rights, both for current and future workers. Modelled events are whether an employee is offered the opportunity to join an occupational scheme, whether he chooses to join it and whether he joins a private pension scheme. To this aim, probit equations using data from the FRS are estimated.

DYNAMITE (Ando et al. 2000, Ando and Nicoletti Altimari, 2004, O'Donoghue 2001) has been built at the Bank of Italy, in collaboration with Albert Ando at the University of Pennsylvania. Its principal aim is to study the effects of demographic ageing (and of the evolution of the family structures) on aggregate saving in Italy, under the assumption of lifecycle behaviour. Further applications concern the effects of the 1995 reform of the Italian pension system - looking its steady state but especially at its transitional phase toward the new regime – and the distributional impact of tax reforms.

DYNAMITE is a population model. Its base population is generated starting from the 1993 wave of the Bank of Italy's Survey on Household Income and Wealth (SHIW). By means of a weighting procedure based on non-response weights, the original sample of roughly 8,000 households was enlarged to 200,000 and made proportional to the Italian population. The unit of analysis is the household, and the model is closed. The demographic module is extremely fine and accurate. The simulation period is very long, more than 100 years.

Almost all the probabilities in the labour market module, such as participation, unemployment and transitions between sectors and occupational status, are calibrated to match aggregate characteristics. A grossing-up procedure is adopted in order to transform declared income, which are net of income taxes, into the taxable basis for social security contributions and pension benefits computation. A correction factor is applied for misreporting purposes, particularly relevant for self-employed. Lifetime income profiles are constructed by estimating a two-steps Heckman's model on the pooled 1987-1995 SHIW cross-sections. In the estimation, cohort-specific effects on wages, which it was not possible to disentangle from age effects, are attributed exogenously assuming they are equal to the productivity growth.

The decision to retire is endogenous and depends on the financial incentives provided to the worker by the pension system. Incentives are measured by the ratio of the expected SSW of working up to age 60 to normal earnings. Two reduced-form behavioural equations are estimated, exploiting the information on the expected age of retirement included in SHIW. The first equation includes as explanatory variables, other than the incentive measure, a set of 'time-invariant' characteristics (e.g. year of birth and education). The second, instead, includes in addition some 'time-variant' characteristics (e.g. the family structure). The first equation is then used to predict the age of retirement of new occupied, while the second to predict it when the worker reaches age 50 and for each subsequent age. The model, in fact, takes into account that older workers may want to revise their expectations on the retirement age in light of updated information on the working career. The computation of social security wealth (SSW) is complex because of the evolving normative framework throughout the simulation period. Different *formulae* are applied depending on the type of workers (employee in the private sector, employee in the public sector, self-employed), cohort and simulation year.

2.6. Micro simulation in the AIM-project: what kind of model is MIDAS, and why?

In this section, the choices which have been made in the development of MIDAS are outlined. The model MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability') is developed within the AIM-project in order to simulate the adequacy of pensions in Italy, Germany and Belgium. The concept of adequacy was defined in the first chapter. Furthermore, it was translated into three objectives, two of which are the main objectives of a public pension system. These are the reduction of the risk of poverty in old age and the preservation, at retirement, of a standard of living comparable to that of the final part of the active life. In what follows, these objectives will be linked to the classification made in the previous chapter. Why should micro simulation models be used in the simulation of these objectives? Which class of micro simulation models seems the most appropriate in this context?

2.6.1. The first objective: the prevention of old-age poverty

Poverty is about a lack of welfare. As welfare is not directly measurable, social scientists often opt for an indirect measure, where poverty is based on the confrontation of the income of a household or family with a poverty line *z*. If this household income *x*, corrected for differences in size and composition of the household is below this line, then the individuals in this household or family are considered to be poor. Suppose *F(x)* the distribution of household incomes *x*, and *f(x)* the density function. The headcount ratio *HC* can then be written as $F(z)=\int_0^z f(x)dx$. In its discrete form, this becomes *HC=p/n*, with *n* being the population, and *p* the number of individuals whose equivalent income is below the poverty line, or *(x-z)<0; p≤n*. This is also denoted as reflecting the 'risk of poverty' in the population. Other, more sophisticated measures of poverty are based on the individual poverty gap, *(x-z)* or *(x-z)/z*, reflecting the intensity of poverty among the poor. These will be discussed in more detail in chapter 5, the simulation results. How poverty is exactly measured is not relevant from the point of view of the modeller. In fact, any model that can simulate the equivalent household incomes *x* in principle allows for the simulation of all kinds of income-based measures of poverty. It has been clear from the previous chapter that micro simulation models are designed to meet this demand. However, the question then is which category of micro simulation models is best suited for the task and hand?

Dynamic models with static ageing can simulate the future pension income of the elderly and they have been used to simulate poverty and income inequality among the elderly before (see, for instance, Dekkers, 2000). Dynamic cohort models with longitudinal dynamic ageing could in principle simulate income distribution among pensioners in a certain future year, but only within the same cohort. This makes them less attractive in the context of AIM, for a comparison of the relative income position between cohorts is not possible. To give an example, the degree to which pension benefits are indexed to the development of wages or prices has a strong effect on the income position of older retired cohorts relative to younger cohorts. This cannot be simulated by a cohort model, just because that it has one cohort as the point of departure. Furthermore, the longitudinal ageing process of these models does not allow for interactions between members of a household. This means that simulating *household* income is not possible, because the lifetime and earnings history of any individual in a typical household is given for any other individual.

Finally, do dynamic population models with cross-sectional ageing meet the requirements to simulate poverty among pensioners? Yes, for they simulate various cohorts and can therefore simulate different poverty risks of elderly versus the young in any future year. Furthermore, the cross-sectional ageing process implies that interactions between simulated individuals within a household (and potentially within every group) are possible, and can be modelled. This implies that a meaningful simulation of household income is possible. In conclusion, both models with static ageing and models with dynamic ageing of the cross-sectional type meet the requirements of the first objective.

2.6.2. The second objective: the preservation, at retirement, of a standard of living comparable to that of the final part of the active life

The most straightforward measure of the preservation of income at retirement is of course the replacement rate. In the microeconomic sense of the word, the replacement rate is the ratio of one's first pension income over one's last salary. In order to simulate future replacement rate's, one needs the pension benefit to be simulated within a model. And as the replacement rate is based on the information gathered in the year that an individual retires, the model must be capable of simulating this transition between work and retirement. It is clear that models with static ageing do not meet this requirement. Furthermore, the 'Bismarckian character' of the pension systems in most European member states is a relevant characteristic. For, the pension benefit one is entitled to when reaching the retirement age, may in some way depend on one's earnings history. So, any model should incorporate and simulate this earnings history. This again implies that models with static ageing do not meet the demands, for this class of models do not have a 'simulation memory' in the sense that simulation results at the future time $t+n$ are independent on the results in $t+n-1$. So there are two reasons why one may conclude that static models or models with static ageing are unsuitable for the simulation of individual future replacement rates. However, static models can be used to reproduce individual replacement rates, and hence to simulate the overnight effect of policy measures on this current replacement rate. Furthermore, if one adopts a more macroeconomic definition of replacement rate –as the average pension of young retired cohorts as a fraction of the average earning of the older working cohorts- then dynamic models with static ageing can simulate this replacement rate, even though they do not simulate the work-retirement transition itself. Using these kinds of models, the effect of partially linking pensions to the development of wages on poverty or inequality can be simulated.

Finally, both classes of models with dynamic ageing (cohort models with longitudinal ageing and population models with cross-sectional ageing) do simulate individuals over time. Microsimulation models of these categories can therefore simulate both macroeconomic and microeconomic replacement rates. They therefore meet the requirements of this second objective.

2.6.3. Finally: the simulation of demographic ageing and pensions

The first objective can be met by models with static ageing and population models with cross-sectional ageing. When we limit the second objective to simulating microeconomic replacement rates, then this second objective can only be met by the latter class of models. Only population models with cross-sectional ageing therefore meet the requirements of both objectives. But there are two other important reasons why this class of models is the most relevant in the context of this project. The key stone of this project is that it concerns the consequences of ageing on the adequacy of pensions, and one therefore needs a model that allows for the simulation of demographic ageing. Let us consider whether the three classes of dynamic MSMs meet this demand.

A MSM with static ageing can in effect simulate demographic ageing by varying the weights associated with individuals from different cohorts. A cohort model can in principle not simulate ageing, for it has only one cohort as the point of departure. Finally, a cross-sectional model is best suited for the simulation of ageing, for it applies exogenous fertility and mortality rates that may change over time. This way, various subsequent cohorts are simulated at once, and ageing – essentially a change of the relative size of cohorts- is therefore inherent in the system. The very fact that the project assesses the consequences of ageing is a strong argument in favour of cross-sectional micro simulation models. Moreover, some important socio-demographic developments appear within households (such as the emergence of two-earner households), and this also requires cross-sectional micro simulation, for only these models allow for interaction between individuals. So, the conclusion is again that population models with cross-sectional ageing are the most suited given the research goals in the project AIM. It is for this reason that the model MIDAS fits into this class of MSMs.

2.7. Conclusions

In this paper, micro simulation models have been put in opposition to various other types of models, be it micro economic models such as standard simulation models, macro simulation models, option value models and generational accounting models. Furthermore, many characteristics that classify within the group of micro simulation models have been presented and discussed. This classification has been taken further to discern various characteristics of 'dynamic micro simulation models with dynamic ageing', often simply referred to as dynamic micro simulation models, where a difference has been made between cross-sectional and longitudinal ageing, and population models and cohort models. Finally, an overview of existing dynamic micro simulation models, for the largest part constructed from previous work of other authors, is presented and some general conclusions are drawn. First of all, most of the models to date are of the dynamic cross-sectional type, and this might be due to their larger scope. Furthermore, the number of models developed is increasing exponentially. This may for a part be caused by the rapid evolution of computers, allowing for more complex and more CPU-demanding models to be developed. But more importantly, it might reflect the growing interest of policy makers into not only the macroeconomic financial effects of social and fiscal policy, but to distributional effects as well.

Next, the choices made in the development of MIDAS are outlined and described. MIDAS aims at simulating the adequacy of pensions in Belgium, Germany and Italy. This requires that the model to be constructed allows for the simulation of old-age poverty, the measurement of a standard of living at retirement and the simulation of demographic ageing and pension system regulations. It is argued that population models with cross-sectional ageing are the best suited for this project.

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3. A short overview of the MIDAS-version of The Life-Cycle Income Analysis Model (LIAM)

Cathal O'Donoghue , John Lennon, Stephen Hynes[9], and Geert Bryon[10]

3.1. Introduction

This paper describes LIAM; a mechanism for making dynamic microsimulation models easier to construct, using a generalised method. This paper draws heavily upon of Cathal O'Donoghue et. al. (2008), but differs in that it describes new functionality added by Geert Bryon. Consequently, the version of LIAM described here is the one used for the development of MIDAS.

3.2. Objectives

The construction of a dynamic model is a very large task, both in terms of grasping the types and forms of behaviour that take place over a lifetime and the effort in programming 1000's of lines of code.

Despite dynamic microsimulation modelling as a science having existed since the 1970's (see Orcutt et al.), the field has progressed only slightly (See O'Donoghue 2001). Part of the reason has been the resources requirements. When dynamic microsimulation models were first developed, they were in fact advances in computer science as well as being advances in social science methodology. Likewise in many countries, data limitations have prevented the development.

However in recent years, difficulties have been overcome as computers have increased in speed and thus allowing for very powerful models to be constructed on PC's. The establishment of household panel datasets in many countries and the increasing availability of administrative datasets has removed the barrier to the estimation of dynamic behavioural processes. However despite these advances, the spread of the dynamic microsimulation technology and the development of the field have been relatively slow. A large potential reason is the apparent benefit to cost ratio. Many institutions when faced with the large cost of developing a dynamic model felt the money better spent on other techniques.

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One way of reducing the cost of building a dynamic microsimulation model, is to avoid the start-up costs and learning curve by utilising the same framework for alternative applications. There were some efforts in the 1970's to write actual microsimulation computer software packages. However because of the complexity of the system to be simulated, users have more specialist requirements than these software packages allowed.[11] The code from CORSIM model (See Caldwell, 1996) has been stripped down and used as a template in the construction of the Canadian DYNACAN, Swedish SVERIGE and for the US Social Security Administration models. There have been four examples of programs that have been written explicitly for multiple Dynamic microsimulation model construction, ModGen (Wolfson and Rowe, 1998), UMDBS (Sauerbier, 2002), GENESIS (Edwards, 2004) and LIAM described here. ModGen is a computer language designed for create microsimulation models and has been used to create a number of microsimulation models (dynamic and static) within the Canadian government such as Lifepaths. ModGen is an open model while LIAM is a closed model and the spouses in LIAM come from within the dataset. UMDBS is a simulation system developed at Darmstadt University as part of academic research. It is implemented in the object oriented language Smalltalk and its main applications are socio-economic investigations. GENESIS is a SAS based modelling framework being used within the UK Department of Work and Pensions to create the Pensim2 pension age dynamic microsimulation model and the state pension forecasting model. While LIAM and ModGen are accessible to researchers, GENESIS is not.

3.3. Framework Features

In this section we describe the main aspects of LIAM, focusing initially on the general structure of the framework and then elaborating the data structure and issues relating to modularisation and parameterisation.

3.3.1. Structure of Framework

A dynamic microsimulation model is essentially a model that takes individual objects (individuals, households, farms, companies) and simulates the probabilities of various events occurring at various points in time.[12] Figure 1 describes the main operations of the ageing component of dynamic microsimulation model. Here the operation of one particular ageing module at one point in time is examined. In the model itself, this process would occur on a number of occasions as all the individuals in the database would pass through many ageing modules at each point in time.

Data for each person are firstly taken from the database having been transformed into the model data-structure, which is described in more detail below. The individual is then passed through

[11] See Leombruni and Richiardi, 2005 (2005) for the development of a model using Agent Based Modelling.
[12] Dynamic events may of course occur at the same point in time as other events.

each ageing module in turn. The ageing modules to be used are specified as part of a parameter list, which allows the order and the types of the transition processes to be varied. Output from each ageing module is stored in alignment storage matrices in memory. For example, alignment regressions produce a deterministic component XB to which is added a stochastic component ε. These are stored in a dynamic data structure and ranked with the highest Z percent of values taken from the exogenous totals in the alignment process. If the ageing module is a transition between states, then the output will be a probability, otherwise if the ageing module is a transition between continuous amounts like for example incomes, output is a real variable. When all individuals have been passed through the particular ageing module, alignment occurs. This is an important feature of LIAM, which ensures that aggregates from the micro model match macro aggregates. This will be discussed in more detail in section 3.5 below. Finally if a variable for any individual changes then this change is registered in the database[13].

3.3.2. Data and Framework Data Structure

In this section we describe how data is handled in LIAM. The data structure not only determines to a large extent the amount of memory required storing the data, but it also has important consequences for the flexibility of the model. Turning first to data storage, we adopt a relational database structure due to organisation and memory handling advantages. Figure 3 describes the data-structure used by LIAM. Structurally the data is stored in a hierarchy of object types such as person, household, firm etc. Each of these object types themselves consists of a number of objects such as the actual incidence of a person or household. Events such as births, tenure status or identification number then occur to objects. Each event can have a number of incidences or values.

We exploit the hierarchical nature of relational databases making data storage event driven. Storing model output as consecutive cross-sections would result in severe inefficiencies, as each variable would be stored for each output period, so for example the gender would be stored for each point in time. Making data storage event driven, new data is stored only when a new event occurs and thus the data changes. Gender is therefore only stored at birth. Each individual variable however requires more information than in the case of the cross-section data structure. For each event it is necessary to know what event occurred, when it occurred, and the value of the event. On the whole, adopting an event-driven data structure, allows for significant savings in memory, which is inversely related to the average speed of change of variables in the model.

There are a number of ways in which data can be stored within LIAM itself during the simulation. Contrary to open models, where each individual could be read from and stored to the database separately, LIAM uses a closed methodology where individual behaviour can be dependent

[13] Note by the term database, we refer to both the physical relational database, stored on the hard disk in ASCII and the virtual database we create in memory.

on the characteristics and behaviour of other members of the sample. It is thus necessary to store all individuals in memory during the simulation. The virtual database stored in memory during the operation of the program mimics the structure of the relational database stored on the hard disk.

Once the data has been read from the database into memory, LIAM runs through each object type (person, family etc.) in turn simulating the life course events desired for each object of that type. Simulation processes are therefore object type specific.

Typically variables which are components of the household data structure are declared in long lists within a dynamic model. They may be initialised elsewhere and have other operations carried out in other parts of the program. As the modelling framework is so large and complicated, it may be difficult to keep track of all the places in LIAM which need to be altered when a new variable is included. Therefore, in order to keep the framework flexible and yet maintain the robustness, it is desirable that the number of alterations necessary is kept to a minimum. As a result instead of declaring variables within LIAM, we declare the list of variables to be used separately in a parameter sheet. LIAM then creates space for the variable, initialises the data and carries out all necessary transformations and operations automatically and therefore is entirely flexible with regard to the set of variables used within the framework. Thus if the user wishes to introduce a new instrument with an output variable such as health status, then he or she simply needs to introduce the variable into the parameter sheet and LIAM will do the necessary steps, without having to recode the framework. Another advantage of the flexible declaration of variables described is new composite variables can be produced easily. For example, a complex variable like disposable income which is not simulated directly can be generated from the vector of its components such as employment income and capital income. A final advantage of the hierarchical method of event-driven data storage pertains to the fact that just the date and value of each event is stored. This can easily be used to to determine such information as duration, duration in the last 12 months, date an event first occurred, date an event ended, duration in a particular state and so on.

3.3.3. Linkages

Many policy instruments depend upon multiple units of analysis. So for example, pensions may depend upon individual characteristics such as contribution histories, age etc., taxation may depend upon family characteristics such as both spouse's incomes and social protection instruments and welfare measures on the household unit. These linkages are not strictly hierarchical (e.g. region, household, family, individual), they may in fact consist of a web of linkages (e.g. region, firm, household, family, individual, mother, father, partner, children etc.). This multi-level structure with its complex interactions between levels is one of the main complications of microsimulation models that make it difficult to use person-based modelling frameworks. In the LIAM framework, the mechanism of linking objects has been automated as a relational database. Potentially any object can be linked to an object of either the same or different object type. For example individuals of object type person (*p*) will be linked to their household of object type (*h*), while in turn the household is linked with the individuals in the household. So therefore to create the number of persons in a household, this process is carried out at the household level. This new household level variable *npers* can be accessed by individual processes using the prefix *h_npers*. Similarly we can have linkages between objects of the same type, accessing say a mother's education level using *m_edlevel* or father's *f_edlevel*.[14]

In the initial framework, there are no predefined linkages as the objects can be of any type defined by the user. The user pre-defines all linkages using the parameterisation described below to essentially create a web of linkages between objects; essentially defining keys to link tables. As long as the nature of the linkage is defined, it is then possible at any level of the model to access information from another level. This is quite a powerful feature of the data-structure, saving both time and memory. In the absence of these linkages, a *h_npers*, a new process would have to be simulated which would store this variable as a person level variable *p_hnpers* (say), which is analgous to a flat file, where household level variables are stored at the person level. The use of linkages or keys provides the space saving advantages of a relational database and avoids the simulation of an extra process to convert the household variable to the person level.

3.3.4. Parameterisation

In order that modules and other components of LIAM can be changed with ease, it is necessary to store model parameters externally. So where possible no parameters are hard coded within the framework. Figure 4 details the set of parameters used by the modelling framework. The sets of parameters, representing the *flow of control* in the model, are in some sense hierarchical.

At the top level we have a file (*dyrunset)* which contains the parameters necessary to run the model, detailing directories (location of input and output files), time period to be run etc. Figure 4 is divided in two by dashed lines indicating sets of parameters dealing with the data structure and sets of parameters dealing with the simulation process.

On the data side the highest level parameters are contained in a file *objtype*. This file tells the model how many object types there are (region, household, person etc.). LIAM creates each object type based upon the list defined here and assigns defined prefixes (r,h,p etc.). The framework then looks for files *objtype_x* containing the incidences of each of the object types (*r*, *h*, *p*, etc.) which in turn contains in the identification numbers or id's of each object of that particular object type. So objtype_p would contain the set of id's of all persons.

[14] Prefixes are defined by the user.

Related to the set of object types is a set of variables associated with each object type. A file *dy-vardesc* contains all variable names used in LIAM, their declaration and description. Associated with each variable, there is a data file containing information about object associated with the variable (who), the time the event occurred (when) and the value of the variable (what).

While each data table within an object type is linked by the key or object ID, we need further information to link objects of the same or other type. The *linkage* parameters define the set of possible links between objects. The user needs to define a name for the linkage (ph – person to household, hp – household to person etc.) and equivalent origin (p for link ph) and destination (h for link ph) types. These linkages between objects are stored in the linkage files *link_xy*. Subsequently, for each linkage listed in these files, LIAM pairs the relevant origin objects (e.g. children) and destination objects (e.g. parents) and stores the resulting origin and destination IDs in a link-specific (e.g. pc) file.

We now consider the set of parameters that define the simulation processes. The highest level is the *agespine or* process spine/list. In any simulation there is an implicit ordering, and events are triggered through conditions. The process spine contains the list of modules to be run in the dynamic model, so that by varying the order of the modules and varying the content of the list, one can vary the types of processes that can be run in the model. This feature exploits the modularisation, where because each process is seen as a separate building block, the number, type and order of processes can vary without having to change the code. A model such as MIDAS is thus a large number of ordered processes, reflecting the demographic module, the labour market module and the pension module.

Each separate process in *agespine* has a corresponding parameter sheet in the parameter file. These parameter files tell the model the output variables of each process, what type of process (described in the next section), whether a process needs to be aligned and the actual process parameters themselves such as the transition rates, regression equation and policy rules etc. If a particular process is to be aligned, then LIAM will look for an appropriate set of *alignment* parameters.

Sometimes individual parameters may be required to be changed between runs without any change to the set of processes. For example, incomes may change over time, following macroeconomic productivity growth rate, pension floors and ceilings follow the development of prices, wages, or something in between, and so forth. The version of LIAM used to develop MIDAS allows these time-dependent parameters to be declared and filled in a separate file. These parameters may then be used in all individual processes.

3.4. Process Modules

If LIAM is a toolbox for developing models, then the processes are the tools that the modeller can use to make his own model. This refers to the collection of operations that are simulated on objects during a simulation. These include fundamental demographic processes such as birth, marriage, having children and death, but also education, labour market processes such as employment, unemployment and retirement, the simulation of incomes and finally, all sorts of rules and regulations that together mimic the pension system of a country.

In order to aid flexibility, we classify processes under a number of headings. In this way, instead of programming each module separately, we only need to program the module type once. In order to run a module, we then only need a module name (which is included in the process spine), a module type to determine which program to run and a set of parameters which is fixed for every process type. In the version of LIAM used for the development of MIDAS allows for 4 module types:

- transition matrices, in the form of a log linear model (*trap*)
- transformations (*tran*)
- regressions, both with continuous and limited dependent variable (*regr*)
- marriage market (*mmkt*)

The first component of a parameter file contains details about what conditions need to hold for the process to be run. At each point in time and in the order set by *agespine*, each individual is passed through the module. If the conditions hold, then the module calculations are carried out and the output passed to the alignment component of the module. The output for each individual is stored until all individuals have passed through the module. If applied in this module, the alignment component then ensures that the aggregates correspond with external control totals.

3.4.1. Transition Matrices (trap)

One of the most important processes in a dynamic model is the transition between different discrete states. Transition Matrices are often used to perform these operations. They specify the probability for an individual of particular circumstances to move from state A to state B and apply Monte-carlo simulation to assess whether such a change indeed occurs.

3.4.2. Regressions (regr)

The second type of transition process used is based upon standard regression models. At present, this type of module allows four types of dependent variable:

- standard continuous dependent variable
- log dependent variable, allowing for use of the log normal distribution.
- logit discrete choice dependent variable

– probit discrete choice dependent variable

Any variable in the model can be used as a dependent variable and any variable can be used as an explanatory variable. The error term can also vary. The default error term takes a normal distribution with independent disturbances. LIAM also allows for the error term to be decomposed into individual specific (u_n) random effects and general error components (v_{nt}) (See Pudney 1992). In the last two cases, LIAM does not directly require the transition probabilities as in the transition matrices (*trap*), but it builds it from the values of the exogenous variables and the regression equation. Whether or not the endogenous state changes is then again the result of a Monte-Carlo simulation, analogous to a *trap*-process.

3.4.3. Transformations (tran)

While regression models and transition matrices are stochastic processes, involving a random component, some processes are deterministic. Examples include age, which depends on the date of birth, widowhood, which depends on the death of a spouse and so on. Likewise if an individual moves from year 6 in education to year 7, years of education increase by 1. This component has also been parameterised as transformations.

Within the transformations there are three types of deterministic transformation *gen*, *fgen* and *fpbcalc*. The *gen* functions are of simpler types, utilising a calculation routines combining sets of variables using standard operations.[15] The *fgen* set of functions contain ad-hoc programs, usually exploiting the relational database structure of the data in operations. Examples of these programs include the number of persons in a household, the creation of individuals (birth) and households, as well as their death or dissolution, respectively. An important feature that pertains only to the MIDAS-version of LIAM is known as the *fpbcalc* transformations. The LEC-language (Langage Econométrique Condensé) is used in fpbCalc. The user can mix macro economic time series and the variables for each individual in an easy textbook-like way. For example, a simple formula like

$$a + b\left(\frac{Y}{P}\right) + cC_{t-1} \qquad \text{(text book)}$$

can be written as

a + b * Y / P + c * C[-1]   (LEC)

The small caps variables are the LIAM-type variables. The all caps variable name are macro economic variables (such as GDP) or time-dependent parameters. These variables are stored in the *macro.av* file. The LEC elements to build a formula are numerical constants, language constants, logical operators, algebraic variables, mathematical functions, lags, leads and values in periods,

15 {+,-,*,/, max,min,^,(,)}

and finally comments. In this, *fpbcalc* not only replaces *gen* but adds important functionality. An important new feature is that it allows for nested conditional statements. Previously, all conditional statements had to be defined separately. Now they can be put and evaluated in one nested condition.

The 'if-functions' simplify the way in which conditions are written: the first argument is the condition, the second argument is the value if the condition is met, and the third argument is the value if the condition is not met. For example, the statement *if(age < 65, 1, 2)* returns 1 when younger than 65 and *2* if older. Furthermore, multiple conditional statements can be nested, for example if(cond1, X, if(cond2, Y, Z))

3.4.4. Marriage Market

If an individual is selected to form a partnership in marriage or cohabitation then a process is needed to determine which spouse they will take. The process used here is to take the characteristics of the individual chosen to form a partnership with and the characteristics of each possible spouse and determine the likelihood of a match. Similar to the method used in other models such as the CORSIM model, this is done using a logit model that estimates the probability of marriage between pairs of individuals. The parameter file therefore is identical to that used in the regression process type. The module itself forms a matrix of the characteristics of the *n* men and *n* women selected to marry. Estimates a probability for each pair and assigns a match to the couples with the highest probability of marrying.

Bouffard et al (2001) has identified some problematical issues associated with the marriage market, in particular with strange matches occurring amongst the last people to be married in a particular simulation. In order to avoid these issues, we allow the user to create a super-set of potential male partners, so that rather the last female in the marriage pool to be select an unlikely match, there are a number of males to choose from. In addition we employ the Order of Decreasing Differences algorithm of Howard Redway at the DWP, which creates a measure of the distance of an individual from the centre of the population (or the average characteristic of the population) and selects the females with the most *unusual* characteristics, who are likely to be the most difficult to match, to be matched first. The logic is that those in the centre of the data "average people" are more likely to find a good match than someone at the extremes. The difference with the traditional approach, where more "average women" where matched before their "less-average sisters", is that now the best match becomes a bit less good, but the worst match can be expected to be (considerably) better.

3.5. Alignment

This section describes the alignment function contained in LIAM. The objective of alignment is to ensure that output aggregates match external control totals. The reason this is done is that micro behaviour (both social and economic) is extremely complex and micro-theory being limited, cannot predict accurately all the variability of the system (in this case the life paths of individuals). In addition, a household model only makes forecasts about a small part of the economy and largely ignores interactions with the rest of the world economy. Also, data taken from relatively short periods of time may not fully reflect the dynamics within the household sector over time. As a result dynamic micro-models may not be able forecast aggregate characteristics of the population well. Furthermore, these models are highly sensitive to Monte-Carlo variance, and the aggregated results are extremely difficult to alter in the development phase of the model. Alignment is one solution to this problem.

In the discrete choice models, the output for each individual is a probability. In order to use these models for predictive purposes, a decision rule is necessary. In other words, what forecasted probability or higher will produce an event. In order to predict a state with a logit (or probit model), one draws a random number uniformly distributed number u_i. When $u_i < \text{logit}^{-1}(\alpha + \beta X_i)$ (or $u_i < \text{p}robit^{-1}(\alpha + \beta X_i)$), then a state is predicted to occur. However, Duncan and Weeks, (2000) highlight that *"even in functionally well-specified models, the predictive performance is poor, particularly where some states are relatively densely or sparsely represented in the data"*. Thus the further the probability of an event occurring is from 0.5, the less effective these decision rules are at producing the desired result. As a result models may under or over predict the number of events. So for example if 5% of individuals of individuals should have the event, then the logit model may not necessarily produce 5% of events. Alignment will however constrain the event to occur to 5% of individuals, using a method described below. This alignment procedure is effectively a calibration mechanism and will produce the correct proportion of events. Care must be however taken in its use as it may disguise errors in the model specification.

The MIDAS version of LIAM applies alignment to the aggregate proportion/number in a state or moving between states. A simple analogy about the relationship between alignment and the process modules is that the process modules such as logit models not directly decide for which individual in the dataset any event *x* will happen or not, but instead produce a ranking variable, that can be used to rank individuals to the risk they run for event *x* happening. Next, the alignment mechanism selects the number of transitions and applies that number of events to those with the highest risk (i.e. those first in line).

For example, in our econometric model we may have an equation of the probability of dying as described in equation (1), that depends on age, gender and whether an individual is disabled or not. Assuming that disabled people have a higher mortality rate, then given the same age and gender and distribution, as expressed by the stochastic component ε_i, the mortality distribution for disabled people will be higher.

$$\text{logistic}(p_i) = \alpha + \beta_1 \times Disabled_i + \beta_2 \times Age_i + \beta_3 \times Gender_i + \beta_4 \times Disabled_i \times Age_i + \varepsilon_i \quad (1)$$

The deterministic component of the model will result in those with a higher risk, having a better chance of the event occurring, while the stochastic part will ensure that there is some variability (so that not only those with high risk are selected). This model therefore produces the risk of dying.

In order to select the number of people that die, we use the alignment probabilities. Firstly individuals are grouped into the appropriate age and gender groups. As everyone in the relevant group will have the same age, gender and occupation, they only differ by the deterministic component for disabled people $\beta_1 \times Disabled_i + \beta_4 \times Disabled_i \times Age_i$ and the stochastic component ε_i. The object then is to select to die, the people in the group with the highest probabilities of dying. As β_1 is positive, proportionally more disabled will die than non-disabled. As a result we see that the output of the model equation is used to rank the individuals to whom the event occurs, but to leave the decision to the alignment process.

3.6. Conclusions

This paper presents the LIAM dynamic microsimulation framework that has been used to develop the model MIDAS for Belgium, Germany and Italy.

Parameterisation has been used extensively throughout the model. This aids flexibility as code does not need to be reprogrammed when parameters change. This in turn improves the durability of the model as it allows new parameters to be included when better information becomes available.

Moreover, when adding new variables to the model, alterations need only to be made in one place, in a parameter file. It therefore reduces the possibility of error and makes the model easier to change.

Using modularisation, all modules work independently of others which means that new modules can be added without affecting the integrity of the model. It therefore adds to the robustness of the model. Also, by allowing the user to focus on small sections of code at time, improves the transparency of the model.

Generalisation of main features of the dynamic model allows for the code which runs transitions, alignment and transformations to be reused for different purposes. Taking these as templates, one can declare a new module in the parameterisation of an existing type and simply change the parameters in order to produce a new process module. This makes the framework highly flexible and adapted to the needs of those developing micro simulation models. A final strong feature of LIAM is its ability to have outcomes align to exogenous current or prospective data.

3.7. References

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3.8. Appendix 1

In LIAM, macro alignment occurs by specifying:

1. Alignment Sheets need to be the same shape for each process (but macro can be a subset), as does the predictor
2. Create Temporary Set of Alignment Structures of type talign (= n+1, where n is the number of processes to be macro aligned - structure (0) is to store the macro level)
3. For each sub process, run through conditions and count the number of people (level.nPer) who meet conditions who are in each alignment cell (we don't store predicted probability at this point as we don't know it - maybe simply assign zero and use the existing code)
4. For macro process, do the same
5. Multiply the cell p times the number in cell N = np, the number to be selected in cell
6. If the sub-processes are more disaggregated than the macro level, collapse to the lower level by summing N over the higher level (ie across education levels)
7. Now we have the N's for the 2 dimensional table for macro and each sub-process. Sum over sub-processes to get expected overall N_t and compare with the Macro N_m
8. To adjust multiply the highest level of the macro sheet (in this case level 2) In each of the sub-process by N_m/N_t
9. Backup original Alignment numbers (to be used in the following year)
10. Store new Alignment totals in the sub-process alignment structures.

Figures

Figure 2: Description of a dynamic module

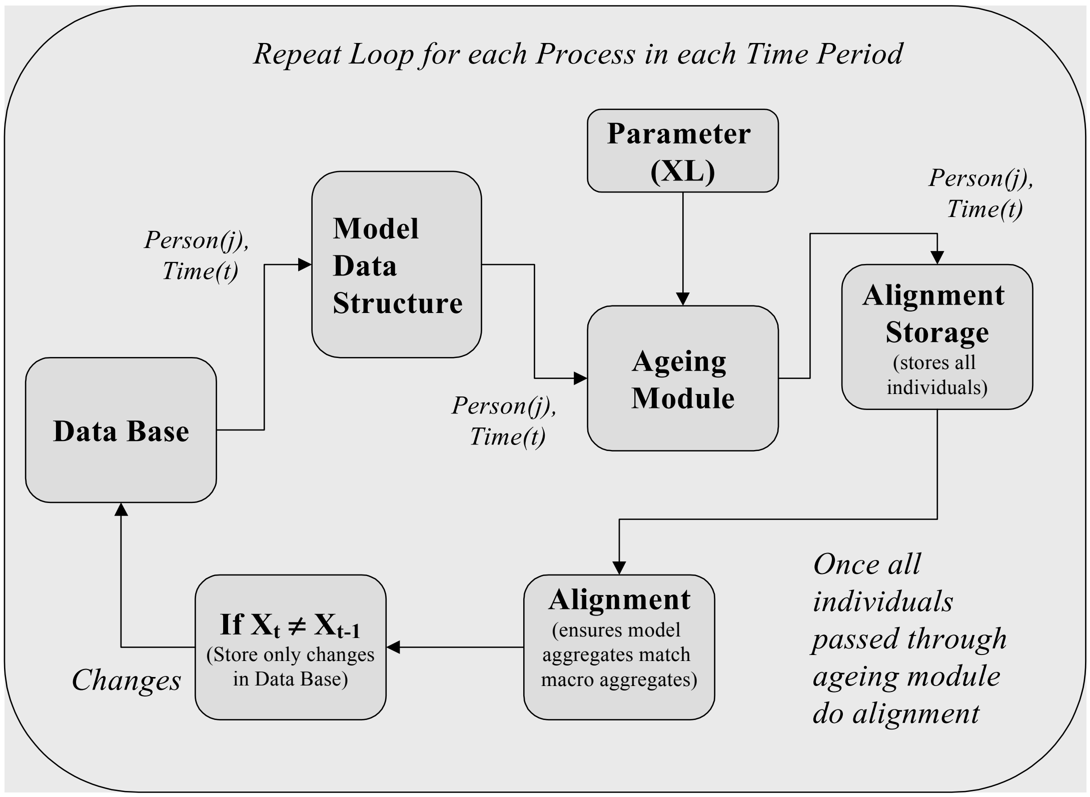
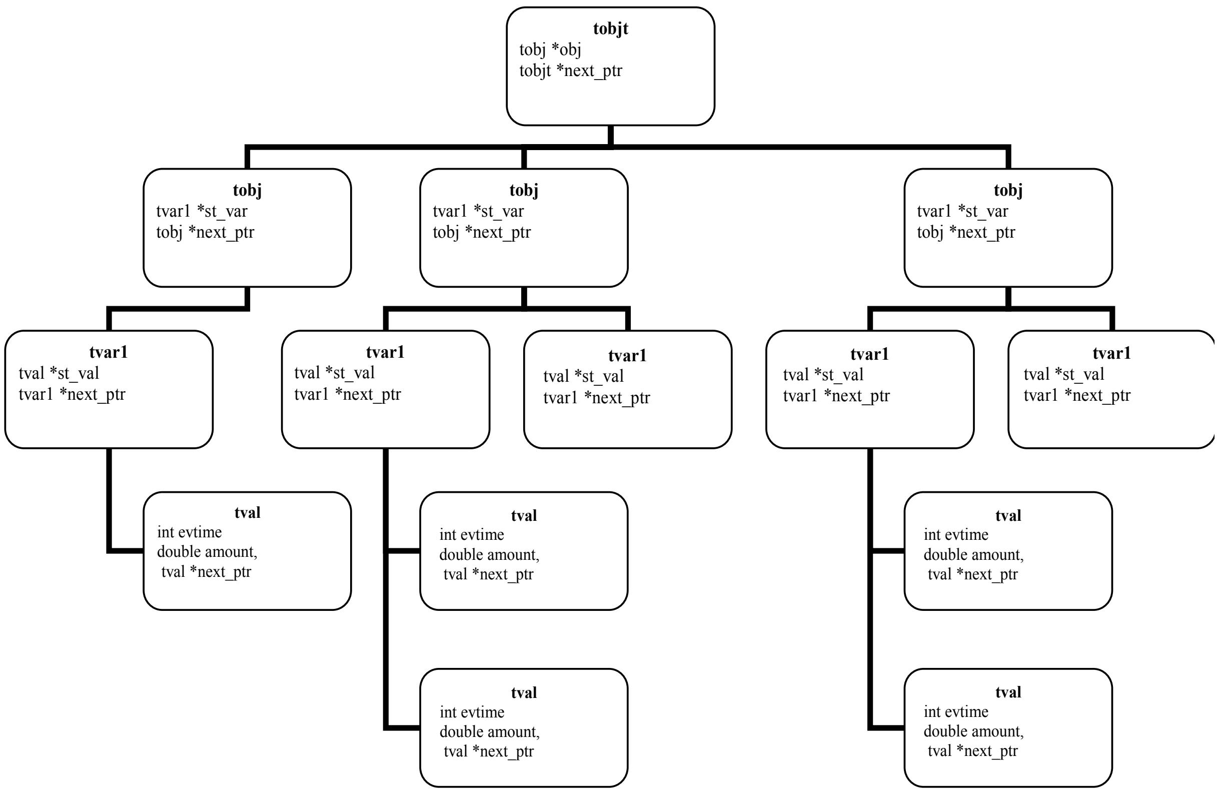


Figure 3: Model data structure



The data is stored in a hierarchy of object types (**tobjt**) such as person, household, firm etc.

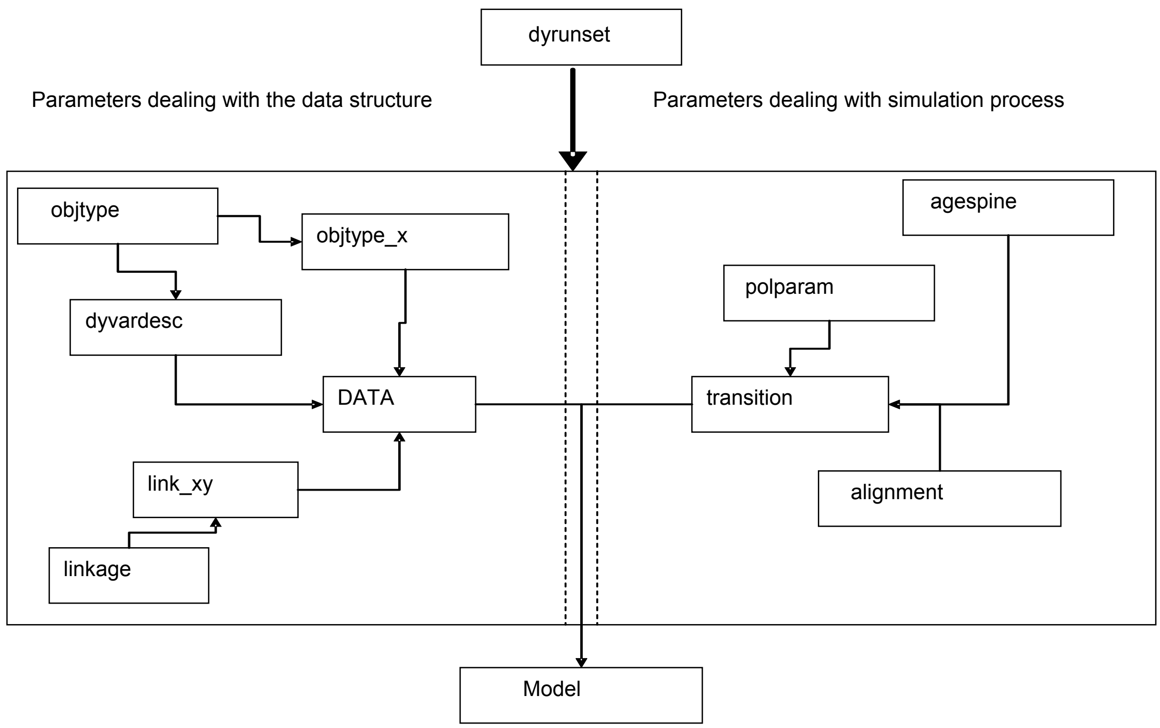
Each of these object types themselves consists of a number of objects (**tobj**) such as the actual incidence of a person or household.

Events (**tvar1**) such as births, tenure status or identification number then occur to objects.

Each event can have a number of incidences or values (**tval**).

For each event it is necessary to know what event occurred (**tvar1**), when it occurred (**tval.evtime**), and the value of the event (**tval.amount**)

Figure 4: Parameter hierarchy



dyrunset: parameters necessary to run the model, input/output directories, time period to be run etc.

objtype: This file tells the model how many object types there are (region, household, person etc.).

objtype_x: contains the incidences of each of the object types (r, h, p, etc.). So objtype_p would contain the set of id's of all persons.

dyvardesc: In this file, all variables used in the model framework are declared and described.

linkage: these parameters define the set of possible links between objects.

link_xy: Stores the linkages between objects.

agespine: contains the list of modules to be run in the dynamic model.

transition: Each module has a corresponding parameter sheet in the parameter file "Transitions". These parameter files tell the model the output variables of each process, what type of process, whether a process needs to be aligned and the actual process parameters themselves such as the transition rates, regression equation and policy rules etc.

***alignment*:** If a particular process is to be aligned, then the model framework will look for an appropriate set of *alignment* parameters.

***polparam*:** this parameter set contains information associated with each parameter for each possible "system", where the system to be run is defined in the *dyrunset* parameters.

See Parameterisation section for more detailed description.

4. The MIDAS model for Belgium, Germany, and Italy

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The microsimulation model MIDAS consists of different modules, being the demographic module, the labour market module and the pension module. The demographic module is for the three countries developed by the FPB, the common labour market module is developed by the DIW and each partner is obviously responsible for the development of its own pension module. This chapter contains a general description of the three modules, followed by the country-specific estimation results of the behavioural equations.

4.1. Demographic module

The first module is the demographic module. This module is compound of four different main parts: The birth process, the survival process, the education process and the marriage market.

4.1.1. Overview

a. The birth process

Estimating a behavioural equation explaining the probability of child birth was not possible, due to a lack of observations. Fertility processes is therefore fully driven by the alignment procedure that is based on the 2004 demographic projections created by Eurostat and used by the AWG. Using only the alignment procedure and given their age, the selection of women that are going to give birth is independent of any behavioural equations. Future mothers are selected randomly through women between 15 and 50 so as that they reproduce fertility rates given as a reference by the alignment.

b. The survival process

For the same reason as with the birth process, the mortality process is completely determined by the Eurostat survival probability tables projections used by the AWG. These mortality tables are introduced through the alignment procedure.

c. Educational attainment levels

The education submodule consists of two serial steps. First, using observed education levels, every ten-year old individual is by chance 'assigned' a level of education. The below Table 1 contains the codes of the International Standard Classification of Education (ISCED) and the group variable used and simulated by MIDAS.

Table 1: Education levels in MIDAS

ISCED-classification		MIDAS grouped variable
0_1	pre-primary and primary education	1
2	lower secondary education	1
3A	upper secondary level, general	2
3B	upper secondary level, vocational or technical B	2
3CL	upper secondary level, vocational or technical, long	2
3CS	upper secondary level, vocational or technical, short	2
4	post-secondary, non-tertiary education	2
5A	first stage of tertiary education	3
5B	tertiary non-university level	3
5A_6	levels that correspond to both ISCED levels 5A and 6	3
6	second stage of tertiary education	3

So the education level is randomly determined and follows probabilities given in Table 2 below. Of course, this is only done for unobserved individuals born after 2002 whose education level is not present in the base dataset.

Table 2: Observed education levels (percentages of age groups)

	15-19	20-24	25-29	30-34	35-39	40-44	45-54	55-64
Belgium								
1	76.65	18.58	19.76	24.71	29.94	36.84	45.21	58.33
2	23.28	61.06	39.92	38.82	37.65	34.76	30.09	23.14
3	0.08	20.36	40.32	36.47	32.41	28.40	24.70	18.53
Germany								
1	93.80	26.73	15.99	14.40	13.86	14.55	16.18	22.67
2	6.09	69.42	66.56	60.54	60.00	59.73	58.64	56.24
3	0.10	3.86	17.45	25.06	26.14	25.71	25.18	21.09
Italy								
1	87.83	30.17	35.03	43.30	47.13	49.79	59.62	75.96
2	12.17	68.46	53.76	43.75	41.72	39.34	30.02	17.59
3	0.01	1.37	11.20	12.95	11.15	10.87	10.36	6.46

Source: Own calculations on data from the Labour Force Survey, OECD[16].

[16] The table presented in the text has been derived from Labour Force Survey data downloaded from the OECD statistics website (http://stats.oecd.org/). The data was extracted on January 18th, 2007. Data are numbers of individuals of a certain ISCED level of education, and of a certain age group, as a share of the population (PO_FREQ)

The above Table 2 contains the probability of observing an individual having a level of education 1 to 3 by age group. Which age category has to be chosen as the point of departure of the assignment process? As this routine is applied to ten-year olds, one would think that the percentages pertaining to the youngest age category should be used. However, this would be a mistake because the level of education set will remain unchanged for the entire life span of the individual. By contrast, the observed probabilities of young individuals will change with age as they 'move through' the educational system. For example, that the observed percentage of individuals aged between 15 and 19 with the highest level of education is close to zero, should not come as a surprise, since one typically enters studies of this level at 19 or older. The observed percentages of lower age groups therefore underestimate the true future education probabilities. And indeed, in younger age groups, one sees the probability of being enrolled in a lower (higher) level of education decrease (increase) with age category.

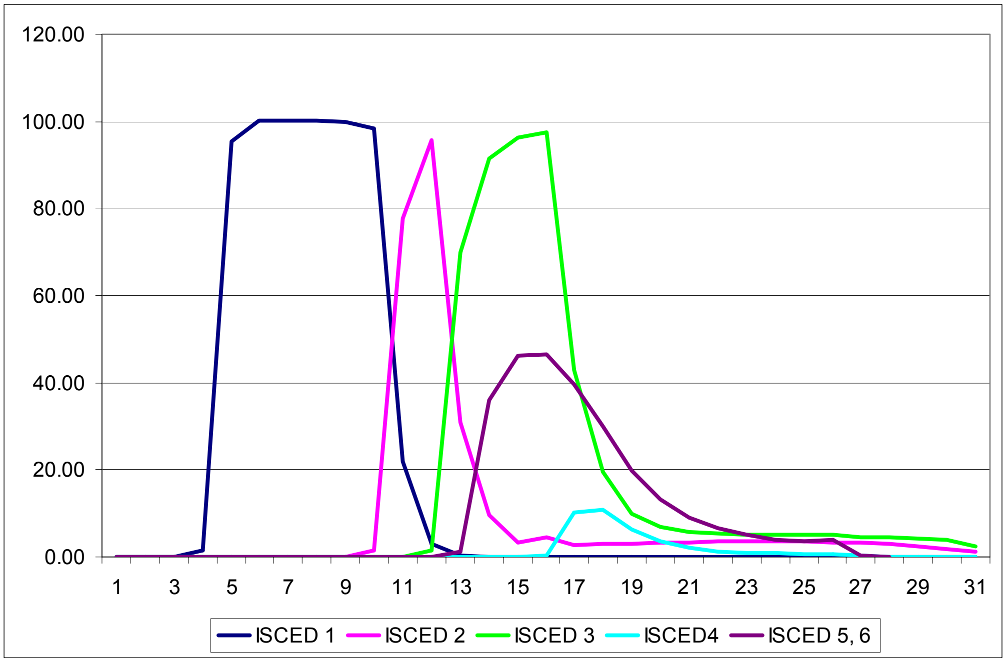
In the other extreme, one may be tempted to solve this problem by selecting the observed probabilities of the oldest age categories (in this case of individuals between 55 and 64 of age). However, this would assume that the education probabilities remained unchanged over time. This of course is not the case. Over time, more and more individuals have enrolled in higher levels of education. Put differently, 20 years ago, the average level of education of the population was lower than it is today. As a result, from a certain age category on, we observe a decrease (increase) of the observed probabilities of higher (lower) levels of education.

So we have to choose an age category where the individuals are old enough for the majority of them to have completed education, but young enough to be representative for the youngest generation finishing education. We have decided to use the observed probabilities of the age category between 25 and 29 years old in the case of Germany and the observed probabilities of the age category between 30 and 34 years old for Italy and Belgium.

Given the assigned or observed level of education, the second routine of the education submodule determines if an individual is still in education or not. This status will depend on the level of education. An age of education ending will be associated to each education level. The average age of education ending is computed on AWG participation rates for each level of education. We have education participation rates from 2002 to 2050. However, these projected rates do not change much over time, as will be shown below

The below Figure 5 presents the observed participation rates to age and ISCED-level in Belgium in 2002.

Figure 5: Observed participation rates to age and ISCED level



Source: AWG-projected education expenditures, Eurostat.

For example, we observe that 100% of the 7 year olds are participating in a training or education of the ISCED 1 level. And about 5% of the 24 year olds participate in an ISCED 3 level education or training programme.

Now we calculate the average age of education ending as that age where 50% or less of the individuals in that age group that did participate when they were younger, have ceased to participate in this education or training programme. For example, the highest participation rate of ISCED 5 and 6 (university) is a bit higher than 23 %. So, the average age of education ending at ISCED 1 is the lowest age where the participation rate is 0.5*23%=11.5% or lower. This is at the age of 23.

Table 3 shows the resulting average ages of education ending in Belgium, Germany and Italy, and given the various levels of ISCED.

Table 3: Average ages of education ending

ISCED	Belgium	Germany	Italy
1	12	11	11
2	14	17	14
3	18	20	19
4	21	21	25 (2002) 27 (from 2003 on)
5/6	23	28 (up to 2006) 27 (from 2007 on)	25 (up to 2004) 26 (from 2005 on)

Source: Own calculations based on AWG-projected education expenditures, Eurostat.

For comparison, the below Table 4 contains the theoretical ending ages to level of education.

Table 4: Theoretical ending ages for level of education

ISCED	Belgium	Germany	Italy
1	11	10	10
2	13	16	13
3	18	19	18
4			
5	21	25	23
6	23+	28	31

Source: European Commission, 2005, Table IX.1., page 145.

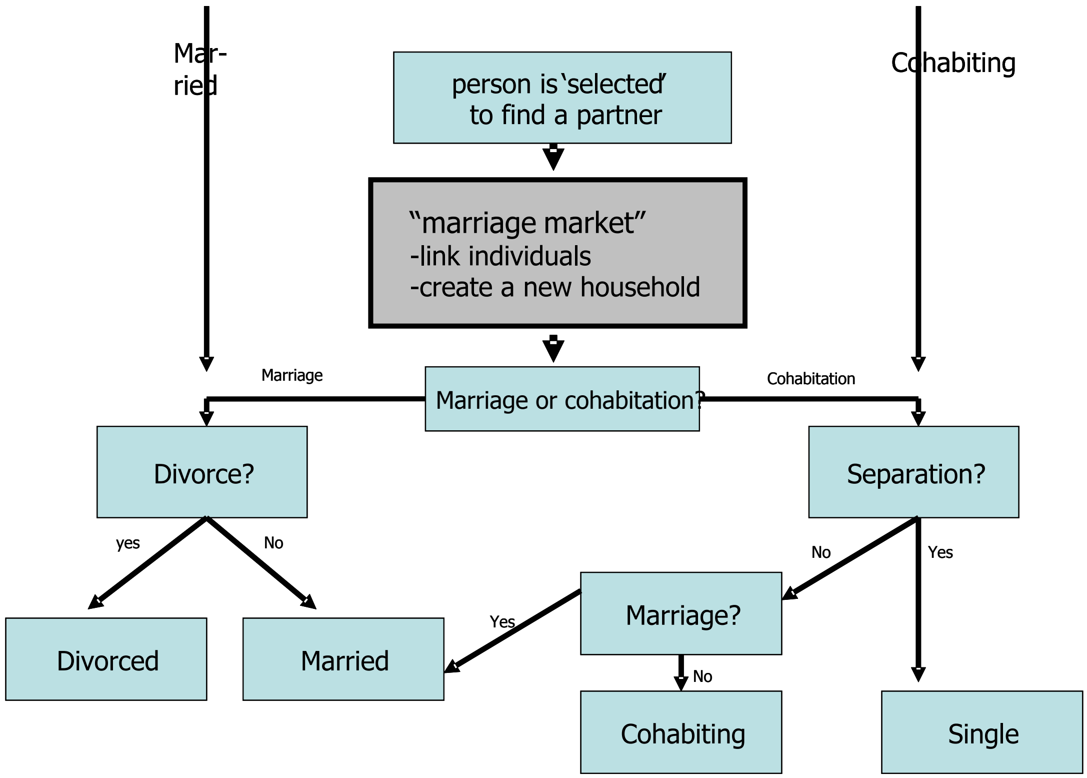
Note that the ending ages in Table 3 are systematically one year higher than those in Table 4, especially for the ISCED 1 to 3. This may be due to definition differences. After all, the average age of ending a certain level of education in Table 3 is that age where 50 or less of the individuals in that age group that did participate when they were younger, have ceased to participate in this education or training programme. So, it is to be interpreted as the *first age at which one has ceased to be in education*, given the level of education. In a discrete environment like MIDAS, this of course is one year plus that age at which one has ended education.

Furthermore, the ending ages in Table 3 take into account those students that failed their exams and that therefore graduate when they are one year older than the theoretical ending age.

d. The partnership formation process

The third demographic sub module is the partnership formation process or "marriage market". The below Figure 6 describes this module.

Figure 6: The marriage market



This process links candidates eligible to marriage as well as cohabitation. It is therefore better to speak of it as the 'partnership formation process'. The actual process of partnership formation is a three stage process, which starts with a simple random selection procedure selecting males and females in the population who are eligible for marriage or cohabitation. In the second step and for each of the selected females, a vector is constructed that contains the probability that she will become partner with any of the males eligible. These probabilities are a function of the difference between the two potential partners with respect to several variables, such as age, education level, having a job, and so forth. The third step in this process is the selection procedure itself. This procedure selects each female in turn, and matches her with a male. For each woman eligible to marriage, each cell of the vector contains the probability that she forms a partnership with each of the available men. The actual matching takes place in an order based on these regression results. The mean and standard deviation for each of the variables in the regression is calculated. For each female the absolute value of the variable amount subtracted from the mean is calculated and then divided by the standard deviation. This division by the standard deviation normalises each variable to the same magnitude. So the following formula is used.

$$\sum_{n=1}^{N} \frac{abs\ (m_n - v_n)}{s_n}$$

where:

N = total number of variables in the marriage market regression.

m = mean of the variable.

v = value of that variable for the particular female.

s = standard deviation for the variable.

The sum of all these results for each female is ranked in order with the highest value determined to be the furthest from the mean of each of the variables, and thus the most difficult female to match. In other words, LIAM selects the females furthest from the mean for each of the standard variables in the regression to be linked to a male first. This ensures that the females most difficult to match are matched before those less difficult to match. The females easiest to match, as they are closer to the mean, are matched last. When a female is to be matched, the male with the highest probability calculated from the regression and still available is selected to be married. Links are then created between the new spouses, and they receive the same household number.

Once two individuals are linked into a couple, the next step consists in determining whether a new couple is married or cohabiting. This is done with a simple selection procedure, based on a logit regression. This procedure is operated just after the partnership process. When cohabiting is chosen, this does not mean that the couple cannot decide later to marry. An additional procedure based on a logit regression permits the transition from cohabitation to marriage. The probability of this happening is, among other things, based on the duration of the period of cohabitation

Note, finally, that marriage or cohabitation is just one way in which a new household can be formed. Another way is that young individuals 'leave the nest' and start a new household of their own. The two conditions for the creation of a household are based on age and marriage. If a woman marries before reaching the age of 24, then a new household is created for her, and her husband and children are brought into this new household. If a male or female remains single until the age of 24 then a new household is again created at that age. If marriage occurs after the individual has reached the age of 24, then he or she has moved out of the parents' household at the age of 24 and no new household is created at marriage. The new husband will join his wife in the existing household.

Any routines describing household formation obviously come with routines describing household dissolution. Indeed, all couples are subject to a certain risk of divorce (in case of marriage) or separation (in case of cohabitation). The probabilities of this happening are again the result of conditional logits, with among other things the duration of the marriage or cohabitation as explanatory variable. The function "divorce" creates a new household for the male partner. The female partner stays in her household with her children. The modelling of divorce and separation however introduces a difference between married and cohabiting couples. If a married couple divorces, the two now single individuals enter the ‘divorce’ state. Analogous to this, if the spouse of a married individual dies, the remaining partner becomes a widow(er). In contrast, cohabitants who split up get the marital status they had before the cohabitation started.

Finally, the demographic module simulates several dependent variables on the individual level (including duration variables, retrospective variables on demographic events), as well as on the household level (size and composition of the household).

4.1.2. Behavioural equations for Belgium

The only behavioural equations of the demographic module are those of the marriage market sub-module. This section thus discusses only regressions pertaining to the marriage market in Belgium.

Two general remarks pertaining to these estimated models of the demographic module but also of the labour market module have to be made. First of all, as a general rule, selection of explanatory variables is not just based on their statistical significance, but also on their effect on the simulation results. This is the most obvious in the case of multicollinearity, i.e. when two explanatory variables are correlated. The significance level of these variables may then be low, but their impact on the dependent variable –in conjunction with each other- may be important. Furthermore and secondly, many of the estimated models describing variables in the field of demographics or the labour market also include a set of dummies for the different waves of the data base. As they are not used for simulations, estimated coefficients of these dummies are not reported in these tables.

The first equation to be discussed is the one related to the partnership formation process between two potential partners. Once the pool of individuals that are eligible for marriage is determined, a regression is estimated to calculate the probability that a particular female will form a partnership with a particular male. This probability is based on the difference between the variables specified in the regression.

The dependent variable of the logit regression is defined as *partnership formed*, taking the value 1 if two selected individuals eventually got married / cohabit, and 0 if they did not get married / cohabit. Explanatory variables are chosen as to check the role of the working status of man and woman, their levels of education, and their respective ages on the decisional process of forming a couple (or not). Specifically, the set of regressors includes: a cubic function of age of male partner, a cubic function of the age difference between the male and female partners, and dummies based on the working status (*inwork1-4*) and the education level (*education1-9*) of the selected individuals. Table 5 and Table 6 provide details on the two latter variables.

Table 5: Working status of the couple

Dummies	Men's working status	Women's working status
inwork1=1 (=0 elsewhere)	Not working	Not working
inwork2=1 (=0 elsewhere)	Working	Not working
inwork3=1 (=0 elsewhere)	Not working	Working
inwork4=1 (=0 elsewhere)	Working	Working

Table 6: Education status of the couple

Dummies	Men's education level	Women's education level
Education1=1 (=0 elsewhere)	1	1
Education2=1 (=0 elsewhere)	2	1
Education3=1 (=0 elsewhere)	3	1
Education4=1 (=0 elsewhere)	1	2
Education5=1 (=0 elsewhere)	2	2
Education6=1 (=0 elsewhere)	3	2
Education7=1 (=0 elsewhere)	1	3
Education8=1 (=0 elsewhere)	2	3
Education9=1 (=0 elsewhere)	3	3

Notes: 1=high educated; 2=medium educated; 3=low educated.

A general to specific approach is applied to select only significant explanatory variables, or at least those that can not be removed without worsening the quality of fit of the regression. Note that *inwork1* and *education1* are poured into the constant term to avoid colinearity.

Table 7: Estimation results for the formation of a new partnership

	Coef.	Std. Err.
Age	-0.4893***	0.1217
Age^2	0.0131***	0.0029
Age^3	-0.0001***	0.0000
Age difference	0.0467***	0.0138
Age $difference^2$	-0.0189***	0.0016
Age $difference^3$	0.0003***	0.0000
Inwork2	-0.9087***	0.2039
Inwork3	-1.3286***	0.2636
Inwork4	-0.6549***	0.1828
Education2	-0.7939***	0.1615
Education3	-1.4128***	0.2664
Education4	-0.8984***	0.1737
Education7	-1.5530***	0.3247
Education9	0.5451***	0.1687
Intercept	1.7198	1.6071
Number of obs.		90954
Pseudo R^2		0.1090

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01.

As Table 7 shows, the selected regression is rather satisfactory. Many coefficients are significant, and the three categories of explanatory variables do play a clear role in the explanation of the probability of forming a couple or not. A cubic influence of the man age and of the age difference in couple is checked, enlightening an asymmetric gender effect for this variable. Actually, the level of estimated coefficients implies a negative impact both of the man age and of the age difference. Also, when at least one individual is working, the probability of forming a couple is lower than if the two were inactive in the labour market. Such a negative effect is also observed in some education patterns, the only exception is when the two individuals are low educated: in this situation, the probability for them to become partners increases.

After the marriage market has selected and linked the two partners on the basis of the results of the above regression, a logit determines whether the new couple is married or cohabits. To estimate this logit, we select observed just formed (real) couples (i.e. the same subsample as the above regression) and the dummy dependent variable of the logit equation is whether they live in cohabitation. The set of explanatory variables remains unchanged. Results are presented in Table 8.

Table 8: Estimation results for the choice between marriage and cohabitant

	Coef.	Std. Err.
Age difference^2	-0.0308***	0.0100
Age difference^3	0.0014**	0.0005
Inwork1	1.5615***	0.4400
Education9	1.5767***	0.5124
Intercept	-1.8934***	0.4173
Number of obs.		220
Pseudo R^2		0.1268

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01.

The results suggest that the probability of being married (rather than being cohabitant) rises only for a working man – not working woman couple, and/or for low educated partners. The other situations in the working status or in education have no significant role. Also, a non linear effect of the age difference is observed, which is often negative though positive for higher age differences (>22 years). Notice that we have included as regressor the working status of the *previous* year, as the logit equation with the *current* year of that variable shows a poor performance. Besides, the number of observations available for the analysis is quite limited (220 newly formed couples), but the overall quality of fit remains acceptable for a panel data regression.

The last regression of the marriage market module concerns the failure in partnership. The basic idea is to select observed individuals who shifted from the marital status 'in couple' to the marital status 'still in couple' or 'no more in couple', and to gather characteristics on the partners in the last year of existence of the couple: age, education, children, working status. To the usual set of regressors is added the number of children between 12 and 15. Notice that we use the working status of the last year of partnership because in one specific year, the recorded working status might be posterior to the date the couple status changed. Separated logit equations are applied for married individuals and for cohabitants, and the estimation results are presented in Table 9.

Table 9: Estimation results for the failure in relationship

	Failure in marriage		Failure in cohabitation	
	Coef.	Std. Err.	Coef.	Std. Err.
Age difference	0.1430**	0.0703	-	-
Age difference^2	-0.0088	0.0057	-	-
Number of children 12-15	0.6714***	0.2108	0.7107**	0.2812
Duration of relationship	-0.0785***	0.0156	-0.0558*	0.0337
Inwork4	-0.8142***	0.3130	-0.6051**	0.3293
Intercept	-4.5463***	0.3334	-3.3366***	0.2605
Number of obs.		15226		1675
Pseudo R^2		0.0742		0.0279

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

The probability of divorce for Belgian married individuals is checked to negatively depend on the duration of the relationship. At the other hand, the number of older children (between 12 and 15 years old) increases the probability of divorce while the number of younger children (less than 12 years old) has no effect. The significant estimated values for the quadratic function of *age difference* suggest that the effect of age difference on the probability of divorce is positive but decreasing as the difference of age increases. Also, when both partners are active in the labour market, the probability of divorce is lower than when one partner, or none of them, is working (in the latter case, coefficients are not significant). We finally observe that the education difference between partners does not influence the decision to stop the marriage.

Results are quite similar when we turn to failure in cohabitation. Again, the number of older children has a positive effect on separation, while duration of the cohabitation as well as the situation where both partners are working, have a negative impact. The only difference with the previous model is the age difference, as this variable does not play a role in explaining the separation of cohabitants. Notice also that the estimated coefficients in the cohabitant regression have slightly larger values than the ones coming from the marriage regression. The probability of failure of cohabitation cet. par. is higher than that of divorce.

4.1.3. Behavioural equations for Germany

This section reports the estimation results for the German marriage market module (for a a more comprehensive description of the marriage market model in MIDAS see section 4.1.1. The sets of dummies that are used in the following regressions to control for the employment status (*In-*

work1-Inwork4) and education level (*Education1 – Education9*) of both partners are described in Table 5 and Table 6 of the preceding section 4.1.2.

The first equation determines the partnership formation process. The second equation determines whether the couple is married or lives in a consensual union. The last two equations finally describe the probability of failure in cohabitation and, respectively, marriage.

We start with reporting the regression results for partnership formation (table 10). All variables except for those controlling for the presence of children and some interacted education dummies show a significant effect, and effects are similar to the results for Belgium. First, the asymmetric gender effect of age can also be found in Germany. Second, comparing to a non-working couple, all other combinations of employment states between partners significantly reduce the probability of forming a partnership. This evidence is also identical to the Belgian case. Moreover, it shows that having the same educational level significantly increases the likelihood to start a new relationship than any other combination of education levels.

Table 10: Estimation results for forming a new partnership

	married	
	Coef.	Std. err.
Number of children 0-11	-0.0042	0.0294
Number of children 12-15	0.0249	0.0981
Age	-0.7010***	0.1016
Age2	0.0190***	0.0027
Age3	-0.0001***	0.0000
Age difference	0.0568***	0.0077
Age difference2	-0.0185***	0.0011
Age difference_3	0.0003***	0.0001
Inwork2	-0.2603***	0.0699
Inwork3	-0.5216***	0.1060
Inwork4	-0.1469*	0.0729
Thiedach1	0.5223***	0.1035
Thiedach3	-0.4489**	0.1473
Thiedach4	-0.1247	0.0975
Thiedach5	0.1013	0.0739
Thiedach6	-0.1944*	0.0959
Thiedach7	-0.6203***	0.1819
Thiedach8	-0.2808**	0.1028
Thiedach9	0.6010***	0.1032
Intercept	1.9170	1.2083
Number of obs.	1339584	
Pseudo R2	0.06	

Table 11 shows the regression results for a newly formed couple's choice between marriage and cohabitation. Here, our key findings are as follows: Whereas having young children increases the likelihood to marry, older children have the opposite effect. The set of education dummies remains insignificant. By contrast, the set of dummies that control for the combined employment status of both partners are all significant. That is to say, the probability of marriage is highest when the male partner is employed and his spouse does not work. Unlike the previous model, these results differ considerably from the Belgian case. In opposition to Belgium, the difference in age between spouses remains insignificant in the German model. Moreover, children do not have any effect on a couple's choice between cohabitation and marriage in Belgium.

Table 11: Estimation results for the choice between marriage and cohabitation

	cohab	
	Coef.	Std. err.
Number of children 0-11	1.0080***	0.0975
Number of children 12-15	-0.4630*	0.2087
Age	0.8250***	0.1992
Age2	-0.0221***	0.0053
Age3	0.0002***	0.0000
Inwork2	0.5830***	0.1631
Inwork3	0.1729	0.2258
Inwork4	0.1508	0.1601
Intercept	-9.6390***	2.3630
Number of obs.	1956	
Pseudo R2	0.12	

The last two equations determine the process of separation and divorce.

Table 12: Estimation results for the failure in relationship

	divorce		fail in cohabiting	
	Coef.	Std. err.	Coef.	Std. err.
Number of children 0-11	-0.1630*	0.0712	-0.1570	0.0966
Number of children 12-15	0.3287***	0.0996	0.0651	0.1885
Age	-0.0351	0.0201	0.0141	0.0209
Age2	0.0000	0.0002	-0.0006*	0.0003
Duration marriage	-0.0471***	0.0116	-0.0574	0.0402
Age difference	-0.0036	0.0134	-0.0113	0.0158
Age difference2	0.0018***	0.0005	0.0001	0.0011
Inwork2	-0.7093***	0.1785	-0.0957	0.1852
Inwork3	0.5830**	0.1921	-0.0832	0.2108
Inwork4	-0.3363*	0.1625	-0.6101***	0.1699
Intercept	-2.2498***	0.4801	-1.6673***	0.4061
Number of obs.	32972		4002	
Pseudo R2	0.06		0.03	

As Table 12 shows, the probability for a couple to divorce or separate negatively depends on the duration of the partnership. Additionally, young children negatively affect the likelihood of divorce or separation. This effect, however, changes with children growing older. Moreover, the likelihood of divorce increases with the age difference between partners. Interestingly, the likelihood of divorce is always lower when the male spouse works compared to the case where he does not work. In the case of cohabitation, the relationship turns out to be more stable if at least one partner works and to be most stable if both partners have a job.

4.1.4. Behavioural equations for Italy

This paragraph presents the behavioural equation for the marriage market module for Italy. See paragraph 4.1.2. for a detailed description of the marriage market. In the demographic module the set of significant explanatory variables used in the regressions do not differ greatly among countries. The first equation estimated is the probability of partnership formation and the results are shown in Table 13 below.

Table 13: Estimation results for the formation of a new partnership

	Coef.	Std. Err.
Age	- 0.3759***	0.0896
Age^2	0.00951***	0.0019
Age^3	- 0.00006***	0.0000
Age difference	0.1141***	0.0119
Age $difference^2$	- 0.0228***	0.0013
Age $difference^3$	0.0003***	0.0000
Inwork4	- 0.1047*	0.0639
Education3	- 1.4434***	0.3055
Education5	0.3443***	0.0764
Education7	- 2.1890***	0.4501
Education9	0.5310***	0.0775
Intercept	- 1.1917***	1.2672
Number of obs.		374360
Pseudo R^2		0.0966

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01.

The usual explanatory variables for this equation (age of man, age difference, measures of distance between partners in education and working conditions) have mainly significant coefficients, confirming the robustness of the specification. Specifically man age and age difference between the partners both have a cubic effect: the estimated coefficients imply a predominantly positive impact of the man age[17]; regarding the age difference between partners the effect is mainly positive[18]. The probability of forming a couple increases when both partners work and have the same level of education (more precisely the low and medium level) compared to case

[17] Negative only before the age of 26 and above that of 74.

[18] Age difference is positive and ranges between -10 to 3 years of age gap, then it is negative when age difference ranges between 3 and 12 years.

where the potential partners differ in working status and educational attainment, while there is a negative impact if the two partners have a different level of education whatever is the gender of the one with the higher level. The positive influences of similar partners' characteristics imply that the formation of a partnership follows an assortative mating pattern (Pencavel, 1998).

The second equation in the module determines the probability that the new couple is married or cohabits. This distinction is considered in the model even if only married individuals have welfare (and pension benefit) implications. The regression results are shown in Table 14.

Table 14: Estimation results for the choice between marriage and cohabitant

	Coef.	Std. Err.
Age difference	0.1386***	0.0385
Age difference^2	- 0.0185***	0.0042
Age difference^3	0.0004***	0.00013
Age	- 0.3252***	0.0673
Age^2	0.0027***	0.0007
Education4	1.0764*	0.7536
Intercept	10.5623***	1.4886
Number of obs.		1093
Pseudo R^2		0.1890

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01.

The probability of being married (compared to being cohabitant) is highest when the couple is composed by highly educated men and a medium educated woman. The working conditions and the other combinations of the couple's education don't have a significant role. The age and the age difference both have a non linear effect: the age has a quadratic - mostly negative - effect[19]; the age difference has a third order polynomial effect and the marginal effect of age difference is mainly positive[20].

The marriage market sub module has two equations for the household dissolution: the probability of divorce (for married couples) and the probability of separation (for cohabitants).

In the base year dataset - created from the Eurostat ECHP data on Italy - the observations on divorced and separated couples are very few and the lack of observations influences the goodness of fit. To overcome this problem the probability of break off of the relationship is imputed by an alignment procedure based on the 2003 Istat data on divorce and separation. It is also assumed that the divorce and separation probability are the same and that the future projected probabilities will not change considerably over the simulation periods. Changes in the simulation trends

[19] It become positive after the 58 years of age.

[20] The effect of age difference turns negative only for values above 3 years (considering that the age difference ranges between -10 and 12 years).

that will occur to the percentages of divorced and separated are also influenced by the marriage and cohabitation probabilities and their subsequent trends.

4.2. Labour market module

4.2.1. Overview

The simulated demographic variables are used as input for the subsequent simulated labour market module. This module simulates the transition between different labour market states and also the corresponding income variables. All transitions are modelled as binary choice decisions (standard logit regressions), i.e. the outcomes are simulated sequentially. All decisions are assumed to be made individually, taking the characteristics and choices of the other household members as given.

The first regression identifies individuals who suffer from chronic illness. This characteristic is of relevance in the selection of the labour market state the individual remains in, or goes to. Next, for all those not in education, it is determined whether a person works during a year. The probability of labour market participation is modelled separately for women (men) for three different subgroups: those who were (1) in work, (2) not in work and not in education, (3) in education in the year before. For the first two subcategories, the labour market participation decision is modelled by a behavioural equation. The resulting activity rates are then aligned with the AWG projections that are specified to age and gender.

However, the in work decision is only the starting point. If the person is gainfully employed during the year, MIDAS simulates related labour market characteristics to that job. Given that a person is in work, she decides whether to work the whole year or only part of the year (decision with alignment) and whether to work as an employee or as self-employed. This is of particular importance because pension schemes differ largely between these different occupation groups in the three countries under consideration (BE, GE and IT), and our analysis is limited to pensions for employees and civil servants.

The transitions modelled for the employees are more complex than those for the self-employed. Employees are assumed to decide on whether to work in the private sector or in the public sector and in case of the public sector whether to work as a civil servant or as a normal employee in the public sector.[21] It is also simulated whether a person has a permanent or a temporary contract. Employees are assumed to decide (separately) on the number of months they work in a year (given that they have not chosen to work the whole year, see above). They decide whether they work full time or part time and about the number of hours worked per week. Save for Belgium,

21 This is of particular importance considering the differences between employees and civil servants with respect to the German labour market and different pension schemes.

where a simple cross-sectional OLS had to be used, the hourly wage rate for employees is determined by a random effects regression. The logarithm of the hourly wage rate is estimated separately for men and women as a function of several personal and job characteristics. Among these characteristics are potential labour market experience, tenure, type of contract, if the person works part time, her level of education and whether she works in the public sector (either as a civil servant or not). Real hourly wage rates increase with productivity over time. We adopted the above-mentioned assumptions about productivity from the AWG projections. Total yearly gross income of an employee is then finally determined by the number of months worked times the average number of weeks per month (4.33) times the individual hourly wage rate. In all countries considered, the yearly gross income from employment is the most important factor for the accrual of pension rights in the public pension schemes.

Given that a person does not work in a given year, it is simulated sequentially whether the person is unemployed, retired or in a residual inactivity category which comprises all remaining inactive states. Given that a person participated on the labour market in the last period but is not working in this period, the model simulates the inactive state via a string of conditional logits. First, the individual has a certain probability of becoming unemployed. If the person does not become unemployed, then she has a probability of becoming disabled. Else and specific to the Belgian case, one may be eligible for Conventional Early Retirement' Benefit (CELS). Next, one may be eligible for regular retirement[22]. If neither of these potential states has become effective, the individual enters the state 'other inactive', which basically is a balance entry. In the Belgian version of MIDAS, and in opposition to the other versions, most of these states, and certainly unemployment and retirement, use age and gender to align on AWG labour market projections.

4.2.2. Behavioural equations for Belgium

A first event that the labour market module simulates is whether one is chronically ill or not. The probability of this event happening depends on the starting state of the individual. It depends on if the individual was already chronically ill during the previous year or not.

[22] This description makes a stylized assumption that all these potential states exist. This may not be the case. For example, if an individual ceases to be in work at 65, then he or she almost automatically becomes retired.

Table 15: Estimation results for the chronically ill status - Men

	Chronically ill previous year		Not chronically ill previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	-0.1927**	0.0969	-0.3010***	0.0733
Age	0.0509***	0.0169	0.0292***	0.0020
Age^2	-0.0003**	0.0002	-	-
Married	-	-	-0.2543***	0.0767
Intercept	-1.2880***	0.4470	-4.0164***	0.1430
Number of obs.		2870		14745
Pseudo R^2		0.0258		0.0484

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

The variable *university* is a dummy denoting whether the individual has a university degree. This significantly reduces the probability that one is observed being chronically ill. Put differently, chronically ill men with a university degree have a higher probability of not being chronically ill. Furthermore, there is a quadratic effect of age. Indeed, the probability of remaining chronically ill increases with age, but the slope of this effect decreases. A probable cause of this is a selection effect of older chronically ill individuals deceasing or entering into convalescent homes, and hence dropping out of the sample.

Men with a university degree who were not chronically ill last year have a significantly lower probability of being chronically ill, as compared to men with lower levels of education. Furthermore, the probability of becoming chronically ill increases with age. The negative estimator of the variable *married* shows that this probability decreases if the man is married.

Table 16: Estimation results for the chronically ill status - Women

	Chronically ill previous year		Not chronically ill previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	-	-	-0.3372***	0.0782
Upper secondary	0.1579*	0.0921	-0.2621***	0.0748
Age	0.0451***	0.0152	0.0265***	0.0020
Age^2	-0.0003**	0.0001	-	-
Married	-0.1607**	0.0815	-0.3008***	0.0631
Intercept	-1.0466***	0.4005	-3.9318***	0.1607
Number of obs.		3329		16831
Pseudo R^2		0.0233		0.0623

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

The dummy *upper secondary* shows that chronically ill women with a secondary degree have a higher probability of remaining chronically ill. The effect of age is the same as with the male.

The interpretation of the results of the regression for women who were not chronically ill is in line with those of men, so it does not need to be repeated.

The next step in the labour market module pertains to the decision of working. This requires some explanation, as this variable is aligned to the exogenous AWG labour market projections. Then what are these regressions for? Remember that the alignment is a two-step process. At first, individuals are ranked according to descending risk of the event happening (in this case, entering or remaining into employment). Next, the actual number of events (the transitions) is set according to bring the sample in line with the AWG-proportional groups in the next year. The below regressions thus determine the non-stochastic part of the risk, and hence of the place of an individual in the ranking.

Table 17: Estimation results for labour market participation - Men

	In work previous year		Not in work previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	-0.3270**	0.1539	-0.2423	0.1958
Upper secondary	-0.2408*	0.1345	-0.3555**	0.1691
Ever had a job	0.7684***	0.2552	0.9161***	0.2278
Potential experience	0.0416**	0.0191	-0.1876***	0.0223
Potential experience2	-0.0026***	0.0003	0.0013***	0.0004
Chronically ill	-0.5585***	0.1302	-0.7686***	0.1892
Other inactive (lag)	-	-	0.2147	-1.6000
Unemployed (lag)	-	-	-0.9702***	0.2043
Spouse in work (lag)	-	-	0.6741***	0.2070
Intercept	4.7792***	0.3414	2.1716***	0.2758
Number of obs.		15395		2498
Pseudo R2		0.2018		0.3808

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Having a high degree (university or upper secondary), being chronically ill during the previous period has a negative impact on entering or remaining in the labour market. If the individual ever had a job he will have a higher probability of entering or remaining in the labour force. The potential experience seems to act differently depending on if the individual has already a job or not. For couples, the employment status of both partners may have an impact on each other. Instead of assuming one partner to move first in a given year, we have made the assumption that the employment status of the partner in the last year is a sufficient proxy for the partners' labour supply in the current period. In the above case, if the man is outside of the labour force, having a wife who is working will have a positive impact and being unemployed last period will have a negative impact.

Table 18: Estimation results for labour market participation - Women

	In work previous year		Not in work previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	0.2296*	0.1177	-	-
Upper secondary	-	-	-0.1860*	0.1001
Ever had a job	0.4662***	0.1706	0.7900***	0.1344
Married	0.5570***	0.1293	-0.7587***	0.1324
Newly divorced/separated	-0.6841*	0.3636	0.6225	0.3798
Number of children 0-11	-0.3441***	0.0555	-0.3789***	0.0585
Number of children 12-15	-	-	0.1515	0.0933
Potential experience	-0.0387**	0.0169	-0.1665***	0.0166
Potential experience^2	-0.0010***	0.0003	0.0011***	0.0003
Chronically ill	-0.3916***	0.1212	-0.5442***	0.1409
Other inactive (lag)	-	-	0.1564***	-4.0400
Unemployed (lag)	-	-	-0.3691**	0.1670
Spouse in work (lag)	-0.6413***	0.1104	0.8166***	0.1210
Intercept	5.1472***	0.2700	1.6363***	0.2107
Number of obs.		13333		6390
Pseudo R^2		0.2050		0.2545

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Married women who were in work the previous years and who have an university degree, clearly have a higher possibility of remaining in the labour force. This probability however decreases with the number of children younger than 12 in the household, with the number of years since graduation (*potential experience, potential experience*^{2}), if the women reports being chronically ill and she has gone through a divorce the previous year. Finally, the probability decreases if the partner of the women was in the labour force in the previous year.

Married women who were not in work the previous year, who have a secondary degree have a lower probability of entering the labour force. Those who ever had a job, and who recently went through a divorce, have a higher possibility of entering the labour force. Analogous to the previous regression, the probability of entering the labour force decreases with the potential experience, and if the women reports being chronically ill, and with the number of children younger than 12 in the household. However, it again increases with the number of children between 12 and 15. Finally, the probability increases if the partner of the women was in the labour force in the previous year and decreases if the women was either 'other inactive' or unemployed.

If one is not in work, then one can be in unemployment. As said, the decision of being in work is determined by the alignment process. In the Belgian version of MIDAS, various inactive labour market states (unemployment, retirement, disability …) are based on the alignment with AWG-data as well. Underlying this alignment process are various behavioural equations determining the risk of being observed as unemployed.

Table 19: Estimation results for the unemployment status - Men

	Unemployed previous year		In work previous year		Neither in work nor unemployed previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-0.0883**	0.0403	-	-	-	-
Chronically ill	1.1049	1.5500	0.7578	0.6169	-	-
Married	-	-	0.4226	0.5572	-	-
Intercept	5.8445***	2.1505	-2.3691***	0.3879	-3.6738***	0.2615
Number of obs.		76		136		606
Pseudo R^2		0.1346		0.0263		0.0000

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Those unemployed men that are younger and are chronically ill have a higher probability to remain in unemployment. As to those who are not unemployed but are working, they have a higher probability of falling into unemployment if they are married and chronically ill.

The probability that those that were not in work last year report being in unemployment is not explained by the available regressors for men.

Table 20: Estimation results for the unemployment status - Women

	Unemployed previous year		In work previous year		Neither in work nor unemployed previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
University	-0.5901	0.7161	-0.5046	0.5567	-	-
Number of children 0-11	-	-	0.7759***	0.2375	0.6962***	0.1688
Intercept	1.8894***	0.2976	-2.1694***	0.3088	-3.5147***	0.2212
Number of obs.		113		166		785
Pseudo R^2		0.0068		0.0874		0.0519

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Unemployed women that do not have a university degree have a higher probability to remain in unemployment. For working women, the probability of falling into unemployment is also lower for those having a high level of education, and higher for those having children younger than 12. As to those who were neither in work nor in unemployment, having children younger than 12 increases this probability of becoming unemployed.

If one is in work, the next decision is whether or not the individual is an employee, or a self-employed. Here again, different equations are estimated depending on the status of the individual previous year. Here it depends on if the individual were already an employee, a self-employed or were not active.

In the first case, there were no significant explanatory variables for men, so only an intercept was used. This implies that all male employees have the same probability of staying employee or, explained differently, the same probability of becoming self-employed. In the second case, the probability of becoming an employee (i.e. ceasing to be in self-employment) decreases with age, and is higher for those with the lowest level of education. Furthermore, it decreases with the length of the career as self-employed. In the third and last case, the probability of being an employee (given that one has entered the work force) decreases with age.

Table 21: Estimation results for the employee status - Men

	In work and employee previous year		In work and not employee previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-	-	-0.0551***	0.0202	-0.0540**	0.0223
University	-	-	-1.1889***	0.3843	-	-
Upper secondary	-	-	-1.8472***	0.5265	-	-
Duration as self-employed	-	-	-0.2102***	0.0638	-	-
Intercept	5.2927***	0.3544	3.1801***	0.9718	3.3285***	0.9662
Number of obs.		1599		248		53
Pseudo R^2		0.0000		0.1242		0.1154

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Three different equations are also estimated for women. For women who were already employee the previous year, the probability of staying employee decreases with age and increases if one previously was in the public sector and if one had a permanent contract. The two other regressions for women are similar to those for men.

Table 22: Estimation results for the employee status - Women

	In work and employee previous year		In work and not employee previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-0.0497**	0.0235	-0.0655***	0.0239	-0.0271**	0.0325
Public sector	2.2244**	1.0362	-	-	-	-
Permanent contract	1.7282***	0.5155	-	-	-	-
University	-	-	-2.1782***	0.5848	-	-
Upper secondary	-	-	-2.0580***	0.5989	-	-
Duration as self-employed	-	-	-0.2720***	0.0862	-0.0076**	0.1603
Intercept	5.0353***	1.0403	4.6954***	1.2322	3.5820**	1.3988
Number of obs.		1425		140		88
Pseudo R^2		0.1372		0.2159		0.0169

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Given that one is an employee, one can work in the private or public sector. The following regressions describe this transition depending on the individual were in the public sector or not last period or if he is just entering the labour market this period.

Men working in the private sector will have a higher probability entering the public sector if they have the highest level of education. Men already working in the public sector and who have the highest level of educational attainment will have a lower probability of continuing so. Hence, men with a university degree show the highest turnover between the private and public sector. Furthermore, the older one is and the longer one has been working in the public sector, the higher the probability that one will remain in the public sector.

As to men who just enter the labour force, a higher age and level of educational attainment increases their probability of entering the public sector.

Table 23: Estimation results for the public sector employee status - Men

	In work not in public sector previous year		In work in the public sector previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-	-	0.2937***	0.0620	0.1181**	0.0473
Age^2	-	-	-0.0034***	0.0007	-0.0014**	0.0006
University	0.2879**	0.1548	-0.3636**	0.1651	0.3560**	0.1494
Duration in public sector	-	-	0.0800**	0.0428	-	-
Intercept	-3.6820***	0.1018	-3.9737***	1.2648	-3.8020***	0.8779
Number of obs.		6372		1641		1241
Pseudo R^2		0.0021		0.0339		0.0111

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

For women, the results of the three different regressions are described next. Women who were not working in the public sector with the lowest educational attainment level have a lower probability of working in the public sector. Also, this probability decreases with the number of children younger than 12, and with the duration that one has been working in the private sector. Women that were already in the public sector show the same behaviour as men except that, here, the upper secondary degree replaces the university degree. As to women who just enter the labour market, the effect of level of education is the same as for men and age now becomes insignificant. Furthermore, having young children decreases the probability of working in the public sector.

Table 24: Estimation results for the public sector employee status - Women

	In work not in public sector previous year		In work in the public sector previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-	-	0.1488***	0.0549	-	-
Age^2	-	-	-0.0018***	0.0007	-	-
University	0.8696***	0.2165	-	-	0.6411***	0.1645
Upper secondary	0.7356***	0.2232	-0.3258**	0.1409	-	-
Number of children 0-11	-0.2052**	0.0825	-	-	-0.2146**	0.1078
Duration in private sector	-0.1465***	0.0353	-	-	-	-
Duration in public sector	-	-	0.1690***	0.0370	-	-
Intercept	-3.0876***	0.2197	-1.3579	1.0782	-1.4157***	0.1168
Number of obs.		4860		2078		905
Pseudo R^2		0.0233		0.0238		0.0213

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

After the decision to work in the public sector or not, the next decision that MIDAS tackles is whether or not one works in the public sector as a civil servant or not. This is important, because civil servants are subject to a completely different (and more generous) pension system than the 'contractual' employees in the public sector, who are subject to the same pension system as employees in the private sector.

The probability that a civil servant will remain in that state increases with the duration of the career as a civil servant and, similarly, the probability that an employee will become a civil servant decreases with the duration of the career as an employee. All other possible explanatory variables are insignificant. This goes for males as well as for females.

Table 25: Estimation results for the civil servant status - Men

	Civil servant previous year		Not civil servant previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
Duration as civil servant	0.6140**	0.3177	-	-
Duration as employee	-	-	-0.3089***	0.1170
Intercept	1.4179	0.9749	-1.3134**	0.6250
Number of obs.		145		280
Pseudo R^2		0.2004		0.0658

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Table 26: Estimation results for the civil servant status - Women

	Civil servant previous year		Not civil servant previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
Duration as civil servant	0.4088*	0.2156	-	-
Duration as employee	-	-	-0.4765***	0.1297
Intercept	1.6091*	0.8891	-1.1105**	0.5516
Number of obs.		135		384
Pseudo R^2		0.1177		0.1491

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

The next relevant step is to simulate whether one has a permanent contract or not. As this is by definition so for civil servants, this equation is only estimated for employees in the public and private sector. Whether one has a permanent contract is among other things relevant to decide whether he or she works the full year or not (see below).

For males and females who had no permanent contact, the probability of getting a permanent contract increases with age. The probability of remaining in a permanent job increases with age, and is lower for those without a secondary level of education (men) and those with a primary level of education (women). No variables were significant for those (re-)entering the labour market.

Table 27: Estimation results for the permanent contract status - Men

	In work no permanent contract previous year		In work permanent contract previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	0.1909*	0.1043	0.2524***	0.0627	-	-
Age^2	-0.0025*	0.0014	-0.0027***	0.0008	-	-
Upper secondary	-	-	0.9109***	0.1984	-	-
Intercept	-4.6243**	1.8704	-4.1341***	1.2433	-1.2685***	0.3773
Number of obs.		277		1145		41
Pseudo R^2		0.0131		0.0390		0.0000

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Table 28: Estimation results for the permanent contract status - Women

	In work no permanent contract previous year		In work permanent contract previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	0.2057*	0.1058	0.0392***	0.0121	-	-
Age^2	-0.0033**	0.0015	-	-	-	-
University	-	-	0.7277***	0.2577	-	-
Upper secondary	-	-	1.2328***	0.2968	-	-
Intercept	-4.0453**	1.8229	-0.5108	0.5730	-1.3545***	0.2804
Number of obs.		376		874		78
Pseudo R^2		0.0382		0.0310		0.0000

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Now we know who is in work, in and outside the public sector, and - in the first case - working as a civil servant or not. Next, the model has to simulate how long the individual works in the current year. This requires simulating the number of months worked per year, and the number of hours per week. The number of months worked per year is a two-step process. In a first step is 'decided' whether the individual works the full 12 months or not and in the last case, a second regression sets the number of months worked.

Age and whether one has a permanent contract are the main explanatory variables for both men and women working the full year. Furthermore, the number of hours worked in the previous year – for women also reflected by the dummy whether one worked full-time - explains whether or not one works the whole year.

Table 29: Estimation results for the "work all year" status – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.4760***	0.0691	0.3267***	0.0601
Age^2	-0.0057***	0.0008	-0.0037***	0.0008
Firm size (lag)	-	-	0.0007	0.0005
Permanent contract (lag)	1.0434***	0.2483	1.3617***	0.1822
Part time (lag)	-	-	0.9799***	0.3119
Worked hours (lag)	0.0920***	0.0103	0.0727***	0.0067
Intercept	-10.6420***	1.2816	-8.1215***	1.1592
Number of obs.		1633		1484
Pseudo R^2		0.4998		0.3634

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Next regressions then set the number of months worked for those that do not work the whole year. Interestly enough, whether or not one has a permanent contract does not seem to play a direct role in determining the odd that one works the full year, but it does negatively affect the number of worked months if one does not work the full year. Furthermore, young men with a high level of education work fewer months. Finally, married women work more months.

Table 30: Estimation results for the number of worked months per year – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.0363***	0.0097	-	-
Age^2	-0.0004***	0.0001	-	-
Permanent contract	-0.3617***	0.0556	-0.2104***	0.0453
University	-0.0773**	0.0335	-	-
Married	-	-	0.0930***	0.0335
Intercept	1.4487***	0.1708	2.0503***	0.0248
Number of obs.		460		488
R^2		0.1352		0.0582

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Analogous to how the model simulates the number of months worked, the simulation of the number of hours is a two-step process. First there is a dummy reflecting whether the individual works part time or not. Next, a regression sets the number of hours worked per week. As there is no obvious and direct relation between not working part time and the reported number of hours worked – indeed, in an extreme case, one who works part time may report working the same or more hours than somebody who works full-time - the sample has not been limited to those working part-time, but this variable is simply used as an explanatory variable in the regression of the number of hours worked.

So the first step is to simulate whether one works part-time or not. For men, the only significant explanatory variable for the odd to work part-time is whether or not they report being chronically ill. For women, the situation is a bit more complex. First of all, being chronically ill does not play a role. Secondly, whether or not they worked part-time in the previous year is the most important determinant for explaining the odd of working part-time this year. Also, whether or not they have children younger than 12 decreases this odd, but when the children are older than that age, then the odd increases again.

Table 31: Estimation results for the part time status – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Chronic ill	2.9144**	1.2274	-	-
Part time previous year	-	-	3.6649***	0.2430
University	-	-	-0.5845**	0.2513
Number of children 0-11	-	-	0.3062**	0.1287
Number of children 12-15	-	-	-0.4666*	0.2413
Intercept	-7.3512***	1.0003	-3.3188***	0.1970
Number of obs.		1730		1574
Pseudo R^2		0.1283		0.3193

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

The next regression describes the number of hours worked per week. It may come as no surprise that the number of hours worked decreases for both the male and the female if they report working part-time. Furthermore, males who work in the public sector report working significantly fewer hours than those in the private sector. Finally, the number of hours reported by women decreases with age.

Table 32: Estimation results for the number of worked hours per week – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Age	-	-	-0.0023***	0.0007
Part time	-0.7978***	0.0920	-0.6398***	0.0224
Public sector	-0.0467***	0.0091	-	-
Intercept	3.7217***	0.0048	3.6277***	0.0271
Number of obs.		1531		1318
R^2		0.0626		0.3923

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

A key element in the labour market module obviously is the wage-equation, that explains the (log of the) hourly wage rate. In the other country versions of the model, a random-effects panel data regression is used for this. In the Belgian case, however, and even though the regression results were by themselves credible, the resulting equation had important negative consequences for the simulation results of the model. We therefore decided to estimate a simple OLS cross-sectional model on the 2002 dataset.

For males and females that work while not being a civil servant, the main determinants are related to age and the level of education. Those with the lowest level of education have a lower hourly wage rate, and this difference is even more important for women than for men. Next, the hourly wage rate increases with age, but the slope of this effect decreases with increasing age. Finally, women who work part-time have a marginally significantly higher hourly wage rate than those that work full-time.

For male and female civil servants, the explanatory variables are roughly the same as for non civil servants. However, the effect of age is smaller and linear, and the effect of having a high level of education is smaller for male civil servants, but stronger for female civil servants. The dummy for having a secondary level of education is stronger for female civil servants than for non civil servants. For male civil servants the effect is not significant and therefore the variable is not included into the equation.

Table 33: Estimation results for the hourly wage rate – Men

	No civil servants		Civil servants	
	Coef.	Std. Err.	Coef.	Std. Err.
University	0.2758***	0.0284	0.1499**	0.0668
Upper secondary	0.0855***	0.0304	-	-
Age	0.0567***	0.0080	0.0102***	0.0038
Age^2	-0.0006***	0.0001	-	-
Intercept	0.9669***	0.1565	2.0368***	0.1819
Number of obs.		1561		157
R^2		0.1313		0.0750

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

Table 34: Estimation results for the hourly wage rate – Women

	No civil servants		Civil servants	
	Coef.	Std. Err.	Coef.	Std. Err.
University	0.3690***	0.0381	0.5476***	0.1499
Upper secondary	0.1283***	0.0400	0.3949**	0.1593
Age	0.0349***	0.0103	0.0171***	0.0038
Age^2	-0.0003**	0.0001	-	-
Part time	0.0925*	0.0521	-	-
Intercept	1.1910***	0.1990	1.2516***	0.2314
Number of obs.		1406		143
R^2		0.0992		0.1870

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

In MIDAS, hourly wages increase with productivity over time, and the speed of this increase is the productivity growth rate assumed by the AWG. In the Belgian version of the model, corrected growth rates are applied to individual hourly wage rates such as the macroeconomic AWG productivity growth rates can emerge[23]. Indeed, if the full labour productivity growth rate were applied directly to the individual hourly wages, we would end up with a different macroeconomic productivity growth rate than the one taken as assumption. This is because both the microeconomic hourly wage rate and the growth rate of productivity to some extend include the same developments. These joint effects -including increasing ages and increased levels of education- therefore affect the simulated aggregated growth rate of wages twice. So, for Belgium, labour productivity is assumed to grow by 1.5 percent per annum between 2004 and 2010. In the years between 2011 and 2030, the annual productivity growth rate is a bit higher, namely 1.8. From then on until 2050, productivity grows by 1.7 percent per year.

A final regression is the one determining the size of the firm or organisation where one works. This equation is of secondary importance as its output only has an impact on the simulation of the odd that a woman in work, and that individuals work the full 12 months or not, and even there the size of the regressor is limited.

Table 35: Estimation results for the size of the firm – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
University	54.2364***	12.7546	35.4482***	10.8242
Age	13.9521***	4.2892	4.0554***	0.5451
Age^2	-0.1534***	0.0526	-	-
Intercept	5.9146	83.4177	5.6366	23.0931
Number of obs.		1729		1573
R^2		0.0203		0.0372

Notes: Coef. = coefficient; Std. Err. = standard error; * = p<0.10; ** = p<0.05; *** = p<0.01. Dashes indicate variables not included in the model.

There are a couple of behavioural equations that are not presented in this text, but which should be mentioned because they exist and may be used in the German and Italian versions of this module. First of all, there is the regression that sets the occupation that one is in. This variable is not used in the labour market module, and the behavioural equation is hence not included in the model and the text. Finally, the transitions into disability (becoming eligible to a disability pension), Conventional Early Retirement (CELS) and retirement are fully driven by alignment. Their behavioural equations hence do not exist.

23 The applied corrected growth rates are obtained in two phases: First the model is run once with AWG growth rates applied individually. Secondly, aggregate productivity growth rates that emerge from the model are compared to the AWG growth rates and the corrected rates are computed so that when they are applied individually, the aggregate growth rates match perfectly AWG growth rates.

4.2.3. Behavioural equations for Germany

In Germany, public pensions are closely related to employment status and earnings over the life cycle. In the following the detailed labour market module is described. The labour market module follows a hierarchical logic and models sequential binary decisions (see 4.2.1).

This section starts by reporting regression results for the impact of the health status on labour market participation. Due to its direct effect on a person's capability to work, health is an important determinant of the labour market status. However, the following estimations focus on severe health problems rather than the health status in general. A person is defined to be chronically ill if her earnings capacity is reduced by more than 50%.[24]

Table 36: Regression samples, chronical illness

	Chronically ill in previous period	
Men	Yes [1]	No [3]
Women	Yes [2]	No [4]

Sample: All persons older than 18, no other restrictions.

As shown in table 36, the sample can be divided into four groups: men and women who had been chronically ill in the previous year, and men and women who had not been chronically ill in that period. About 90% of those respondents in the first two groups turned out to be still in that state in the following year. That means, the status "chronically ill" is characterised by a high degree of persistence. Moreover, the health status "chronically ill" is not very prevalent in the population. Only a minority of about 11% of all individuals aged over 18 finds itself in this state, and, given its high persistence, the inflow into this state is also very low. Furthermore, we rarely observe people leaving the state of chronic illness.

The available information does not account for much of the variance in explaining the high stability of this state. Thus, as Table 37 reports, the equations determine a random share of individuals leaving the status 'Chronically ill' without conditioning on any characteristics other than age and, marginally significant, tenure.

[24] The dummy variable "chronically ill" is generated on the basis of the answers to the following two questions "Are you officially registered as having a reduced capacity for work or of being severely disabled? (If you are receiving disability benefits, then enter 'yes.') (**yes, no**). *If yes, what is the degree of your disability? (percent of disability).*

Table 37: Estimation results for chronical illness. Chronically ill in previous period (men and women).

	Men		Women	
	Coef.	Std. err.	Coef.	Std. err.
Age	-0.0113**	0.0042	-0.0172***	0.0038
Tenure (lag)	0.0158	0.0089		
Intercept	2.9275***	0.2753	3.2529***	0.2460
Number of obs.	4211		3796	
Pseudo R2	0.01		0.01	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Things are different with the models that control for the likelihood to become chronically ill. In this case, for various characteristics, both models yield a significant effect as table 38 shows. Additionally, results are very similar for both men and women: higher education reduces the probability to become chronically ill, the same holds for tenure, and for the presence of small children. The age profile is concave. Moreover, for women, the likelihood to become chronically ill decreases with the duration of marriage.

Table 38: Estimation results for chronical illness. Not chronically ill in previous period (men and women)

	Chronically ill		Chronically ill	
	Coef.	Std. err.	Coef.	Std. err.
University	-0.8857***	0.1249	-0.4057**	0.1351
Upper secondary	-0.2962**	0.0995	-0.1545	0.0879
Age	0.1714***	0.0177	0.1643***	0.0179
Age2	-0.0010***	0.0002	-0.0010***	0.0002
Tenure	-0.0368***	0.0060	-0.0351***	0.0086
Number of children 0-11	-0.5135***	0.1370	-0.8039***	0.1686
Duration of Marriage			-0.0103***	0.0025
Intercept	-9.5539***	0.5016	-9.3489***	0.5065
Number of obs.	48285		52726	
Pseudo R2	0.14		0.11	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Having determined the health status, we now turn to the participation decision. This variable has been aligned to the AWG labour market projections in a two-step process. The first step is to rank individuals in descending order according to their risk of entering into or remaining in employment. The second step, then, is to set the actual number of events (the transitions) in accordance with the AWG-proportional groups for the following year. Thus, the regressions below determine the non-stochastic part of an individual's risk, and hence its rank. As reported in table 39, we discriminate between persons who had been working in the previous year and those who had not.

Table 39: Regression samples, employment participation

	Gainfully employed last period	
Men	Yes [1]	No [3]
Women	Yes [2]	No [4]

Sample: persons aged between 16 and 64 with completed formal education

The estimation is performed separately for the following four groups: women / men who had or had not been working in the preceding period, who were between 16 and 64 years of age in both waves, and who had completed their education in the current period[25].

Table 40 shows the results for men. Lagged tenure, having worked in the public sector, being married and highly educated have a positive influence on the likelihood to remain employed. To be chronically ill has a strong negative impact on labour market participation. Interestingly, for both lagged hours and upper secondary education, coefficients turn out to be negative. That means, for this group, being lowly educated increases the probability to stay employed as compared to those with mid-level education. However, the coefficient is small and only marginally significant.

For those who enter the labour market, the picture is more consistent with our expectations: high- and mid-level education have both a positive impact on labour market participation, and the coefficient of high education is larger. Chronical illness again negatively affects participation behaviour. Men who had been unemployed or inactive show a higher probability to enter the labour market in the following period than those men who had still been in education.

Table 40: Estimation results for labour market participation (men)

Men	In work previous year		Not in work previous year	
	Coef.	Std. err.	Coef.	Std. err.
University	0.1971**	0.0660	0.4787***	0.0807
Upper secondary	-0.0969	0.0574	0.3491***	0.0678
Married	0.0889	0.0474		
Potential experience	0.0855***	0.0081	0.0726***	0.0099
Potential experience2	-0.0023***	0.0002	-0.0029***	0.0002
Tenure (lag)	0.0190***	0.0024		
Public sector (lag)	0.1151*	0.0535		
Working hours (lag)	-0.0101***	0.0015		
Chronically ill	-0.8199***	0.0912	-1.5040***	0.1302
Spouse in work	0.6358***	0.0448	0.6637***	0.0589
Other inactive (lag)			0.0893	0.0792
Unemployed (lag)			0.1609*	0.0731
Intercept	1.6124***	0.1222	-1.2938***	0.1121
Number of obs.	29197		11135	
Pseudo R2	0.05		0.20	

25 Note that we do not exclude persons that had been in education in the *previous* period.

Table 41 reports the results for women. In contrast to men, we find the expected positive effect of education in both models. Moreover, and in opposition to men, children have an important impact on women's labour market attachment. Being more care intensive, small children exhibit a stronger negative effect on the labour market participation of their mothers then older children do. In general, to be married has a negative effect. However, if the spouse works, this effect turns positive offsetting the latter. Finally, to be inactive in the first period is more prevalent among women and, compared to school leavers, reduces the probability to enter the labour market in the following period. A plausible interpretation of this evidence is of course that this employment state is closely linked to the presence of children in the household.

Table 41: Estimation results for labour market participation (women)

	In work previous year		Not inwork previous year	
	Coef.	Std. err.	Coef.	Std. err.
University	0.4611***	0.0672	0.4900***	0.0642
Upper secondary	0.1390*	0.0558	0.2381***	0.0527
Number of children 0-11	-0.6376***	0.0290	-0.4015***	0.0281
Number of children 12-15	-0.1319**	0.0476		
Married	-0.5193***	0.0542	-0.3722***	0.0590
Potential experience	0.1364***	0.0080	0.0246**	0.0083
Potential experience2	-0.0030***	0.0002	-0.0018***	0.0002
Tenure (lag)	0.0195***	0.0029		
Public sector (lag)	0.0870	0.0460		
Chronically ill	-0.5012***	0.1123	-1.5258***	0.1375
Spouse in work	0.5665***	0.0477	0.5255***	0.0530
Other inactive (lag)			-0.6206***	0.0695
Unemployed (lag)			0.3506***	0.0708
Intercept	0.5403***	0.1040	-0.6324***	0.0890
Number of obs.	21699		20429	
Pseudo R2	0.06		0.15	

The unit of time in MIDAS is one year, and it is generally assumed that all modelled decisions hold for a given period in the simulation model. However, an exception exists regarding spells of employment that last shorter than one year. For the employed, a model is estimated that determines whether individuals had been working for only part of the respective year. For those who had indeed worked for less than twelve months, in a next step, the number of months worked has then been estimated (see table 56).

Table 42 shows for both men and women the results from the regression estimating whether they had been working throughout the whole period or only part of the year. Having a university degree increases the likelihood to be employed over the whole period. For men, we observe that being married and having small children also positively affect the probability to remain employed for the entire period. For women, the opposite relationship holds: whereas marriage has no effect, little children reduce their likelihood to work during the whole period. Additionally, the age profile is similar for men and women, and chronic illness has the expected negative coefficient.

Regarding the employment status, the reference category is to be an employee in the previous period. Most states show no significant effect. Only men or women who were self-employed or unemployed during the previous year have a higher probability of being in employment during the whole year. For women we also observe a positive probability for school leavers.

Table 42: Estimation results for being employed over the whole year (men and women).

	Men		Women	
	In work all year		In work all year	
	Coef.	Std. err.	Coef.	Std. err.
University	0.3286***	0.0938	0.3000***	0.0833
Upper secondary	0.0025	0.0841	0.0734	0.0753
Married	0.3680***	0.0764		
Number of children 0-11	0.0843	0.0460	-0.4038***	0.0440
Age	0.2158***	0.0205	0.1834***	0.0201
Age2	-0.0027***	0.0002	-0.0023***	0.0003
Chronically ill	-0.8966***	0.1470	-0.2306	0.1612
Self employed (lag)	1.1043***	0.1919	1.0935***	0.1550
Unemployed (lag)	0.8298***	0.1958	0.9674***	0.1602
Other inactive (lag)	0.3366	0.2357	0.1729	0.1557
In education (lag)	-0.2703	0.2523	1.3835***	0.2154
Tenure (lag)	0.0054	0.0038	-0.0043	0.0041
Public sector (lag)	-0.0531	0.0869	0.1140	0.0658
Firm size (lag)	0.0002***	0.0000	0.0001*	0.0000
Permanent contract (lag)	0.4416***	0.0935	0.1810*	0.0876
Working hours (lag)	0.0113**	0.0039	0.0344***	0.0030
Spouse in work	0.1193	0.0629	-0.1371*	0.0554
Error decil2	2.0572***	0.0839	2.2085***	0.0718
Error decil3	3.1741***	0.0911	3.0857***	0.0783
Error decil4	6.7910***	0.3003	3.4781***	0.1515
Error decil5	7.5311***	0.3620	3.5729***	0.1685
Error decil6	6.9409***	0.2420	3.7202***	0.1672
Error decil7	7.2018***	0.2549	4.2215***	0.1306
Error decil8	7.7571***	0.4200	5.7203***	0.1476
Error decil9	6.7955***	0.3175	6.9325***	0.2051
Error decil10	9.2768***	1.0070	8.0894***	0.2455
Intercept	-6.1597***	0.5172	-6.5396***	0.4150
Number of obs.	28655		21497	
Pseudo R2	0.57		0.58	

We estimate separate models for men and women, in both cases conditioning on three different states in the previous period: having worked as employee, having worked as self-employed[26], and not having worked (table 43).

26 If a person is employed but not as an employee she becomes automatically self-employed.

Table 43: Regression samples, labour market status employee

	In work and *employee* in t-1	In work and *not employee* in t-1	Not in work in t-1
Men	[1]	[3]	[5]
Women	[2]	[4]	[6]

Sample: working persons aged between 16 and 64

For men (table 44), the probability of remaining in the state of dependent employment decreases with education. Age profiles are similar across groups showing an increasing probability to remain in dependent employment with growing age. Tenure in the previous job increases the likelihood of remaining as well as becoming an employee. The same holds for firm size, sector and – not surprisingly – for permanent jobs. For those who had not been employed, previous unemployment shows a positive impact on becoming an employee as compared to other states out of employment.

Table 44: Estimation results for being an employee (men)

Men, employee	In work, employee		In work, not employee		Not in work	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
University	-0.6916**	0.2278				
Upper secondary	-0.0214	0.2208				
Age	-0.0709	0.0523	-0.2194***	0.0604	-0.1393**	0.0509
Age2	0.0009	0.0006	0.0021**	0.0007	0.0013*	0.0006
Tenure (lag)	0.0258*	0.0103	0.0959**	0.0341		
Public sector (lag)	1.2779***	0.2493				
Firm size (lag)	0.0008***	0.0001				
Permanent contract (lag)	1.8762***	0.1413				
Unemployed (lag)					0.8733***	0.2224
Other inactive (lag)					-0.3370	0.2184
Intercept	3.8902***	1.0329	2.0574	1.2625	5.2808***	0.9024
Number of obs.	23170		3056		2721	
Pseudo R2	0.12		0.04		0.04	

Turning to the results for women (table 45), we can observe similarities and differences alike. First of all, for those who had been employees in the preceding period, higher education also negatively affects the probability of remaining an employee in the following period. However, this effect is as well significant for those women who had not been employed in the previous period. For those who had been self-employed or not employed, the linear age effect on being employee in the following period is negative and the quadratic age effect insignificant. Only for the group of employees, we can observe the marginally significant age profile that was already found for men. The job characteristics show the expected positive sign. The family variables seem to matter in the case of those women who had been self-employed or not employed at all in the first period. More precisely, for self-employed women, to be married reduces the probability to become an employee in the following period. However, if the husband works, this effect is, though only marginally, significantly positive and may offset the first. For formerly not employed women, young children increase their likelihood to become self-employed. The effect of previous unemployment is positive.

Table 45: Estimation results for being an employee (women)

	In work, employee		In work, not employee		Not in work	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
University	-1.2023**	0.4154			-0.9079***	0.2244
Upper secondary	-0.6049	0.4066			-0.5794**	0.2065
Age	-0.1638	0.0861	-0.0409**	0.0131	-0.0659***	0.0071
Age2	0.0020	0.0011				
Tenure (lag)	0.0355	0.0190	0.1162*	0.0578		
Public sector (lag)	0.6629**	0.2542				
Firm size (lag)	0.0008***	0.0002				
Permanent contract (lag)	1.5154***	0.2221				
Married			-0.5346*	0.2723		
Spouse in work			0.4804	0.2649		
Number of children 0-11					-0.4548***	0.0781
Unemployed (lag)					0.9588***	0.2255
Other inactive (lag)					-0.1589	0.2084
Intercept	6.9993***	1.6921	-0.9532	0.5850	6.2138***	0.4502
Number of obs.	17233		1349		3264	
Pseudo R2	0.09		0.04		0.10	

For a person to be an employee in MIDAS means that she either works in the private or in the public sector. If she works in the public sector, she can also be a civil servant. Thus, as a fist step, we discriminate between private and public sector employees.

The regressions are performed according to the previous ones. We estimate separate models for men and women, and for each group, we estimate three models that condition on the individuals' employment state of the previous year: having been employed in the public sector during the previous year, having worked as employee in the private sector in the preceding year, or not having been employed the year before (table 46).

Table 46: Regression samples, working in the public sector

	In work and *public sector* in t-1	In work and *not public sector* in t-1	Not in work in t-1
Men	[1]	[3]	[5]
Women	[2]	[4]	[6]

Sample: employees aged between 16 and 64 in year t

As Table 47 shows, higher education and age increase men's likelihood to switch from the private into the public sector. On the other hand, the probability declines with tenure in the private sector. For those who had been working in the public sector in the previous period, the probability to remain working in the public sector in the following period increases with tenure and with their spouse being also employed. For men who had not been employed in the preceding year, a positively linear age effect occurs as well as a positive effect of higher education. Moreover, to have a working spouse reduces the probability that men work in the public sector in the following period.

Table 47: Estimation results for working in public sector (men)

	In work, not public sector		In work, public sector		Not in work	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
University	0.7301***	0.2115			0.8350***	0.1679
Upper secondary	0.2250	0.2016			-0.1684	0.1557
Age	-0.1376**	0.0425			0.0148**	0.0047
Age2	0.0016**	0.0005				
Tenure	-0.0153	0.0079	0.0763***	0.0075		
Spouse in work			0.2452*	0.1202	-0.3947**	0.1223
Intercept	-0.7882	0.8406	1.1155***	0.1397	-1.7631***	0.2084
Number of obs.	17770		5317		2510	
Pseudo R2	0.06		0.11		0.04	

Table 48 reports the results for women, for whom we find a positive effect of higher education on working in the public sector in all models. The age profile of those who had been working in the private sector in the previous year shows the same shape as the age profile of men. For the remaining two groups, most variables turn out to be insignificant as it is the case for men. For women, the effect of tenure is the same as for men. Additionally, for the first group, family effects can be observed. While small children increase the likelihood to work in the public sector, the opposite effect holds for a spouse who is employed.

Table 48: Estimation results for working in public sector (women)

	In work, not public sector		In work, public sector		Not in work	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
University	0.8657***	0.1677	0.3591*	0.1814	1.4260***	0.1341
Upper secondary	0.0002	0.1599	-0.1378	0.1777	0.2299	0.1190
Age	-0.1027**	0.0389			0.0083*	0.0039
Age2	0.0012*	0.0005				
Number of children 0-11	0.1729*	0.0786				
Spouse in work	-0.2123*	0.1059				
Tenure	-0.0358***	0.0088	0.0942***	0.0093		
Married			0.2955*	0.1256		
Intercept	-0.4320	0.7273	2.3987***	0.5706	-1.5740***	0.1635
Number of obs.	10957		6273		3011	
Pseudo R2	0.09		0.13		0.05	

Once we have determined whether a person works in the pubic sector, we can then estimate the probability of working as a civil servant. Table 50 shows the respective results for men. Again, we conditioned our models on the individuals' employment state in the previous period: those who had already been civil servants during that period, and those who had not been in that state in the previous year (table 49).

Table 49: Regression samples, working as a civil servant

	Civil servant in t-1	Not civil servant in t-1
Men	[1]	[3]
Women	[2]	[4]

Sample: public sector employees aged between 16 and 64 in year t

The left model shows that the probability to become a civil servant increases with age. All other coefficients, however, are negative. For the group of civil servants, we find a high and positive effect of tenure and an age profile that decreases with age but which has a very high positively linear age effect.

Table 50: Estimation results for working as a civil servant (men)

	Not a civil servant previous period		Civil servant previous period	
	Coef.	Std. err.	Coef.	Std. err.
University	-0.1866	0.2384	-0.9586	0.5584
Upper secondary	-1.2624***	0.2541	-1.6209**	0.5855
Age	-0.1521**	0.0519	0.2771**	0.1039
Age2	0.0018**	0.0006	-0.0038**	0.0012
Tenure (lag)	-0.0763***	0.0190	0.1219***	0.0236
Public sector (lag)	-1.5307***	0.2631		
Working hours (lag)	-0.0136*	0.0063		
Intercept	2.2294*	1.0047	-1.7348	2.1067
Number of obs.	3698		2048	
Pseudo R2	0.24		0.17	

The results for women are very similar to those of men (table 51). Besides the coefficient of higher education for women who not had been civil servants in the previous period and the coefficient of having children between 12 and 15 the models do not differ markedly.

Table 51: Estimation results for working as a civil servant (women)

	Not a civil servant previous period		Civil servant previous period	
	Coef.	Std. err.	Coef.	Std. err.
University	0.5346*	0.2340	-1.2689	0.8204
Upper secondary	-1.6306***	0.2938	-1.7406*	0.8656
Age	-0.1830***	0.0536	0.5057***	0.1468
Age2	0.0019**	0.0007	-0.0066***	0.0018
Tenure (lag)	-0.0890***	0.0268	0.1285**	0.0401
Public sector (lag)	-0.8130**	0.3060		
Working hours (lag)	-0.0415***	0.0086		
Number of children 12-15			-0.8703	0.4670
Intercept	2.5739**	0.9725	-3.6334	2.7349
Number of obs.	6276		898	
Pseudo R2	0.29		0.20	

For all employees, we estimate several regressions to model the form of employment contract, more precisely whether it is permanent or temporary. Again, we condition on the lagged state (table 52).

Table 52: Regression samples, working under a permanent contract

	In work and permanent contract in t-1	In work and temporary contract in t-1	Not in work in t-1
Men	[1]	[3]	[5]
Women	[2]	[4]	[6]

Sample: employees aged between 16 and 64 in year t

The first model of Table 53 refers to men who had not been working in the previous period. Compared to school leavers, men coming from unemployment or from the residual inactive state are more likely to have a permanent contract. Note that the level of education turned out to be insignificant. Being married and having small children also positively affects the likelihood to work under a permanent contract as well as does the fact of having a working spouse.

For men with a temporary contract in the first period, to have children positively influences the probability of working in a permanent employment relationship in the following period. Higher education, working in the public sector and having work as a self-employed in the previous period, negatively affects the likelihood of obtaining a permanent contract though. Things are different for those who had already worked with a permanent contract in the previous period. Here, education has a positive impact as well as tenure. However, the negative effect of the public sector remains.

Table 53: Estimation results for working under a permanent contract (men)

	Not in work		In work, no permanent contract		in work, permanent contract	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Married	0.5011***	0.1123				
Number of children 0-11	0.1549*	0.0700	0.1597*	0.0629		
Other inactive (lag)	0.2868*	0.1340				
Unemployed (lag)	0.2128	0.1137				
Spouse in work	0.3580**	0.1118			0.1466	0.0759
University			-0.3090*	0.1548	0.4827***	0.1097
Upper secondary			-0.2884	0.1491	0.3888***	0.0986
Number of children 12-15			0.3144*	0.1300		
Tenure			0.0200***	0.0057	0.0193***	0.0049
Public sector			-1.3962***	0.1117	-0.5987***	0.0857
Self employed (lag)			-1.4011***	0.2112	-3.7661***	0.3014
Age					0.0812**	0.0278
Age2					-0.0010**	0.0003
Firm size					0.0002**	0.0000
Intercept	1.7403***	0.4330	0.5178**	0.1793	0.1241	0.6199
Number of obs.	2510		1939		21148	
Pseudo R2	0.03		0.09		0.05	

Table 54 reports results for women. For those women who had not been employed during the preceding period, marriage, to have a working spouse, and to come from the residual inactive state, all have a positive impact on the probability to get a permanent contract. Women who used to work in the public sector with a temporary contract are less likely to receive a permanent contract than women in the private sector. Tenure has a positive effect for both those who have had a permanent contract already and those who have not had one. We find also significantly positive effects of education, size of the firm, and working hours for women who worked under a permanent contract in the preceding period.

Table 54: Estimation results for working under a permanent contract (women)

	Not in work		In work, no permanent contract		In work, permanent contract	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Married	0.2121*	0.1070				
Other inactive (lag)	0.4526***	0.1189				
Unemployed (lag)	-0.0241	0.1146				
Spouse in work	0.2467*	0.0974				
Tenure			0.0213**	0.0075	0.0462***	0.0065
Public sector			-0.7103***	0.1020		
Self employed (lag)			-1.5609***	0.2992	-2.9793***	0.4112
University					0.4667***	0.1248
Upper secondary					0.4816***	0.1098
Firm size					0.0002***	0.0001
hours					0.0351***	0.0039
Intercept	1.4814***	0.4012	-0.0197	0.1095	0.3454	0.4301
Number of obs.	3011		1766		15464	
Pseudo R2	0.03		0.04		0.07	

Next we turn to the size of the firm. Here we estimate two OLS models for men and women as table 55 shows. Men work on average in larger firms than women do. It can also be observed that firm size is negatively correlated with education for women. For men it is different, here the best educated work on average in larger firms and the second best educated in smaller firms. The age profile for both groups is concave. Being married is negatively correlated with firm size for women and positively for men. We find also a difference between men and women with respect to working hours: those men who work more tend to work in smaller firms and vice versa for women.

Table 55: Estimation results, size of firm (men and women)

	Men		Women	
	Firm size		Firm size	
	Coef.	Std. err.	Coef.	Std. err.
University	91.2409***	15.4829	-98.2545***	16.8600
Upper secondary	-78.5948***	14.1534	-63.7113***	14.9548
Age	17.3899***	3.8221	19.5398***	4.0289
Age2	-0.3615***	0.0462	-0.3180***	0.0497
Married	35.1642**	13.4518	-58.1706***	12.8681
Spouse in work	-22.9347*	10.4484		
Public sector	338.0306***	11.8748	285.1896***	11.4414
Tenure	24.8226***	0.5970	17.4864***	0.7181
hours	-6.8339***	0.6714	6.0515***	0.5106
Number of children 0-11	13.9813*	7.1033		
Number of children 12-15	-29.5802**	11.3497	-58.6308***	12.0453
Permanent contract	49.8920**	16.5060	84.6206***	16.2226
Intercept	763.1173***	89.8684	169.9876	94.4781
Number of obs.	25850		20450	
Pseudo R2				

Having determined states (with the exception of firm size) it remains to model some important continuous job characteristics. First of all we estimate for those who do not work over the whole year a model for the number of months worked (see table 42 above). Then we turn to working hours and hourly wages. All these models are random effects models and additionally to the normal usage of estimated coefficients we also use the individual effects and their variances during the simulation process. Thereby we improve the projection of the distribution of the three mentioned variables. We add the estimated random effects to the expected values. Once estimated an individual keeps its random effect throughout the simulation. For whom we could not estimate a random effect (simulated newborns e.g.) a random variable is drawn from a normal distribution which has the same variance as the individual effects. This is done separately for men and women which is particularly important considering that e.g. the variance of working hours is much larger for women than for men.

Table 56 shows that higher education increases the number of months worked among men who do not work the whole year. We also see that there is a concave age profile. A permanent contract has a positive influence which is also true for being married. For women a similar age profile is found. The family variables however, have opposite signs. That is, having small children and a working husband reduces the months worked in a given year.

Table 56: Estimation results, (log) number of months worked per year (men and women)

	Men		Women	
	Coef.	Std. err.	Coef.	Std. err.
University	0.0676^{*}	0.0288		
Upper secondary	-0.0022	0.0248		
perm	0.0568^{**}	0.0176		
Age	0.0288^{***}	0.0053	0.0196^{***}	0.0045
Age2	-0.0004^{***}	0.0001	-0.0003^{***}	0.0001
Spouse in work	0.0358	0.0194	-0.0274^{*}	0.0131
Married	0.0579^{**}	0.0215		
Number of children 0-11			-0.0348^{***}	0.0089
Working hours			0.0020^{***}	0.0004
Intercept	1.3447^{***}	0.1025	1.4551^{***}	0.0859
Number of obs.	3271		5432	

For the hours equations (table 57) we find that higher education positively affects hours worked for both men and women. Men show a concave age profile while women have a negative linear age effect. However, it must be taken into account that tenure works in an opposite direction, it is negative for men and positive for women. The positive effect for women may partly offset the effect of age. Chronically illness has a negative effect. For women we find also negative effects of family variables. The presence of small children strongly reduces working hours while this effect decreases when children grow older. Being married or having a spouse who works have a negative effect.

Table 57: Estimation results, (log) weekly working hours (men and women)

	Men		Women	
	Coef.	Std. err.	Coef.	Std. err.
University	0.0294^{***}	0.0058	0.0893^{***}	0.0114
Upper secondary	0.0111^{*}	0.0048	0.0275^{**}	0.0094
Age	0.0191^{***}	0.0014	-0.0050^{***}	0.0005
Age2	-0.0002^{***}	0.0000		
Chronically ill	-0.0423^{***}	0.0113	-0.0454^{*}	0.0201
Tenure	-0.0006^{*}	0.0002	0.0017^{***}	0.0005
Public sector	-0.0139^{**}	0.0047	0.0218^{**}	0.0072
perm	0.0274^{***}	0.0040	0.0418^{***}	0.0068
Firm size	-0.0000^{**}	0.0000	0.0000^{***}	0.0000
Married			-0.0903^{***}	0.0084
Spouse in work			-0.0142^{*}	0.0062
Number of children 0-11			-0.2087^{***}	0.0056
Number of children 12-15			-0.0823^{***}	0.0056
Intercept	3.2636^{***}	0.0278	3.5883^{***}	0.0237
Number of obs.	25850		20450	

We close this section with the results from the wage regression that are reported in Table 58. As the table shows, most coefficients meet our expectation, in sign as well as magnitude. The educational premia turns out to be more than 20% for higher educated men and women. Upper secondary education still leads to a higher wage rate than having only a low educational degree or no degree at all. The age profile, modelled as potential experience, has the well known concave shape. Being married has a positive effect for men and a negative one for women. The same holds for small children. Tenure also positively affects wages.

Table 58: Estimation results, (log) hourly wage (men and women)

	Men		Women	
	Coef.	Std. err.	Coef.	Std. err.
University	0.2086***	0.0086	0.2212***	0.0109
Upper secondary	0.0360***	0.0068	0.0677***	0.0087
Potential experience	0.0278***	0.0012	0.0281***	0.0013
Potential experience2	-0.0005***	0.0000	-0.0006***	0.0000
Married	0.0347***	0.0065	-0.0507***	0.0073
Firm size	0.0001***	0.0000	0.0001***	0.0000
Number of children 0-11	0.0260***	0.0032	-0.0391***	0.0051
Chronically ill	-0.0367*	0.0161		
Tenure	0.0067***	0.0003	0.0085***	0.0004
Public sector			0.0734***	0.0066
civserv			0.0950***	0.0170
Number of children 12-15			-0.0254***	0.0053
Intercept	2.0470***	0.0154	1.8912***	0.0170
Number of obs.	25867		20463	

4.2.4. Behavioural equations for Italy

The Italian labour market module follows the same general framework as the Belgian and German versions of the model. Some specific features are the following:

1. The probability of labour market participation is estimated separately for women (men) for two different subgroups only: those who, aged between 15 and 64, were (1) in work and (2) not in work and not in education.
2. Among the employees we distinguish private and public sector workers only without further disaggregating for civil servants due to the similar pension treatment among public sector employees.
3. The probability of being disabled, and hence to receive a disability pension benefit, is fully driven by alignment.
4. The early retirement choice (before the legal age provided for old age retirement) does not depend on a behavioural equation but, once a worker has achieved the requirements for seniority pension, we assigned a probability to have the transition which depends on being part of groups defined according to discrete values of replacement rate. In such a way we will be

able to hypothesize different scenarios for retirement choice. In fact, the Italian Pension system was heavily reformed in last two decades implying a very long transition phase and therefore in the future the behaviours could be very different from those of the estimation period.

Table 59 shows the probability, estimated for men and women separately, of being chronically ill depending on the health status of the individual (have been chronically ill or not) during the previous year.

The probability of becoming chronically ill is lower when men and women (both those who were and those who were not chronically ill last year) have high educational attainment (university or upper secondary degree) compared to those with lower levels of education (Table 59 and Table 60). Furthermore, for men and women who were not chronically ill last year the probability of becoming chronically ill increases with age.

Table 59: Estimation results for the chronically ill status - Men

	Chronically ill previous year		Not chronically ill previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	-0.40401	0.1391	-0.4090	0.1734
Upper secondary	-0.48575	0.07523	-0.1328	0.0845
Age	-	-	0.0179	0.0018
Intercept	1.0098	0.0843	0.1601	0.1401
Number of obs.		5368		50349
Pseudo R2		0.0272		0.1440

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

Table 60: Estimation results for the chronically ill status - Women

	Chronically ill previous year		Not chronically ill previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	-0.7137	0.0862	-0.40267	0.1049
Upper secondary	-0.8047	0.0464	-0.2803	0.0523
Age	-	-	0.0582	0.0011
Intercept	-4.9459	0.0689	-7.1289	0.0992
Number of obs.		6213		51889
Pseudo R^2		0.0268		0.1735

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

Turning to the participation decision, as already said for Belgian and German labour market module, the decision of working is aligned to the exogenous AWG labour market projections. The regressions first placed individuals in the ranking according to descending risk of entering or remaining into employment and then set the transitions according to the AWG proportional groups in the next year. Thus, the regressions below determine the non-stochastic part of the individual's risk, and therefore its rank.

Table 61: Estimation results for the working status - Men

	In work previous year		Not in work previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	0.7642	0.1191	-0.1311	0.1130
Upper secondary	0.4659	0.0575	-0.4298	0.0577
Ever had a job	0.8610	0.0708	1.4174	0.0651
Married	0.3636	0.0767	0.8360	0.1067
Newly divorced/separated	0.0393	0.4156	2.3357	0.5995
Number of children 0-11	0.2057	0.0775	0.5397	0.1076
Number of children 12-15	0.3698	0.1045	0.4959	0.1444
Potential experience	0.0959	0.0077	-0.1586	0.0089
Potential experience^2	-0.0024	0.00014	0.0009	0.0002
Chronically ill	-0.5420	0.0776	-0.8800	0.1038
Other inactive (lag)	1.2249	0.0984	-1.599*	0.0806
Unemployed (lag)	-1.3151	0.0657	-1.149	0.0740
Spouse in work (lag)	0.2077	0.0645	0.0510	0.0924
Intercept	0.7674	0.0972	1.2961	0.0868
Number of obs.		30718		11134
Pseudo R^2		0.1306		0.2243

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

Having been chronically ill or unemployed during the previous period has a negative impact on entering or remaining in the labour market. If the individual ever had a job he will have a higher probability of entering or remaining in the labour force. The impact of having a higher education level (university or upper secondary), having been inactive in the previous year and the potential experience differs between individual already having a job and those that do not. In particular, to be graduated or having an upper secondary education compared to lower secondary, has a positive impact on the probability of working for those that already have a job, while the effect is negative for those who were not in work previous year. For this group having a low education increases the probability to get into the labour market compared to those with an upper secondary level. This evidence reflects a different behaviour in job searching among young people according to the level of education. Also the effect of potential experience on probability varies depending on working status in the previous year; the probability of working increases with the years of experience for those who already have a job while decreases for those not working in the previous year. For this group high potential experience signals the individual is not a young searching for the first job.

For both groups of male respondents, the probability of being in work increases with the marriage and the number of children.

Table 62: Estimation results for the working status - Women

	In work previous year		Not in work previous year	
	Coef.	Std. Err.	Coef.	Std. Err.
University	0.7600	0.1026	-0.1016	0.0961
Upper secondary	0.5446	0.0587	-0.3935	0.0545
Ever had a job	1.269	0.0743	1.7879	0.0601
Married	-0.4262	0.0843	-0.2345	0.0912
Newly divorced/separated	0.1833	0.5309	1.3442	0.3559
Number of children 0-11	-0.2122	0.0683	-0.5432	0.0725
Number of children 12-15	0.0985	0.0894	0.1773***	0.0888
Potential experience	0.0814	0.00906	-0.1498	0.0087
Potential experience^2	-0.0021	0.0002	0.0009	0.0002
Chronically ill	-0.0358	0.1044	-0.6186	0.1189
Other inactive (lag)	-1.7674	0.0707	-1.8157	0.0674
Unemployed (lag)	-1.2340	0.0737	-1.4151	0.0794
Spouse in work (lag)	0.2259	0.0742	0.2592	0.0864
Intercept	0.5095	0.1109	1.0698	0.0848
Number of obs.		17822		23789
Pseudo R^2		0.1401		0.3104

Notes: Coef. = coefficient; Std. Err. = standard error; Dashes indicate variables not included in the model.

The main determinants of being in work for women are not the same as for men. Contrary to men, the probability of remaining in the labour force decreases when a woman is married and lives with children younger than 12 in the household. The regressions results are strongly consistent with the problem of reconciling work and family life for women in Italy especially when young children are present in the household (due to the lack of childcare services).

A prevalent condition of unemployment or inactivity in the previous year decreases significantly the probability of being in work. An upper secondary educational level and even more the degree determines a positive effect on the labour market participation if the woman has already a job. On the contrary, the same variables exert a negative effect for the women who were previously not in work. Furthermore the probability of entering or remaining in the labour force increases if her husband was in work in the previous year, as well as if she ever had a job and with the number of children in household older than 12 and younger than 15.

After the regression estimating the decision of being in work the model carries out the regression determining who are unemployed, conditioning on three states in the previous year: being unemployed or in work or neither in work nor unemployed. This event as well is subjected to the alignment with AWG-data.

Table 63: Estimation results for the unemployment status – Men

	Unemployed previous year		In work previous year		Neither in work nor un-employed previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
University	-1.2551	0.2371	-1.1998	0.35459	0.54236	0.14342
Upper secondary	-0.7523	0.1067	-0.5188	0.1386	-	-
Age	0.3572*	0.0320	0.4354	0.0292	0.21491	0.02394
Age^2	-0.0046	0.0004	-0.0060	0.0004	-0.00361	0.00032
Spouse in work (lag)	-	-	-	-	0.10772	0.20451
Married	-	-	-0.3667	0.1755	-	-
Intercept	-3.8469	0.5132	-7.5039	0.4442	-4.97194	0.38129
Number of obs.		3272		2552		10494
Pseudo R^2		0.0570		0.1404		0.1092

Notes: Coef. = coefficient; Std. Err. = standard error; Dashes indicate variables not included in the model.

In the first two groups a higher educational level decreases the probability to be unemployed while for the third group (neither in work nor unemployed previously) the effect is positive. The probability of remaining/entering in/into unemployment increases (at decreasing rate) with age.

Turning to women, the age and the working status of the husband influence, with a positive and negative sign respectively, the risk of unemployment.

Table 64: Estimation results for the unemployment status - Women

	Unemployed previous year		In work previous year		Neither in work nor unemployed previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
University	-	-	-	-	0.7853	0.1172
Age	0.1547	0.0294	0.5215	0.0418	***0.3103	0.0233
Age^2	-0.0024	0.0004	-0.0074	0.0006	-0.0051	0.0003
Spouse in work	-1.220	0.100	-	-	-1.2906	0.0853
Married	-	-	-1.5557	0.1797	-	-
Intercept	-1.074	0.475	-9.2199	0.6180	-6.372	0.3618
Number of obs.		3168		2380		26744
Pseudo R^2		0.0561		0.1353		0.1564

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The next decision for those in work is whether or not the individual is an employee, or a self-employed. Here again, different equations are estimated for men and women depending on the status of the individual previous year (the individual were already an employee, a self-employed or not in work).

Both for men and for women, this decision is mainly driven by age with a negative effect at decreasing rate.

Table 65: Estimation results for the employee status - Men

	In work and employee previous year		In work and not employee previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-0.1663	0.0393	-	-	-0.1370	0.0702
Age^2	0.0019	0.0005	-	-	0.0013	0.0008
University	-	-	-0.3095	0.1899	-	-
Upper secondary	-	-	-0.1196	0.1553	-	-
Permanent contract	1.4353	0.1207	-	-	-	-
Intercept	1.7055	0.7739	0.8789	0.2205	0.1010	1.369
Number of obs.		18812		7228		3333
Pseudo R^2		0.1163		0.0491		0.3508

Notes: Coef. = coefficient; Std. Err. = standard error; Dashes indicate variables not included in the model.

Table 66: Estimation results for the employee status - Women

	In work and employee previous year		In work and not employee previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-0.1441	0.0768	-	-	-0.25517	0.1082
Age^2	0.0021	0.0010	-	-	0.0026	0.0013
Public sector	1.4765	0.3611	-	-	-	-
Permanent contract	1.7260	0.2258	-	-	-	-
University	-	-	-	-	-0.9036	0.6385
Upper secondary	-	-	-	-	-1.0563	0.4454
Married			-	-	-0.9103	0.4404
Intercept	1.1639	1.4499	1.1907	0.4453	2.8492	1.9287
Number of obs.		8847		2099		3036
Pseudo R^2		0.0667		0.005		0.2569

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The employees can work in the private or public sector and the following regressions describe this transition depending on the status of individuals in the previous year (being in the public sector or not or just entering the labour market this period).

Men working in the private sector have a lower probability entering the public sector if they already have a permanent contract. For men already working in the public sector the probability to keep on working in that sector increases with their tenure while, for those not working in the previous year the probability of entering in the public sector increases with the highest level of educational attainment (university and upper secondary degree) compared to the lower levels.

Table 67: Estimation results for the public sector employee status - Men

	In work not in public sector previous year		In work in the public sector previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
University	-	-	-	-	2.2078	0.3077
Upper secondary	-	-	-	-	0.7898	0.2143
Tenure	-	-	0.0126	0.0006	-	-
Permanent contract	-0.4928	0.1119	-	-	-	-
Intercept	-2.4973	0.1183	0.0228	0.1193	-2.9484	0.3006
Number of obs.		6700		14572		1695
Pseudo R^2		0.0018		0.1220		0.0111

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

For women as for men, the probability of entering in the public sector decreases if they already have a permanent contract. The probability of remaining at work as a public employee increases with the presence of children younger than 12. For those women who just entered in the labour market, the higher is the educational level the higher is the probability.

Table 68: Estimation results for the public sector employee status - Women

	In work not in public sector previous year		In work in the public sector previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
University	-	-	-	-	1.7768	0.3292
Upper secondary	-	-	-	-	0.9780	0.2580
Number of children 0-11	-	-	0.3639	0.0972	-	-
Married	-	-	-	-	0.5002	0.2257
Tenure	-	-	0.01371	0.0008		
					-	-
Permanent contract	-0.5220	0.1206	-	-	-	-
Intercept	-2.3557	0.1255	0.4404	0.1465	-3.4847	0.3601
Number of obs.		5342		8578		1668
Pseudo R^2		0.0010		0.0234		0.0203

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The next regression simulate whether one has a permanent contract or not and this equation is estimated for all employees in the public and private sector.

Table 69: Estimation results for the permanent contract status - Men

	In work no permanent contract previous year		In work permanent contract previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	-	-	0.3412	0.0183	-	-
Age^2	-	-	-0.0042	0.0002	-	-
Intercept	-0.6506	0.0952	-4.0279	0.3673	-0.4519	0.1457
Number of obs.		6849		14423		1781
Pseudo R^2		0.000		0.0296		0.000

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

For the employees the estimations are under the condition of the states in the previous year: in work but not with a permanent contract, in work with a permanent contract and not in work.
The only explanatory variable, and for men solely in the second group, is age. No variables were significant for those males and females just entering the labour market.

Table 70: Estimation results for the permanent contract status - Women

	In work no permanent contract previous year		In work permanent contract previous year		Not in work previous year	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Age	0.1808	0.0229	0.3312	0.0248	-	-
Age^2	-0.0022	0.0003	-0.0039	0.0003	-	-
Intercept	-4.4523**	0.4881	-4.075***	0.4408	-0.5831	0.1471
Number of obs.		4864		9056		9056
Pseudo R^2		0.0265		0.0220		0.0000

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The model estimates if individuals work the full year or not. Age, having a permanent contract, working in the public sector and being self employed are the main explanatory variables increasing the probability of working the full year for both men and women. Furthermore, the number of children younger than 12 and if the spouse is in work both have a negative impact on the probability of working the whole year.

Table 71: Estimation results for the "work all year" status – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.4599	0.0177	0.3838	0.0249
Age^2	-0.0052	0.0002	-0.0045	0.0003
Number of children 0-11			-0.2917	0.0562
Chronically ill	-0.5267	0.1161		
Self employed (lag)	2.1679	0.0962	2.1079	0.1242
Public (lag)	0.9351	0.9351	1.4789	0.1022
Permanent contract (lag)	2.4238	0.0726	2.6206	0.0829
Spouse in work	-	-	-0.2211	0.0797
Intercept	-11.2685	0.3605	-10.0431	0.4759
Number of obs.		30635		17959
Pseudo R^2		0.3551		0.3784

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The following regression determines the probability of being a part-time worker. For men, the probability of working part-time decreases if having a permanent contract and increases if working in the public sector. For women, having children in household increases this probability.

Table 72: Estimation results for the part time status – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Public	2.3495	0.1351	-	-
Permanent contract	-0.6849	0.1357	-	-
Number of children 0-11	-	-	0.0744	0.0539
Number of children 12-15	-	-	0.4274	0.0759
Intercept	-4.929	0.1987	-3.0739	0.1057
Number of obs.		23961		16527
Pseudo R^2		0.41		0.1232

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

Then the model estimates the three factors which determine the yearly earnings - the number of months worked per year, the hours worked per week and the hourly wage – using a GLS estimator for panel data with random effects.

For those who do not work the whole year the number of months worked is estimated. Having a permanent contract and the tenure are the main explanatory variables for both men and women affecting positively the number of worked months.

Table 73: Estimation results for the number of worked months per year – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Permanent contract	0.1275	0.0273	0.0896	0.0296
Tenure (Duration in work)	0.0017	0.0004	0.0016	0.0004
Intercept	1.5397	0.0152	1.5399	0.0159
Number of obs.		2992		2804
Wald chi^2		139.48		83.76

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The number of hours worked decrease if both men and women working part-time, if they work in the public sector and if they have a degree. On the contrary, age increases at the decreasing rate the number of hours worked per week for men; for women worked hours increase with seniority and firm size and in presence of a permanent contract while decreases with age.

Table 74: Estimation results for the number of worked hours per week – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.0042	0.0010	-0.0093	0.0019
Age2	-0.00006	0.00001	0.00007	0.00002
Part time	-0.6159	0.0083	-0.5284	0.0077
Duration in work	-	-	0.0001	0.00004
University	-0.02737	0.0062	-0.0322	0.0087
Upper secondary	-0.0052	0.0031	-	-
Public sector	-0.0520	0.0033	-0.0272	0.0055
Permanent contract	-	-	0.0193	0.0049
Firm size	-	-	0.00003	0.00001
Agriculture (lag)	0.0213	0.0065	0.0656	0.0147
Industry (lag)	0.0102	0.0031	0.0466	0.0064
Intercept	3.6300	0.0202	3.7499	0.0349
Number of obs.		20586		13141
Wald chi2		6298.3		5235.99

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

The next step is the estimation of the hourly wage. Hourly wages increases with the level of education, for individuals working in the public sector, with a permanent contract and with potential experience, while decreases; moreover, only for men, hourly wage increases with tenure.

Table 75: Estimation results for the hourly wage rate – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
University	0.4788	0.0134	0.4397	0.0165
Upper secondary	0.1204	0.0066	0.1612	0.0096
Public sector	0.0730	0.0067	0.1527	0.0093
Permanent contract	0.0772	0.0066	0.0812	0.0084
Potential experience	0.0359	0.0012	0.0303	0.0016
Potential experience^2	-0.0005	0.00002	-0.0004	0.00003
Duration in work	0.00017	0.00003	-	-
Intercept	1.2163	0.0152	1.1692	0.0204
Number of obs.		24071		15409
Wald chi2		7372		3998.29

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

Also for Italy a macro economic wage growth path is exogenously imported into the model according to productivity growth rate assumed by the AWG.

A final regression in the labour market module determines the size of the firm where men and women work. Firm size is negatively correlated with women's education (degree) while for men the relation is positive. The age profile is concave for both men and women.

Table 76: Estimation results for the size of the firm – Men and women

	Men		Women	
	Coef.	Std. Err.	Coef.	Std. Err.
University	36.0624	4.1018	-12.3486	3.7810
Age	11.6962	0.8553	9.2527	0.9217
Age^2	-0.1361	0.0101	-0.1063	0.0114
Married	7.5795	3.4148	6.8672	2.9737
Intercept	-167.8733	19.0647	-103.4586	19.8167
Number of obs.		23053		15674
R^2		0.0296		0.0250

Notes: Coef. = coefficient; Std. Err. = standard error. Dashes indicate variables not included in the model.

4.3. The pension module

The demographic and labour market modules of MIDAS are as least country-specific as possible, save obviously for the data used to estimate the behavioural equations. This is especially the case for the demographic module. For the labour market module, the most important country-specific characteristic of the Belgian version is that the labour market states result from an AWG-alignment process. The requirement that the modules be as uniform as possible over the three countries was obviously dropped for the pension module, as it is the primary goal of MIDAS to assess the impacts of these country-specific pension systems, in conjunction with the AWG-projections, on the adequacy of pensions. The below three sections will present and discuss the main regulations of pension systems of Belgium, Germany and Italy. For a full description of rules and regulations of these pension systems the reader is invited to consult the appendix 2 of this report.

4.3.1. The Belgian pension module

The Belgian retirement system consists of three pillars. The first pillar contains the public social security programs, which are the most important source of income for current pensioners. The second pillar is that of the company pension schemes. Although coverage of these schemes is increasing rapidly, its importance in terms of the income it provides to current pensioners is still limited. The third pillar consists of the individual life-insurances and retirement savings. We concentrate upon the first-pillar social security retirement schemes[27].

As in most countries with a Bismarckian pension system, first-pillar pension benefits in Belgium have an occupationally tied character that is toned down by diverse minimum provisions and ceilings. The first-pillar retirement system for employees provides former private sector employees and public-sector employees that were no civil servants a pension benefit that essentially is a function of the past career. The mandatory age of retirement is 65 for males. For females it is gradually increasing from 61 years of age up to 65 (from 2009 on). However, one can become eligible for early retirement from the age of 60 on, if one has a career of minimum 35 years for males. For females, this minimum career length also is increasing up to 35 years in 2009.

The pension benefit is calculated as

Benefit=(.60 or .75)*(length of career/length of career for full pension)*wage-base

The wage-base essentially is the average of past salaries, indexed on the development of prices and with additional discretionary adjustments for the development of wages between the year of earning and the year of retirement. This modified average of corrected salaries is then multiplied by the length of the career and divided by the length of the career needed for a full pension. The latter equals the age at which one becomes eligible to a full pension benefit minus 20. So, for males, it is 65-20=45 years. For females, it is gradually increasing to 45 years. As a result, if one does not have a full career, continuing to work causes the pension benefit to move towards the 'full-career pension benefit'. This wage-base is then multiplied by either 60 or 75%. If the individual is single, the 60% is used. If he has a partner, he can choose the 'family pension benefit' of

27 The pension regulation that is described here and more largely in appendix 2 is based on the regulation of 2005.

75%, but then his partner loses his or her own pension entitlement. So, this is only beneficiary if one's partner has no significant revenues of his/her own.

Redistributive solidarity is embedded in the pension system in several ways. First of all, the wage one earns in a certain year during ones career is taken into account only up to a certain limit or ceiling. All incomes higher than this limit do not add to the wage-base, and hence not to the future pension benefit. Those earning a higher income therefore face a lower replacement rate. Moreover, there are two ways in which a minimum benefit is implemented in the pension benefit: The minimum right by career year and the minimum pension.

The conventional early leavers' scheme (CELS) is essentially an unemployment scheme. It allows older private-sector workers to exit the labour market and become unemployed at favourable conditions until the mandatory retirement age. One generally may become eligible for a CELS benefit from the age of 58 on[28]. Unlike the retirement benefit, the CELS benefit does not depend on the number of working years. Furthermore, when one enters the CELS, one formally does not retire but becomes unemployed. The career length, on which the future pension will be based when one will reach the mandatory retirement age, therefore continues to increase.

The disability scheme for wage earners is also considered as a pathway of withdrawal out of the labour market. Indeed, even if disability is not an absorbing state, statistics reveals that, after the age of 50, the re-entry into the labour market is very rare. For this reason, we consider in this modelling that disability after the age of 50 is an absorbing state. The disability benefit is equal to 40% of the last wage when the individual is cohabitant and 50% of the last wage when the individual is single. This amount is subjected to minimum and maximum.

Civil servants are subject to a first-pillar pension system that is separate to that of the private sector. Public sector pensions are considered as deferred income rather than old-age insurance. Indeed, public pensions are paid out of the general federal budget and no contribution is raised to finance it. The only official insurance aspects are the 7.5% social security contributions that public-sector employees have to pay to finance survivor benefits. Benefits are essentially individualized, that is, there are no difference between a "household" benefit and a "single" benefit.

Indexation rules of public sector pensions are different than the one that prevail for wage-earners pensions. Indeed, in addition to indexation to the CPI, public pensions are indexed to average wages. Civil servants therefore enjoy the benefits of productivity increases even when they are retired.

[28] In practice, many older workers retire to the CELS before the age of 60. But these regulations are of an ad hoc nature and therefore not considered in this paper.

Civil servants' pensions are compulsory as of age of 65 for both men and women. An early retirement is possible from the age of 60 if at least 5 years of work as civil servant is proved. This 5 years condition is also necessary to be entitled to the normal age retirement benefit.

Public sector pensions are based on the income earned by an individual during the last five years before retirement. Benefits are computed according to a formula that can be represented as follows:

Benefit = n/N * reference earning,

where *n* is the number of eligible years spent in the public service, *N* is a benefit accrual factor and the reference earning is the average wage over the last five years. The benefit accrual factor depends on the rank the person occupied in the hierarchy. It is in general equal to 60 but can vary from 55 for some teachers to 30 for university professors and magistrates.

Even if self employed are out of the scope of this analysis, it has appeared a necessity to implement the computation of their retirement benefits in the pension module. Indeed, as self employment is a state that can emerge from the labour market module, it would have been nonsense not to include benefits related to self-employment periods into adequacy measures.

Self employed retirement benefits are not modelled using exact regulation as it is done for civil servants and wage-earners. As data concerning self-employed career are often missing, it is not possible to compute their benefits. It has therefore been decided to give to self-employed retirees the minimum pension for self-employed. For those who have only a part of their career as self-employed, they receive the minimum pension computed at the pro rata of their career as self-employed. As 78% of "pure" self employed benefit from the minimum pension (Scholtus 2008), the output of this simplification might nevertheless be realistic. This high level of self-employed benefiting from the minimum pension is due to the computation formula of the system that is largely less generous than the one of wage-earners. The large difference between these formulae, that are quite similar, is the "reduction coefficient" that is applied to self employed and whose consequence is to divide almost by two the self-employed pension compared to the pension that would have been computed in the wage-earners' regime. The "reduction coefficient" takes into account lower contribution rates of self-employed. It is equal to the ratio between the contribution rate of self-employed and the contribution rate of wage-earners.

It has to be noted that the new regulation introduced by the Solidarity Pact between generations has not been implemented into this version of the model. The impact of this set of measures could therefore be estimated in a future version of the model taking the present version as the base case.

Summarizing, the Belgian pension module of MIDAS simulates first-pillar old-age pension benefits for private sector employees and civil servants. Furthermore, it simulates the Conventional Early Retirements (CELS) benefit, the disability pension benefit for private sector employees, and –finally- the widow(er)s' pension benefit, again for private sector employees as well as for civil servants. As said in the previous section, hourly wages increase with productivity over time, and the speed of this increase is the hourly productivity growth rate assumed by the AWG.

Social policy hypotheses used in MIDAS for other pension systems are those used to produce the 2005 AWG projections for Belgium. It concerns the growth of wage ceilings, welfare adjustments, indexation to wages for the civil servants' pensions and real growth of lump-sum benefits. These growth rates are defined as a difference relative to the productivity growth rate.

Wage ceiling: difference of 0.5% with productivity growth

Welfare adjustment: difference of 1.25% with productivity growth

Welfare adjustment for civil servants: difference of 0.5% with productivity growth

Lump-sum benefits: difference of 0.75% with productivity growth

Minimum right by career year: difference of 0.5% with productivity growth

So, if productivity grows by 1.5 percent per year, then the wage ceilings and civil servants' pensions grow by 1.0 percent (i.e. macro economic productivity growth minus wage thrift), ongoing employees' pensions grow by 0.25 percent, and lump-sum benefits grow by 0.75 percent per year and the minimum right by career year grows by 1.0 percent. Over time, the impact of wage-ceilings will therefore increase, or –put differently- the wage ceiling becomes more restrictive over time. Furthermore, the impact of the minimum pension – that is a lump-sum benefit – will become quickly non operational. Indeed, as the minimum right by career year increases faster than the minimum pension, this last instrument will progressively be totally replaced by the first one. Note that, even though there was less generosity in the past, this welfare adjustment hypothesis fits not only in the AWG projections, but has been made explicit in the so-called "Generation Pact" of autumn 2005 (Federal Planning Bureau, 2006, page 35)[29].

4.3.2. The German pension module

The vast majority of gainfully employed persons in Germany is compulsorily insured in the public pension scheme (PPS). The most important exceptions are civil servants and the majority of self-employed persons. For civil servants, a specific old-age provision system exists which is financed by the general tax revenue. Self-employed have to insure themselves in private pension

[29] See also Fasquelle et. al. (2008, 4) for a discussion.

schemes. Furthermore, disability pensions exist and derived pensions such as surviving spouse pensions.

The PPS is a pay-as-you-go system and strongly related to individual employment careers. Most of accumulated pension rights result from so called "earning points" which represent the relation of individual earnings to average earnings in a given year. Earnings points can also be derived from other sources, e.g. from childrearing, education, unemployment. A person becomes eligible to a pension if she has a minimum insurance record and if she reaches a certain age (age at which a person becomes first eligible to an old-age pension depends on the birth cohort).

The individual pension amount depends on the whole employment career. Thus, the simulation takes into account information from the past for all adults in the base year of the simulation. The necessary information was provided using the waves 1984-2003 of SOEP. SOEP not only includes information on the current work status and income. Retrospective questions also provide information on the working career prior to the first SOEP interview. As this information does not include the past wage income, we estimated a relative wage regression. The estimated coefficients served to impute earnings points for all periods a person was employed before she was a participant of SOEP. The information provided for the starting year of the simulation includes the number of years relevant for the minimum pension record, the sum of earnings points acquired in periods of employment, unemployment, education, and earnings points for raising children. Moreover, we take into account information on the duration of the current marriage and the earnings points acquired during marriage. This information is required in the case of a (possible) divorce in the future as pension rights acquired during a marriage are divided between the partners in the case of divorce.

During the simulation period, individuals accumulate (further) earnings points due to employment income, periods of unemployment and raising children. In case of a divorce, earnings acquired during the marriage are divided between spouses. The sum of all earnings points up to retirement builds the basis for the pension amount. Eligible for old age pensions are persons who have a minimum insurance record and have reached a certain age which differs between several groups of insured persons at the starting year of the simulations. At present, the regular retirement age (65) is equal for all individuals with the exception of handicapped persons. Several groups are allowed to retire before the regular retirement age (up to 5 years). However, each month (year) of early retirement leads to a deduction of pensions of 0.3% (3.6%). Retirement before the age of 60 is only possible for disabled persons. In order to keep the simulation model tractable, the take up of disability pensions was restricted to persons between age 55 and 59 and governed by a separate regression.

The old-age pension amount without deductions is given by the product of the sum of earnings points and the current pension value. The current pension value is identical for all persons.[30] The annual adjustment of the current pension value follows a quite complex rule which takes into account the growth rate of the average wage, changes in the ratio of pensioners to employees, changes in the income share of subsidized private pension provisions, and changes in the PPS contribution rate. In addition to old-age and disability pensions, the public pension scheme also provides surviving spouse benefits. The amount of a surviving spouse benefit is a fraction of the pension of the deceased spouse. The pension is withdrawn to some extent if own income of the surviving spouse exceeds a threshold. Civil servants are insured in a separate system. The amount of the pension benefits is mainly based on the wage level in the last years of service (the reference earnings) and the length of service. Surviving spouses of civil servants are entitled to a pension which amounts to 55% of the pension of the deceased person.

As already mentioned above, the current pension value is adjusted according to a complex rule. One of the determinants of the current pension value is the change in (average) gross wages. For the growth of gross wages, we use the assumptions of the AWG (1.6 % on average per year).[31] Due to the complex rule for the adjustment of the current pension value, the development of the current pension value has to be simulated making assumptions on the changes of all factors that enter the adjustment rule. We base our assumptions on a simulation of the current pension value of Buslei and Steiner (2006). As they assume a slightly lower growth rate of wages (1.5%), we have accordingly adjusted the growth rate of the current pension value. The development of wages and current pension value are shown in the following table 77.

Table 77: Assumptions on the development of wages and current pension value

	2010	2020	2030	2040	2050
% Increase of wage compared to 2002	4,6	21,4	43,7	70,0	101,3
% Increase of pension compared to 2002	2,9	15,7	27,9	48,0	73,4

While wages double up to the year 2050, the current pension value increases by about 73%.

4.3.3. The Italian pension module

The Italian public pension system has been reformed many times during the last 15 years, mainly concerning the reforms both the retirement age (i.e. the requirements for being eligible to seniority and old age pensions) and the formula for computing benefits.

In Italy two different kinds of options for retirement are allowed; actually workers can receive:

30 Currently it differs between West and East Germany.

31 AWG, Special Report, No. 4, (2005).

- an old age pension when they are aged 65 if males and 60 if females and their contribution years are not lower than a specific threshold (anyway, females have the option to continue to work until 65).
- a seniority pension, when, before being aged 65 or 60, specific requirements concerning both age and seniority are satisfied (e.g. 40 years of seniority or, since 2008, at least 58 years old with at least 35 seniority years).

As a result of the 1995 reform, in Italy there are currently three different public pension schemes which differ with respect to the pension formula. Workers' enrolment to such schemes depends on their seniority at 1995 according to the following rules:

- Individuals with a seniority of at least 18 years at that date receive a benefit wholly earnings related (so called *retributivo*). Such benefit is computed through two different quotas: the "A quota" linked on the average of wages earned during last five working years (only the final wage for public employees) and the "B quota" linked to the average of wages earned in last 10 working years for both public and private employees. In the "A quota" wages are indexed only to inflation rate, while they are indexed to inflation rate plus 1% in the "B quota".
- Individuals entered in labour market since 1996 receive a benefit wholly based on the NDC scheme (so called *contributivo*). In NDC regime the pension is based on contributions paid which are accumulated – receiving nominal GDP growth rate as rate of return – and are transformed in an annuity stream through transformation coefficients depending in an actuarially fair way on retirement age (coefficients do not differ for males and females).
- Individuals with less than 18 years of seniority receive a mixed benefit computed *pro quota* by a weighted average of pension benefits resulting in earnings related and NDC schemes, where weights are, respectively, years worked until and after 1995 (but the "B quota" of the earnings related part is now based on wages earned during the whole working life rather than only on last 10 working years).

In addition, for workers fulfilling the requirement concerning years of contributions for receiving an old age pension, in the earnings related and mixed schemes a means tested integration to a fixed minimum pension is guaranteed (so called *integrazione al minimo*), taking into account income only. For individuals enrolled in the NDC scheme there is no such guarantee. Individuals enrolled to *contributivo* – or not fulfilling the contribution requirements if enrolled to *retributivo* or *pro rata* – can receive at 65 a means tested social assistance benefit, the so called *assegno sociale* (amounting less than the minimum pension). This however falls outside the scope of the Italian version of MIDAS.

After the 1992 reform pension benefits are indexed only to prices (until such date they were instead indexed to nominal wages).

Because of the specific features of the Italian pension system, for computing benefits many retrospective information on seniority, past earnings and employment statuses are needed. Given that in the Italian ECHP such information is not available, in the first step we had to build a micro-simulation module for computing past (before 1994) workers' histories. The main steps for building such module have been the following ones:

- Given the wide diffusion on informal economy in Italy very often (especially in the past decades) individuals worked without paying contributions. Consequently the length of working career (available in ECHP) is a poor proxy of seniority (on which is based the earnings related scheme), whose length is instead not available in ECHP. We then estimated on a national data source (SHIW dataset, provided by Bank of Italy) the relationship between seniority and individual variables and imputed to ECHP individuals the seniority derived through such regression. Such estimated seniority has then been used also for identifying the specific pension scheme to which individuals enrol.
- Once computed the seniority, through regressions on the probabilities of working without paying contributions we imputed in the individual working lives the specific years without contributions.
- Then we estimated the past transitions between work statuses (i.e. qualifications, sectors, public and private employees or self employed).
- Finally we computed past earnings (expressed in constant 2001 prices) according to average wage growth for qualifications and sectors.

The pension module is then based on two different data sources: the retrospective dataset, including wages and working statuses until 2001, and the 2001 cross-section on which simulation runs.

The first two steps of pension module concern the classification of individuals in the different pension schemes afore-mentioned and the specifications of requirements for eligibility to early retirement benefits (which have been reformed many times and are still increasing). Then, we simulate the early retirement option. Finally the different kinds of benefits are computed. Further, a fiscal module for computing net of taxes pensions and wages is added in order to compute and compare gross and net replacement rates and inequality and redistribution indexes.

The pension module simulates first pillar old age and early retirement pensions for private and public sector employees. In addition to "pure" pensions we compute other types of benefits:

- minimum integration for individuals enrolled wholly or *pro quota* in the earning related scheme;
- survivor pensions, paid when the dead was still working or was already retired;
- disability pensions.

No benefits for divorced are instead computed, because in Italy the amount of the alimony allowance is not fixed by law, but it is decided on a case by case basis as part of the divorce settlement.

Finally, it has to be pointed out that even if self employed are out of the scope of the model, we compute also their pensions. In Italy the most of self-employed, also due to a huge underreporting of incomes, usually pay the minimum contribution fixed by the law. As a consequence merely the minimum pension is imputed as pension benefit to self-employed enrolled (wholly or *pro quota*) to the earnings related scheme (and fulfilling requirements for receiving such pension). For self-employed enrolled to *contributivo* the payment of the minimum contribution is instead accumulated into the model and the benefit is computed according to the usual rules of the NDC scheme.

The main assumptions on which the Italian pension module is based are the following:

– When workers satisfy requirements for early retirement, a regression simulates which individuals retire before reaching old age. Such regression is linked to a “trap file” which increases the probability to early retirement when the potential replacement rate (i.e. the replacement rate received if the worker should retire in that moment) increases.
– Even if old age pension is paid to females at 60, we allow to women the chance to continue to work until 65.
– At 65 both males and females are identified as “coann_retired”.
– The “tran” files do not include alignments.
– Every income threshold of the pension system (e.g. for means tested minimum integration or for the maximum contributions) is kept constant in real terms at its 2005 value.
– Once paid pension benefits are constant in real terms given that in Italy no wage indexation exists. Anyway, “tran” files can be easily modified in order to run sensitivity scenarios concerning different indexation formulas.
– Transformations coefficients of the NDC schemes are updated every 10 years according to the official demographic projections. The reform approved in 2007 has provided that coefficients will be updated every three years since 2010 and the computation formula regarding these could be slightly changed. However, currently such new coefficients have not yet been published. As a consequence the model will be updated when the new coefficients will be published.
– NDC returns are linked to the projected GDP growth rates provided by the AWG.

4.4. References

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5. The Simulation Results

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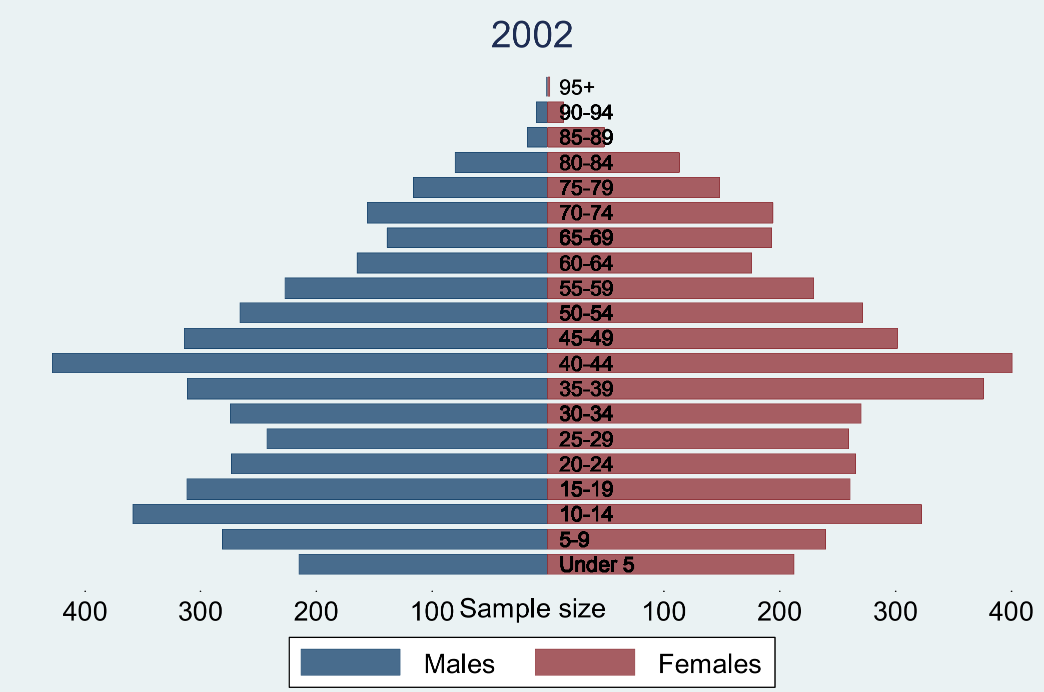
5.1. Belgium

5.1.1. Demographics

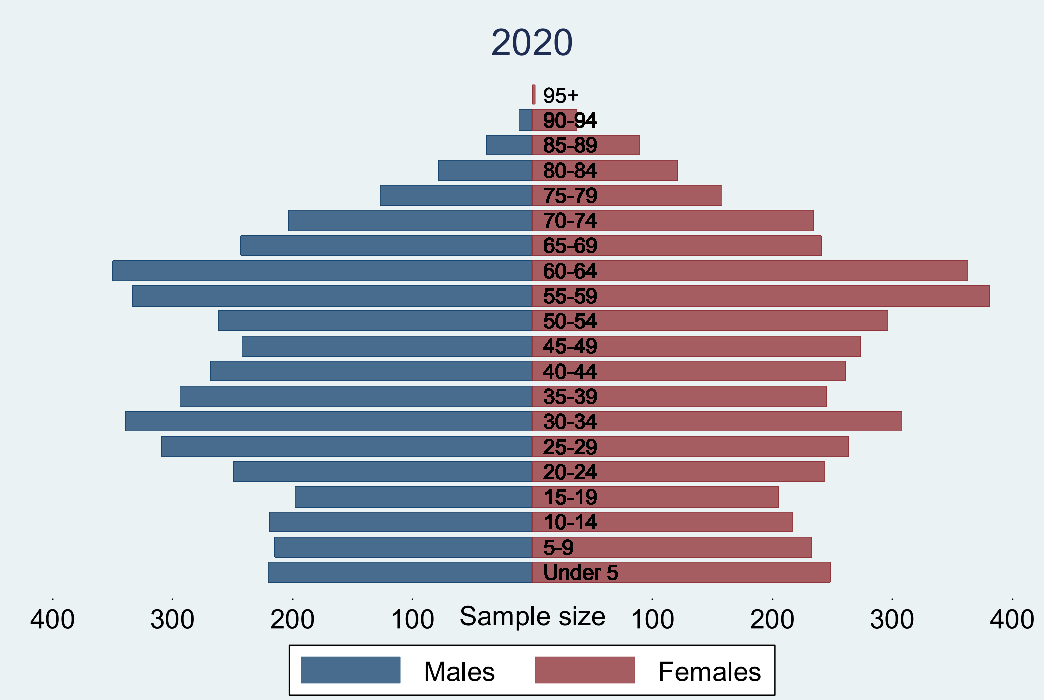
The most fundamental variables are gender and age. These variables are fully driven by the alignment process of MIDAS, thereby reflecting the demographic projections of the AWG. The development of the proportional sizes of gender classes in various simulation years is not discussed, because they only stand witness to the presumption that these proportional sizes do not change considerably over time.

Figure 7 shows the distribution of ages in 2002, 2020, 2035 and 2050.

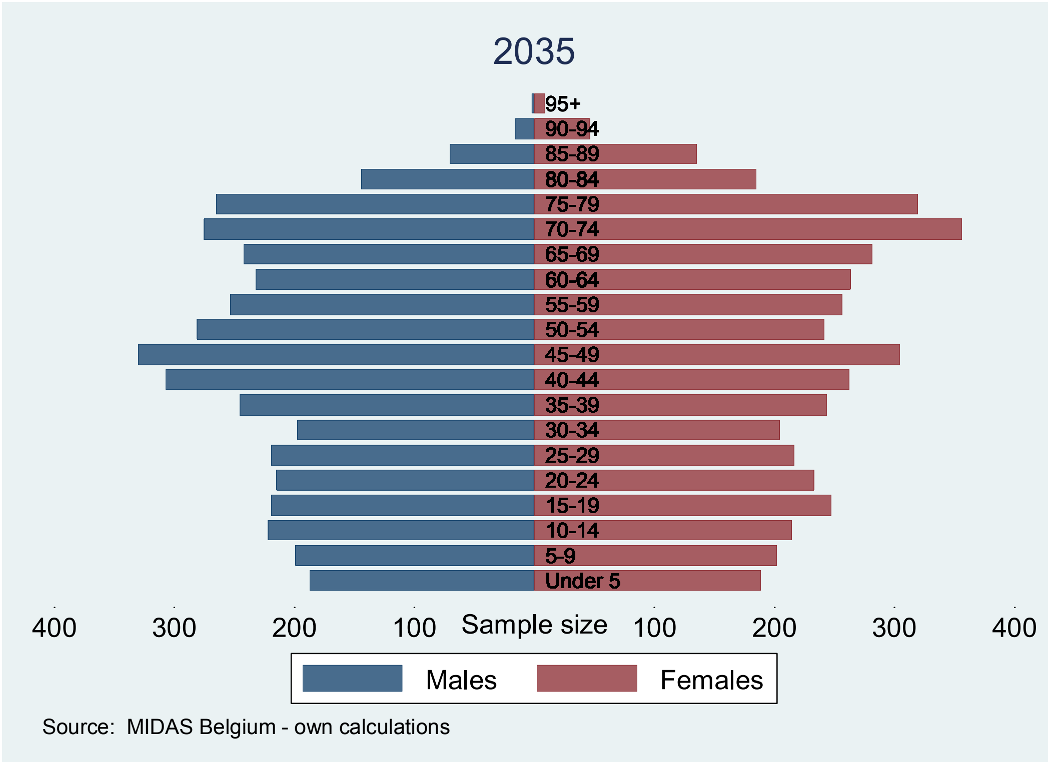
Figure 7: Males and females in age groups in selected years

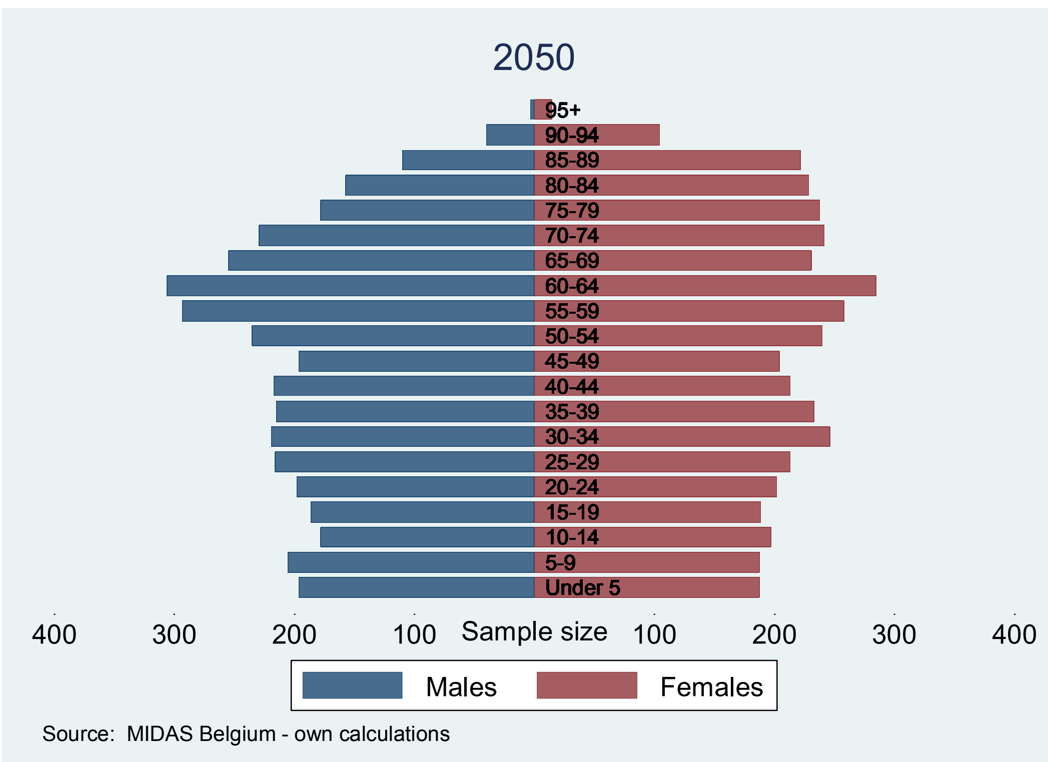


Source: MIDAS Belgium - own calculations



Source: MIDAS Belgium - own calculations

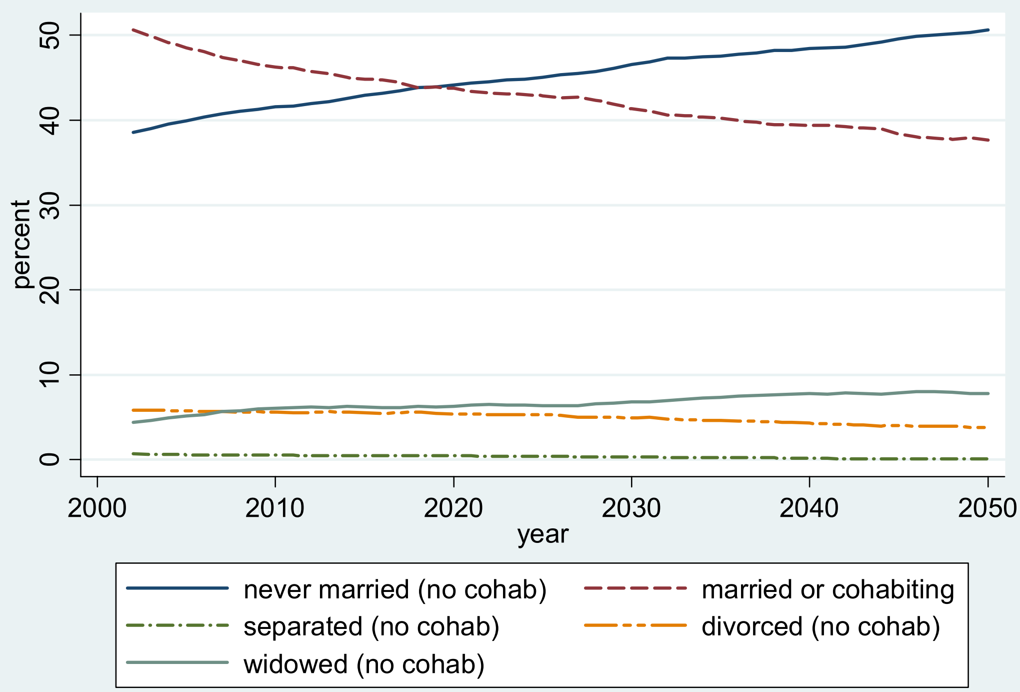

2035
95+
90-94
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
Under 5
400 300 200 100 Sample size 100 200 300 400
Males
Females
Source: MIDAS Belgium - own calculations


2050
95+
90-94
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
Under 5
400 300 200 100 Sample size 100 200 300 400
Males
Females
Source: MIDAS Belgium - own calculations

In the starting year 2002, the observed distribution shows two 'lumps', especially for males. The members of the first cluster of large cohorts are between 40 and 50. There is also a young cluster whose members are between 10 and 20. Furthermore, the 'basis', the size of the youngest cohorts is rather small. In the later years, one can see both bumps shift upwards as their members' age. So the population ages in that there are proportionally more elderly, but also dejuvenates in that the size of the youngest cohorts decreases. Only in the last simulation year, 2050, do we see that the proportional differences between the cohorts become less outspoken, especially for females.

Next, we consider the simulation results of the marriage market. Figure 8 shows these results, taking married and cohabiting individuals together.

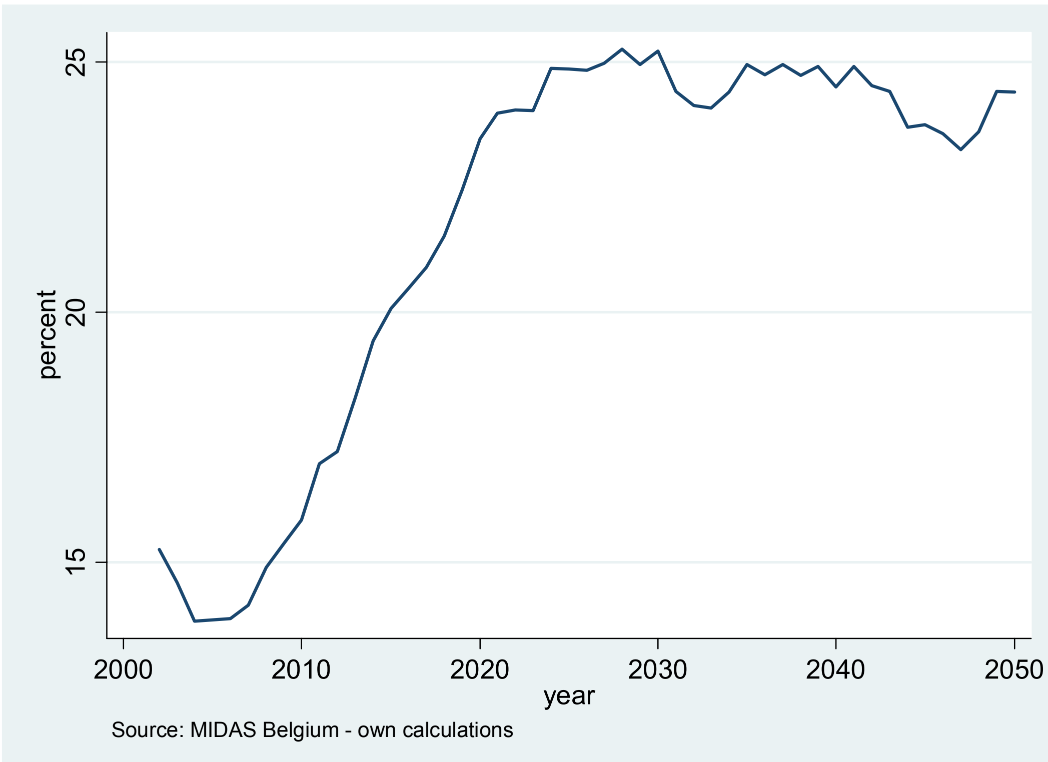
Figure 8: Proportional size of marital status



Source: MIDAS Belgium - own calculations

Figure 8 shows foremost that the largest majority of individuals are either married or cohabiting, or are single. This description may be misleading, however, because cohabiting means living together with a partner. Somebody who lives with his or her parents is not cohabiting. The proportionally large number of singles indeed is caused by children that actually live with their parents. The proportional size of the other categories (widowed, separated, divorced) clearly are much smaller. As time goes by, we see that the proportion of single individuals increases at the expense of the proportion of married or cohabiting individuals. Furthermore, within the group of those being part of a couple, the proportion of cohabiting individuals increases at the expense of the proportion of married individuals. This is shown in Figure 9.

Figure 9: Proportional size of cohabiting individuals within the group of those living together

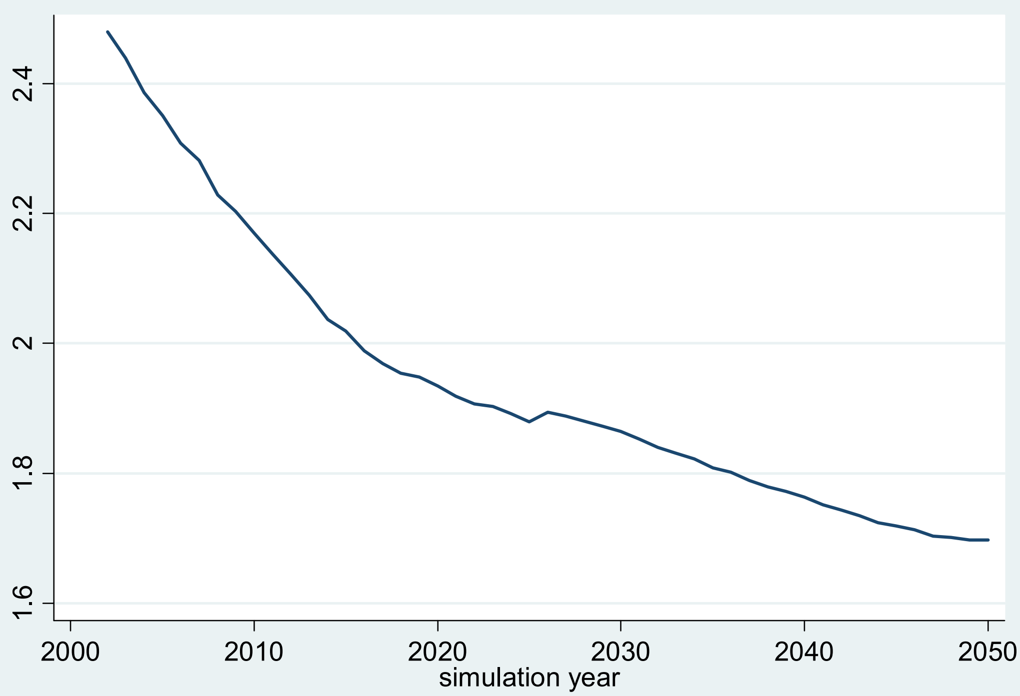


Now why does the proportion of married or cohabiting individuals decrease over time in Figure 8? The answer lies in Figure 9, showing the increasing popularity of cohabitation. Indeed, ceteris paribus, the probability of separation is often higher for cohabiting partners than the probability of divorce is for married partners (Verschueren, 2006: 6). Furthermore, those who separate, return to their previous marital status (most often being single) while those divorcing enter the state of divorcee. So as the proportion of cohabiting individuals increases over time, the average probability that a couple splits up, increases as well. As a result of this, the proportion of married or cohabiting individuals decreases. Furthermore, when they do split up, proportionally more people return to the status of being single. The proportion of singles hence increases.

This can also be observed through Figure 10 plotting the average number of individuals in households. This is continuously decreasing over time. As explained above, the increasing number of cohabitations, that leads more often than with marriage to a separation, creates an increasing number of single households. The second effect that explains the decline of the households' size is directly related to the modelling of households' creation. As described in chapter 4, the model includes a procedure of households' creation that allows avoiding, for example, that children stay in their parents' household during their all life, hence creating an overrepresentation of multigenerational households. But, as a consequence of the implementation of this procedure, we will end up with a situation where the elderly by definition form households on their own without their children. This is particularly obvious in Figure 11. This figure shows the same indicator than Figure 10 but only for households in which at least one individual is retired. This number stays more or less constant until about 2020, after which it decreases. This decrease is because the observed multigenerational households are gradually replaced by simulated households. For the latter, household formation and dissolution rules are such that multigenerational household cannot occur. Combined with the fact that the average age of retirees increases –thereby increasing the probability of being a widow or widower, this causes the average size of retired households to decrease slowly.

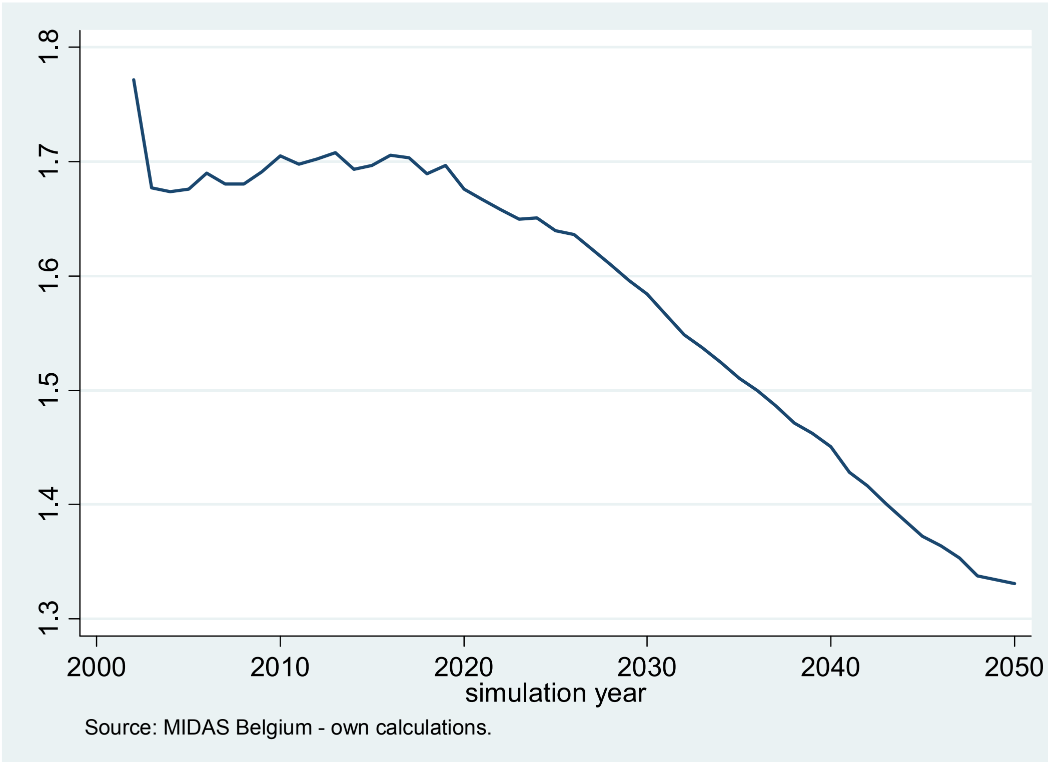
This variation in the structure of households is more important than it seems to be at first sight. Indeed, as we will see bellow, the composition of households has an important impact on poverty and inequality measures.

Figure 10: Average number of individuals in households



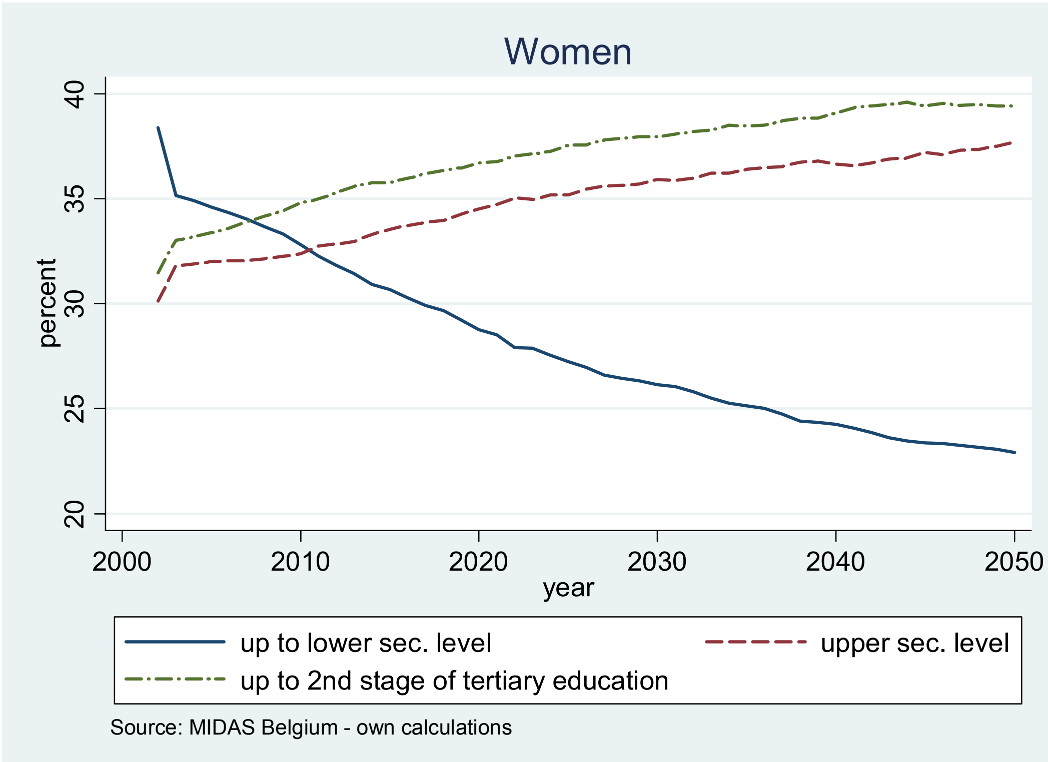
Source: MIDAS Belgium - own calculations.

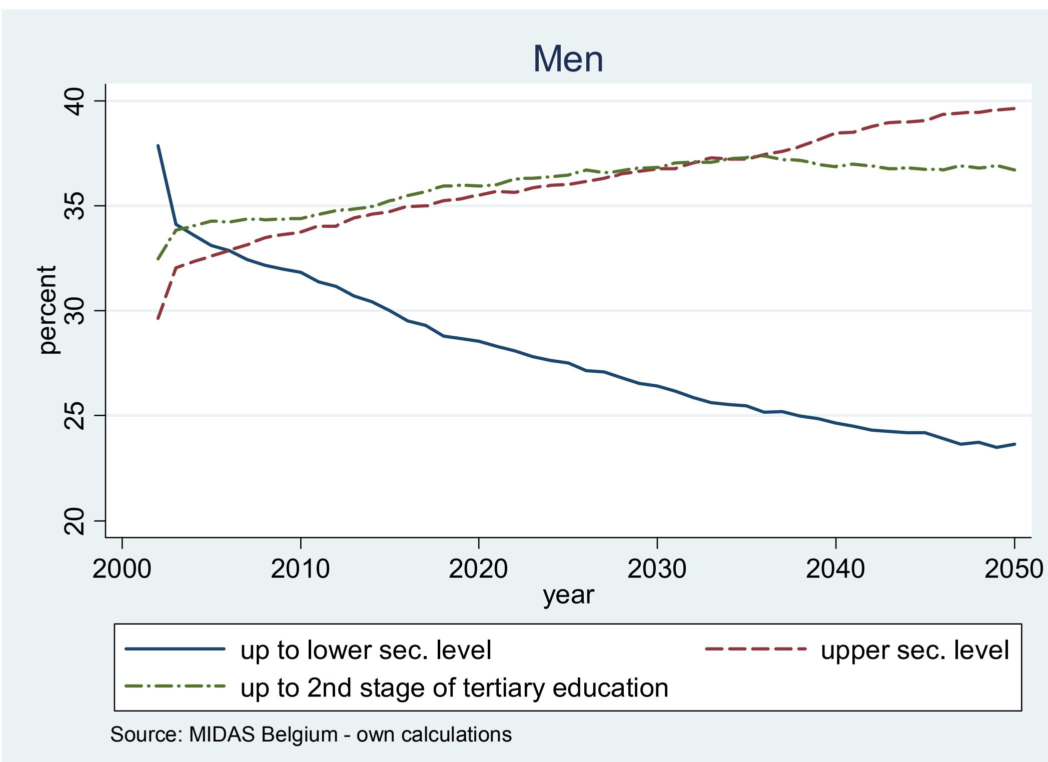
Figure 11: Average number of individuals in households where at least one individual is retired



Next, Figure 12 shows the development of the proportional educational categories.

Figure 12: Proportional educational attainment of women and men





For both men and women, the average level of educational attainment rises over time. This is because the proportions of individuals with lower levels of education (ISCED equal to 2 or lower) decreases. In MIDAS, a level of education is 'assigned' using the observed proportional attainment levels of the age category between 30 and 34 years old.

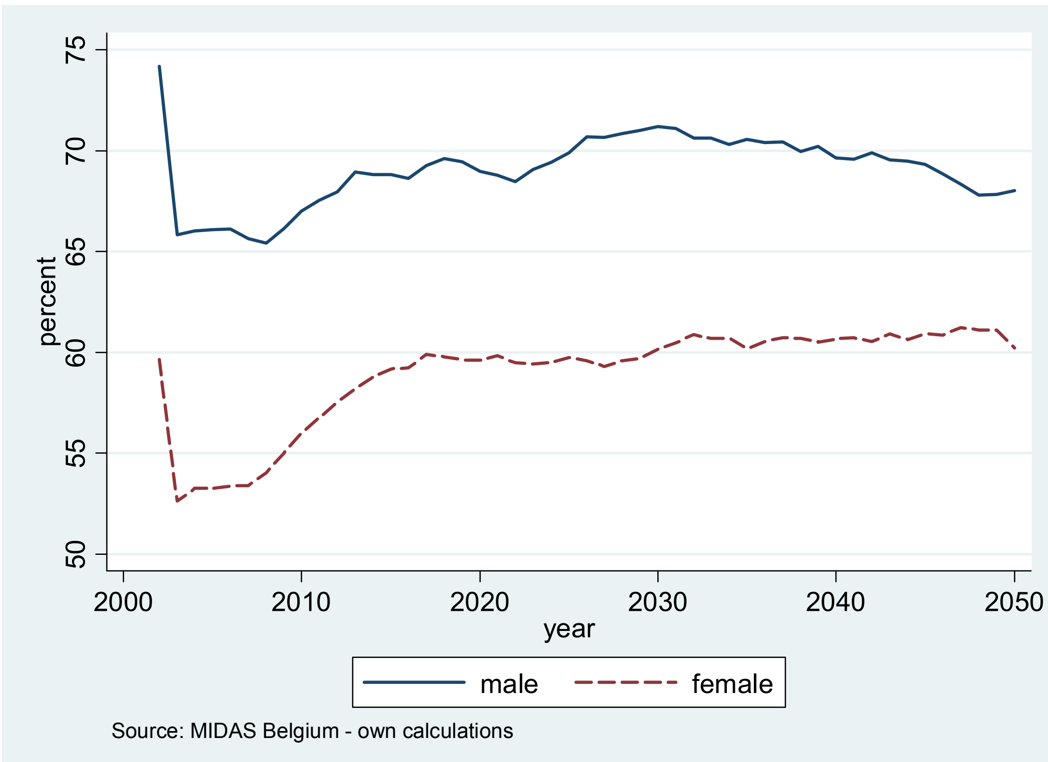
An age category had to be chosen where the individuals are old enough for the majority of them to have completed education, but young enough to be representative for the youngest generation finishing education. As the educational attainment levels decrease with age in a cross-section, the level of education of later cohorts in MIDAS are on average superior to those of the earlier cohorts, and the attainment levels therefore increase.

It has to be noted that this modelling of educational attainment has no effect on the age of entry in the labour market, this latter being the result of labour market participation rates of the AWG that are implemented trough the alignment. The labour market participation rates of younger age classes being only slightly increasing on the mid term and staying constant on the long term, the resulting entry age on the labour market will stay constant over the simulation period. So individuals are unemployed or 'other inactive' for some time between ceasing to be in full-time education and finding the first job. As a result of the higher levels of educational attainment, this period shortens throughout the simulation period. Finally, note that the impact of the increasing simulated entry age on the level of retirement benefits is quite limited. It will only have an effect on the pension benefits of those retiring during the last decade of the simulation – i.e. those entering the labour market during the first decade of the simulation. The level of retirement benefits of individuals that retire earlier than the last decade of the simulation period will be influenced by the observed entry age in the labour market (see Figure 24 below).

5.1.2. Labour market states and earnings

The central labour market variable is the 'inwork' variable, which determines if the individual has a job or not. This process is aligned to the country-specific activity rates per age and gender of the AWG. Figure 13 shows the percentage of males and females who are in work.

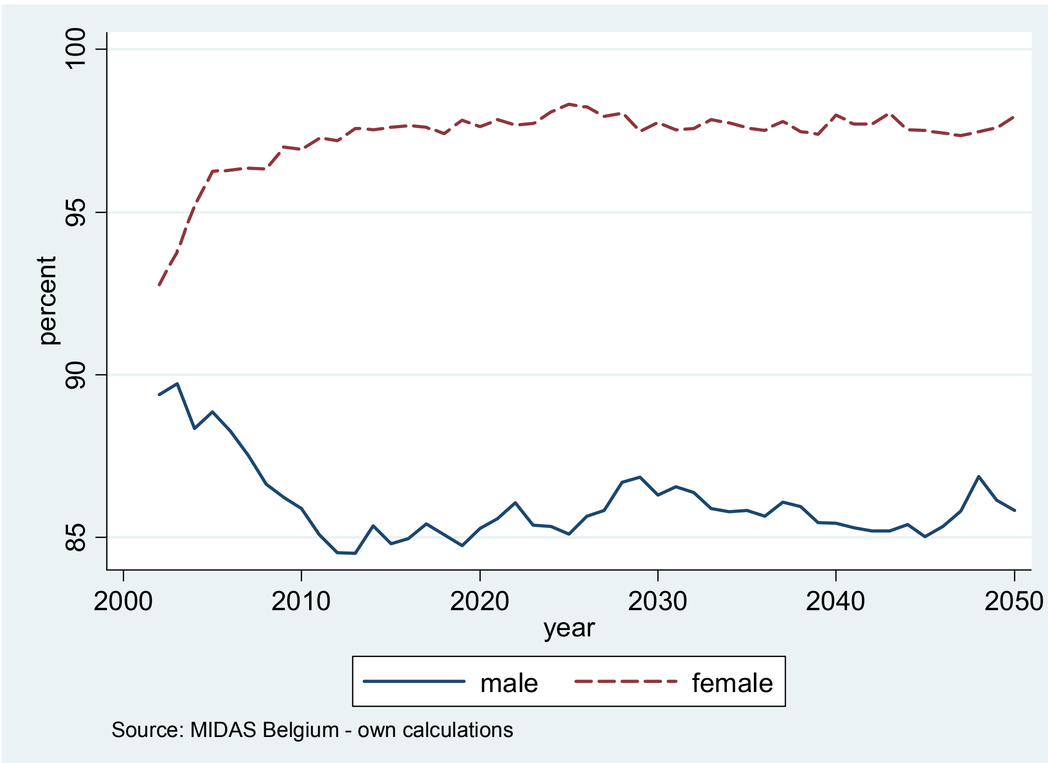
Figure 13: Employment rate by gender (age 16 – 64)



This Figure 13 immediately shows a typical characteristic of the model, a characteristic that is the direct result of the alignment process. If the 2002 starting dataset is not in line with the 2003 proportions that come from the age-gender specific alignment data, which obviously is the case here, then the model immediately adjusts to the alignment proportions. This results in an important one-shot adjustment between 2002 and 2003. Indeed, the starting dataset overestimates the proportion of males in work, and the alignment procedure thus causes a sharp decrease in this proportion. For both males and females, the activity rate increases up to about 2030 and stabilizes thereafter.

Next, the model separates between employees (both public and private sector) and self-employed. The earnings of the latter category is irrelevant in this context, because we assume that self-employed retirees receive the minimum pension for self-employed (see section 8.1.3.). So the self employed will not be discussed further. Figure 14 shows the number of male and female employees as a proportion of working males and females, respectively.

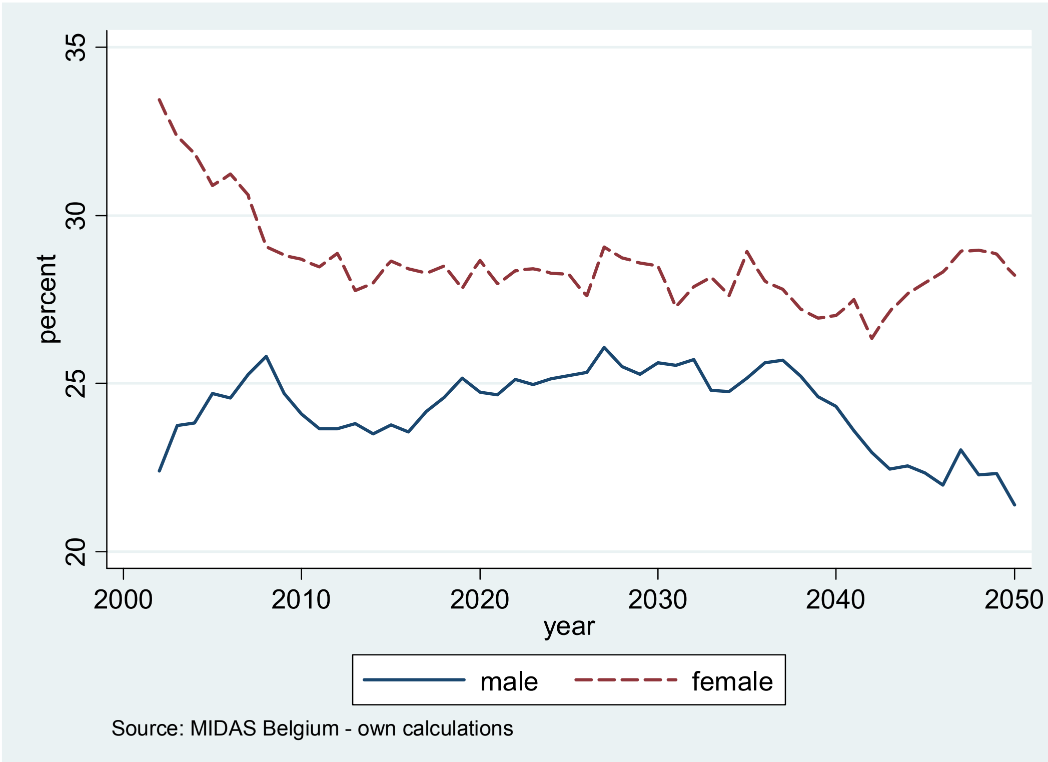
Figure 14: Employees as a fraction of working population



The main conclusion from this Figure 14 is that men have a higher probability to be observed in self-employment than women. Furthermore, these proportions diverge in the first years of the simulation. This is mainly a result of the changing age-structure of the population.

Given that one is in work and that one is an employee, one may be employed in the private sector, or in the public sector. Figure 15 shows the number of males and females that work in the public sector, as a proportion of respective male and female employees.

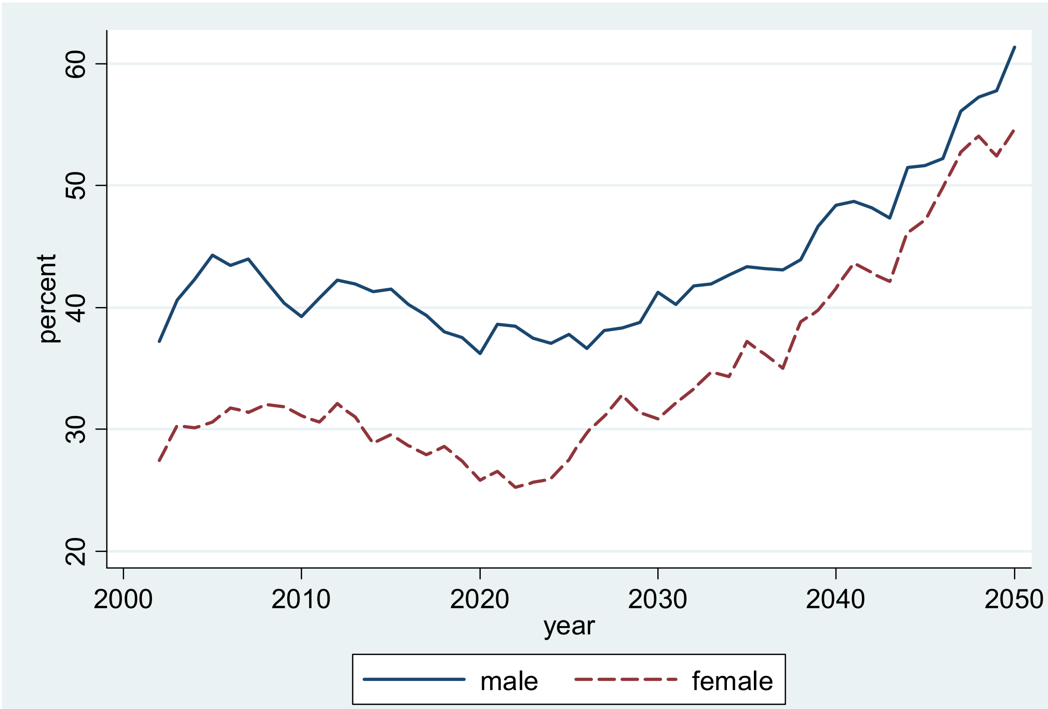
Figure 15: Workers in the public sector as a fraction of employees



There are two remarkable things about this figure. First of all, women have a higher probability to be observed as working in the public sector as men. This difference may be caused by the large number of women in social and medical care. Secondly, the importance of the public sector would slowly decrease in the years to come, especially for males. Contrary to what one might suspect, this is not a deliberate choice of policy makers represented in the model, but a purely mechanical effect. Indeed, the logit describing the probability of remaining in the public sector decreases with the level of education (see paragraph 4.2.2).

Those that work in the public sector are either civil servants or not. This difference is relevant, because both categories of workers are subject to different pension systems, as was discussed earlier (see chapter 4, and the appendix to this report). Figure 16 shows the proportional size of civil servants in the public sector.

Figure 16: Civil servants as a fraction of workers in the public sector



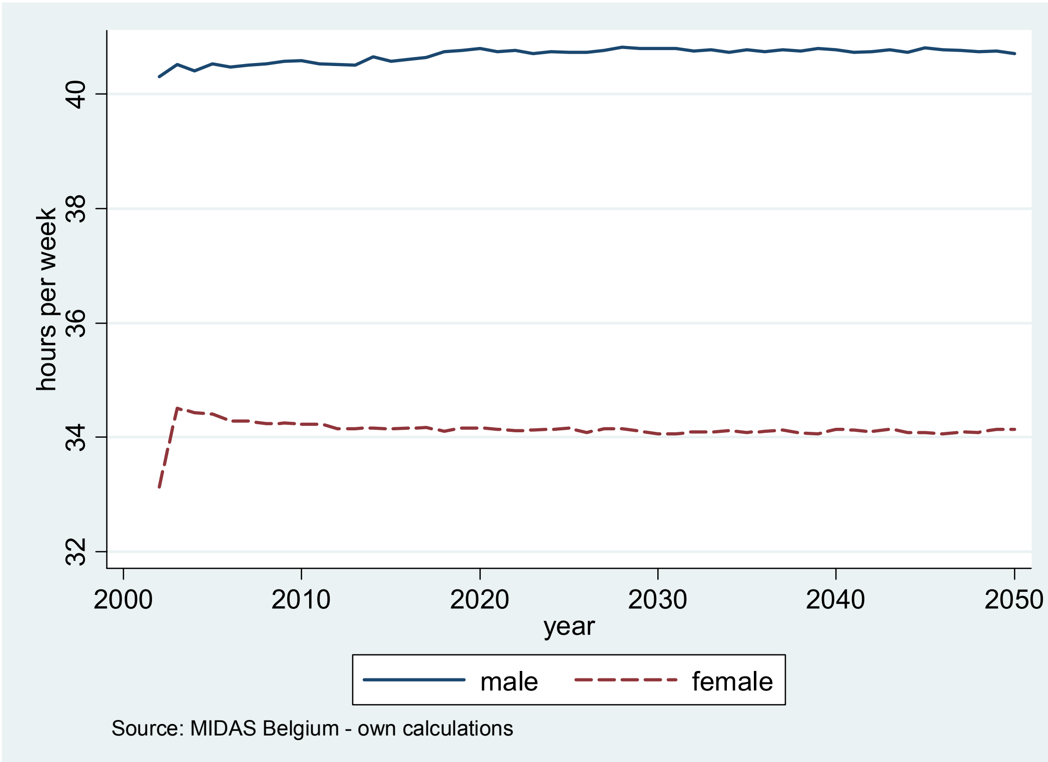
Source: MIDAS Belgium - own calculations

Even though women have a higher probability to be observed working in the public sector than men (Figure 15), they have a lower probability to be a civil servant (Figure 16). This again suggests that a large proportion of women in the public sector work in the health care system, where they are not a civil servant, and therefore not subject to the public pension system.

Furthermore, the model simulates whether one has a fixed or temporary contract, works part time or not, and if one works a full year or not. These results will not be discussed here, as it would bring us too far. Instead, we will focus on gross earnings and the variables that determine these earnings: hourly wage-rate, the number of hours worked per week and the number of months worked per year.

Figure 17 represents the average reported number of hours worked per week, obviously for men and women that are in work.

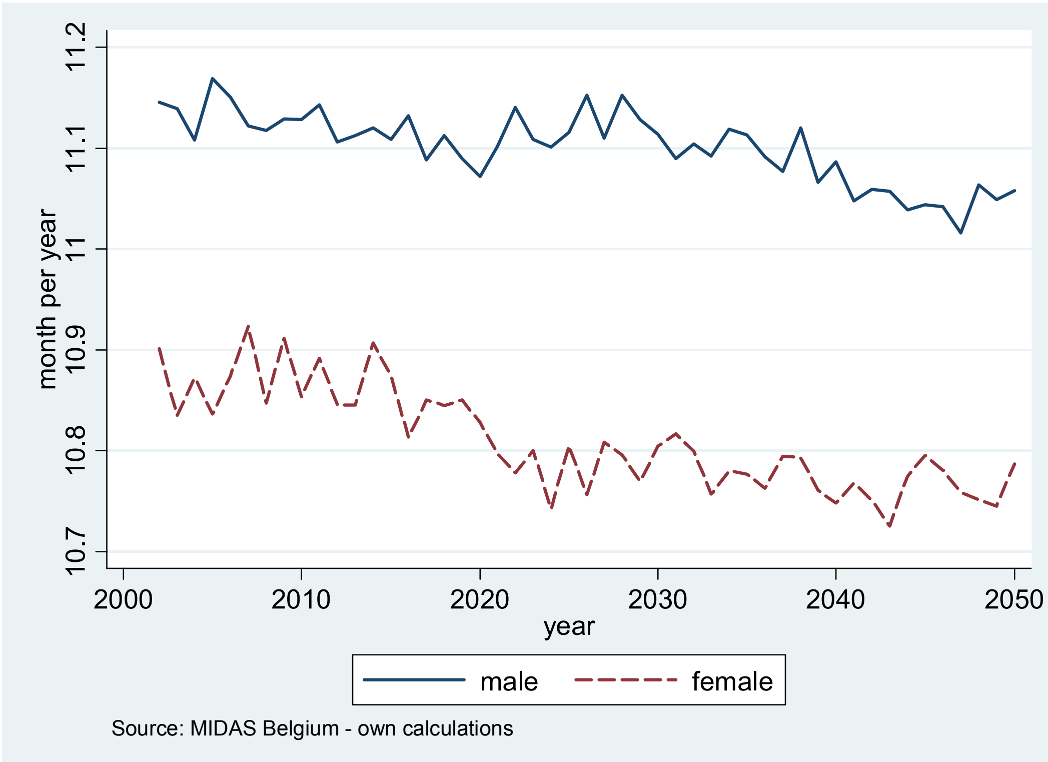
Figure 17: Average actual number of hours worked per week of employees



Women report between 34 and 35 working hours per week, and this number is lower than the hours reported by men. However, those women that work full-time also report a bit more than 40 hours per week. The average hours per week remain more or less the same throughout the simulation period.

The next Figure 18 presents the number of months worked per year, again for men and women separately, and for those that are in work.

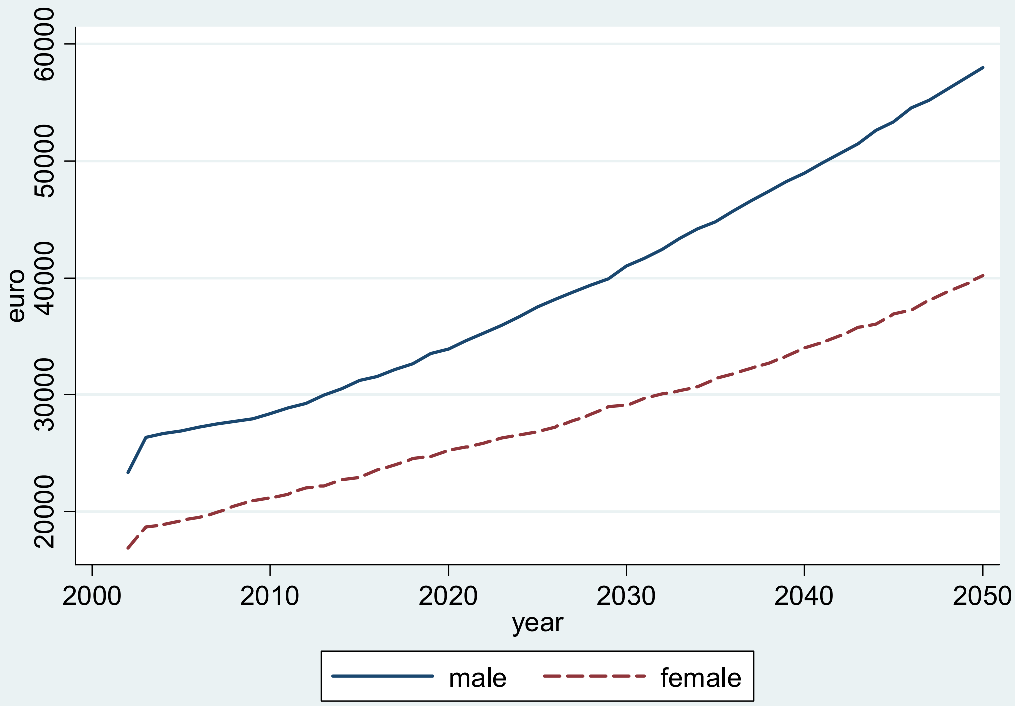
Figure 18: Average number of months worked per year of employees



For males, the average number of months worked gradually and slowly decreases around 11.1 months. For women, it starts off between 10.8 and 10.9, and then decreases somewhat between 2015 and 2025. This decrease is the result of a decreasing proportion of women that work the whole year round. But even then remain the results fairly stable at almost 11.8 months.

Finally, the annual wage equals the hourly wage times the number of hours per month, times the number of months per year. Also, real hourly wage rates increase with productivity over time. We adopted the productivity-assumptions from the AWG projections (see the appendix of this report). The logarithm of the hourly wage rate is a function of potential labour market experience (age minus the age at which one has ceased being in education), its square value, gender, whether or not one has a fixed contract or work part time, level of education, whether one works in the public sector (either as a civil servant or not; see paragraph 4.2.2.). Hourly wages increase with productivity over time, and the speed of this increase is the productivity growth rate assumed by the AWG. Figure 19 shows the resulting average annual wage for men and women.

Figure 19: Average gross annual wage



Source: MIDAS Belgium - own calculations

This development of the annual aggregate wage rate follows exactly the productivity growth rate assumed by the AWG. Corrected growth rates are applied to individual earnings in such a way that the AWG productivity growth rates emerge to the average earnings[32]. Note that the model takes the minimum hourly wage into account. This minimum wage increases over time following the growth that is assumed for lump-sum amounts (see growth rate assumptions in section 4.3.1.).

Next, given that one was in work last year, but is no longer this year, the model discerns several states. One can either be unemployed, a CELS beneficiary, in retirement, disabled, or being 'other inactive'. The latter obviously is the balance entry in that all those that are not working nor in any of the aforementioned inactive states, are put in this 'other inactive' state. For a large part, this state contains those that are not in the labour market, such as children or those doing housework.

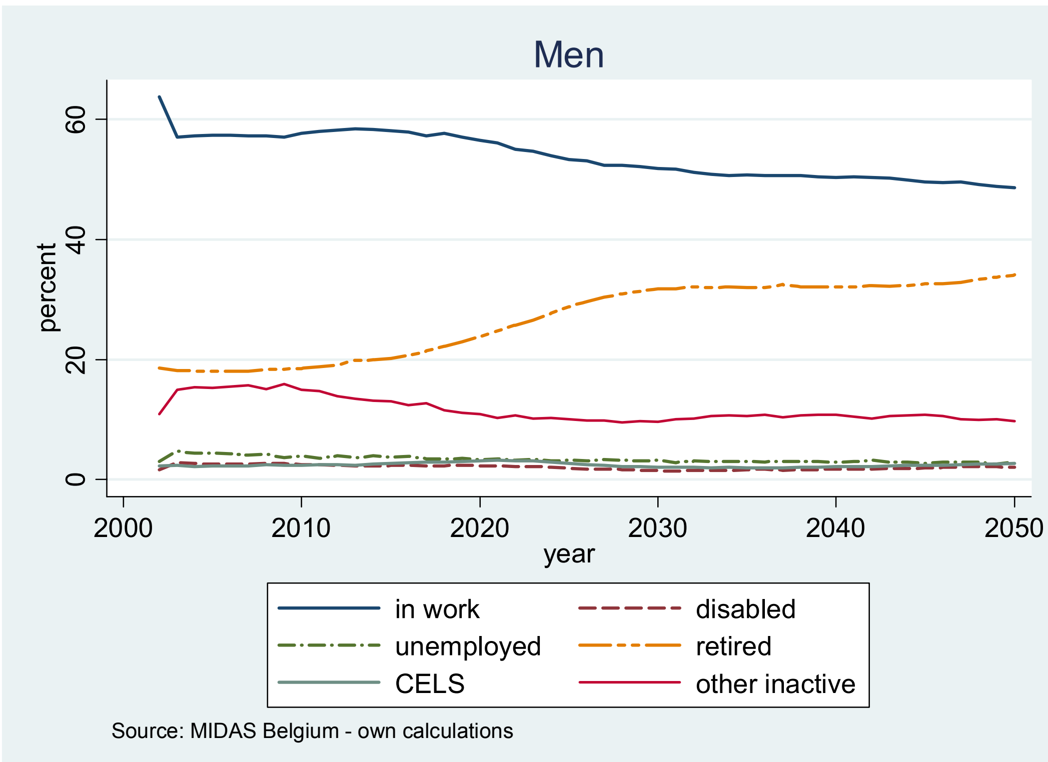
The labour market module of MIDAS simulates these inactive states as a string of 'decisions', all conditional upon the individual becoming inactive (i..e. the 'inwork' dummy changes from 1 to 0). First, the individual has a certain probability of becoming unemployed. If not, then he or she has a probability of becoming disabled. Else, one may be eligible for Conventional Early Retire-

32 See footnote 23 for the explanation of corrected growth rates computation.

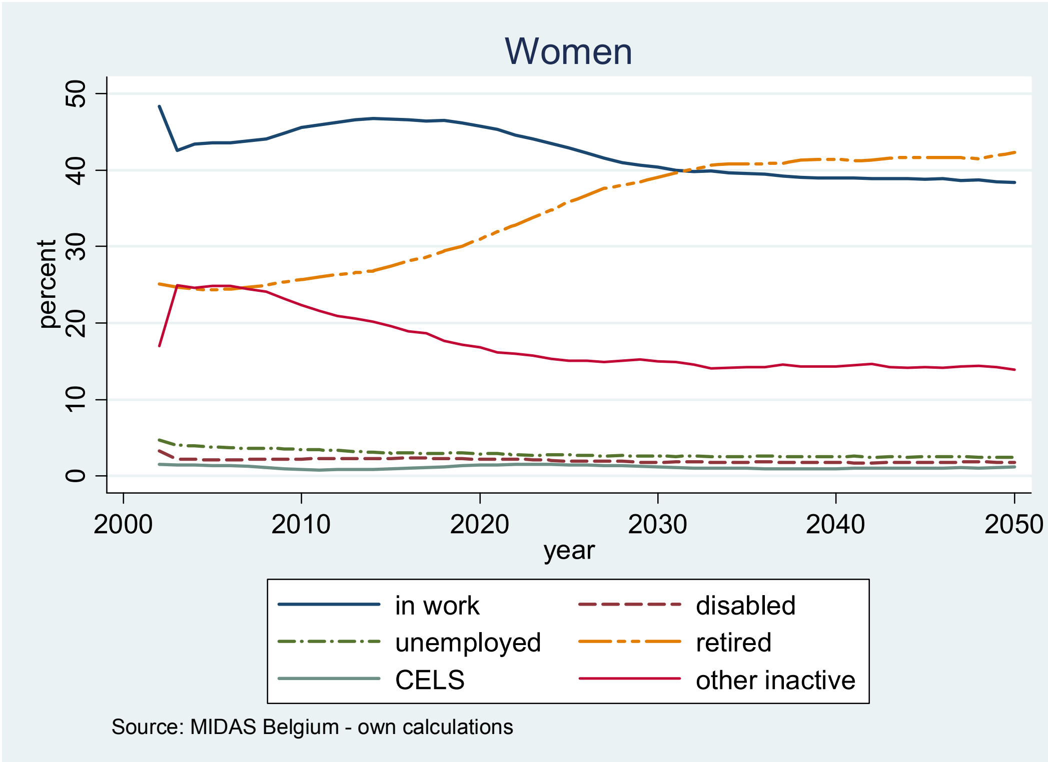
ment' Benefit (CELS). Else, one may be eligible for regular retirement[33]. If neither of these potential states has become effective, the individual enters the state 'other inactive'. The development of this 'state-variable' is thus the result of several separate individual logits. Finally, and contrary to the German and Italian versions of the model, the inactive states are aligned to Belgian AWG projections.

The below Figure 20 shows the development of labour market states for males and females of 16 and older, separately

Figure 20: Labour market status of individuals of 16 and older



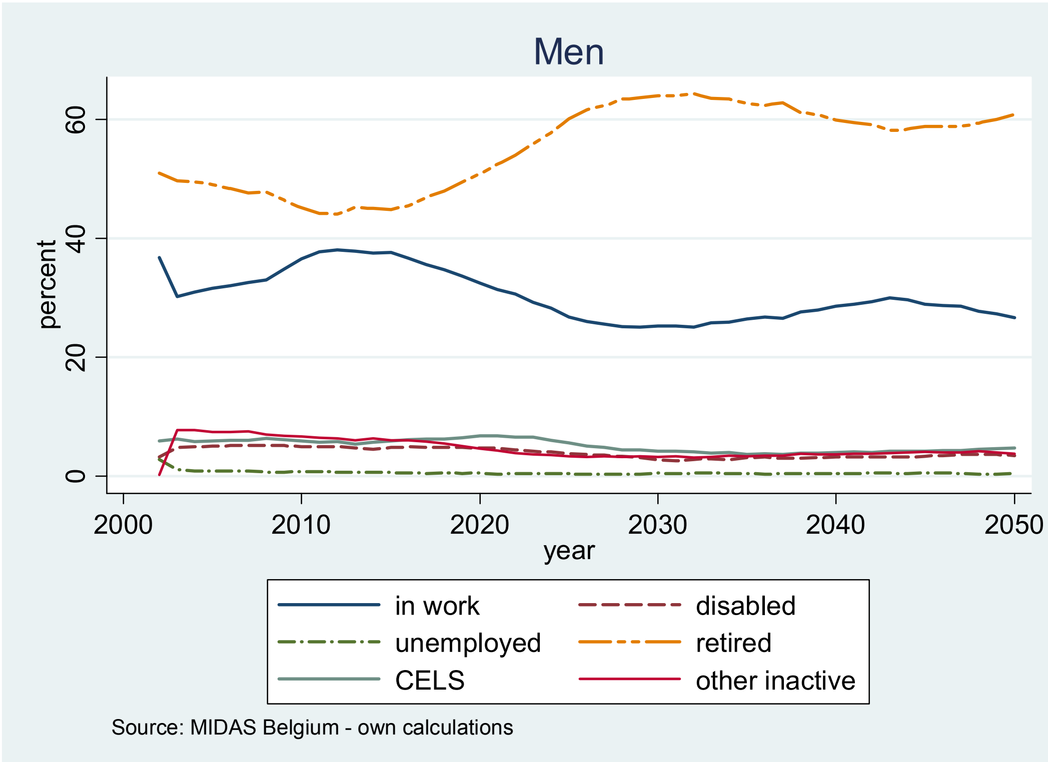
[33] This description makes a stylized assumption that all these potential states exist. This may not be the case. For example, if an individual ceases to be in work at 65, then he or she almost automatically enters retirement.

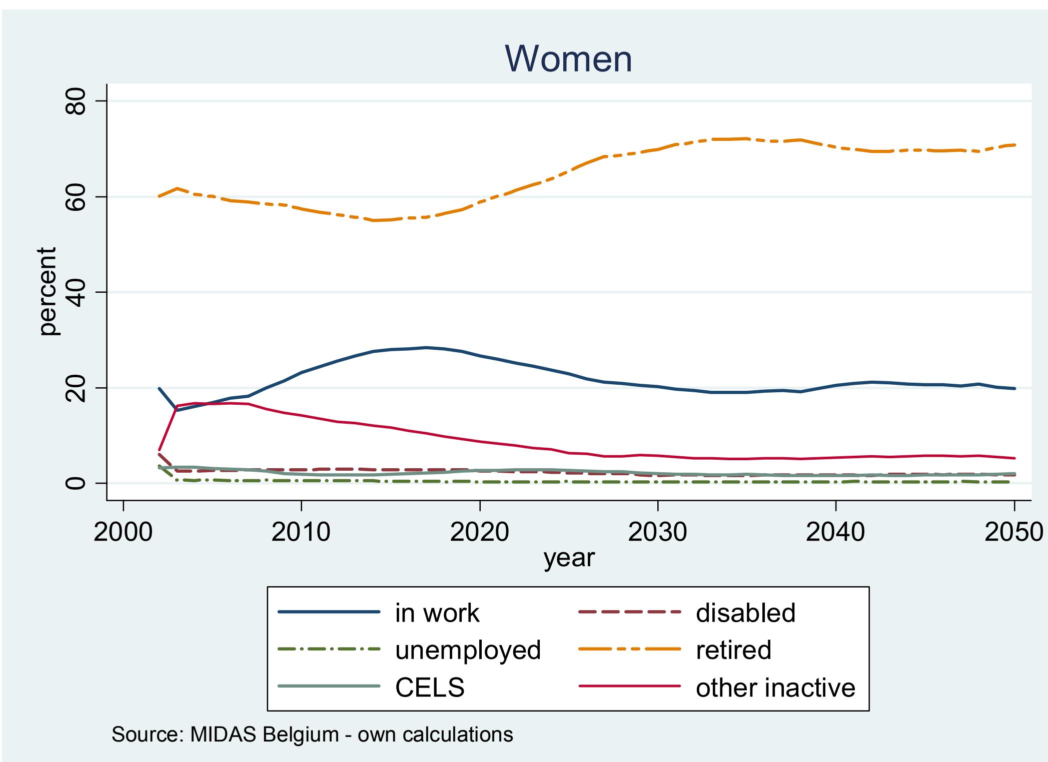


The most important states are being in work, being retired and 'other inactive'. The development of the first state was discussed in Figure 13 previously. The proportion of retired individuals increases especially until 2030 as demographic ageing causes the proportion of elderly to increase. The category of 'other inactive' is a balance entry, and it is therefore obvious that it increases between 2002 and 2003 to cover for the one-shot downward correction of the proportion of individuals that are in work. Its proportional size is also higher for women than for men, which might be caused by the higher proportion of housekeeping women. Mainly dejuvenation before 2030 causes the size of the category of 'other inactive' to decrease over time.

The point of focus of the research project is the adequacy of pensions, and it is therefore relevant to discuss the proportional sizes of the states of men and women of 50 years and older. These are presented in the below Figure 21.

Figure 21: Labour market status of individuals of 50 and older





Obviously, the proportional size of retirees now exceeds that of the working population, and also the size of the 'other inactive' state now becomes smaller. Indeed, men and women of 50 and older are less often in school. Even though the other states (CELS beneficiary, disabled, unemployed) increase in proportional size, they remain less important, compared to retirement, being in work or 'other inactive'. For women, the proportional size of disabled starts of quite high (between 5 and 6 percent of the sample) but decreases around 2010, when these women reach the mandatory retirement age. We see the same development, though less outspoken, for CELS beneficiaries and unemployed. For men of 50 and older, the situation is different than for women. In this case, the proportional size of the category of CELS beneficiaries is by far the largest. This size however decreases until about 2012. This decrease comes with a (smaller) increase of the proportional size of disabled.

5.1.3. Retirement

When analysing retirement income in MIDAS, two problems have to be dealt with. First of all, questions on pension income in the PSBH starting dataset do not make a difference between benefits from the first, second or third pillar of the pension system. Neither does it make a difference between pension benefits coming from the pension systems for former employees, civil servants or self-employed. So, the pension income in the starting dataset (i.e. of those retired in the starting year 2002) is likely to be too high on average, and to much skewed to the right. Furthermore, it does not allow making a separate analysis of the systems for civil servants or employees.

A second problem is that transitions within labour market states result in many low pension benefits. This does not necessarily mean that the individuals actually have a low retirement income, because a proportion of individuals in MIDAS have a benefit from both the employees' and civil servants pension system[34], or have been self-employed for many years. Consequently, studying the benefits from the pension systems of employees and civil servants separately, overestimates the inequality of pension income, while underestimating the average retirement level.

Both problems cannot be solved, but we can try to surface them as much as possible so that they become explicit in the analysis. Table 78 shows the two problems and some 'cope strategies'.

[34] Especially many employees working in the public sector become civil servants somewhere during their career.

Table 78: Problems and cope strategies in the analysis of pensions

	Problem 2: mixed careers	Strategy 2.1.	Strategy 2.2.
Problem 1: current retirees		Take benefits from various systems together	Limit the analysis to those that did not make a transition between being an employee and a civil servant.
Strategy 1.1.	Separate current and future retirees		
Strategy 1.2.	Do not separate current and future retirees		Not possible

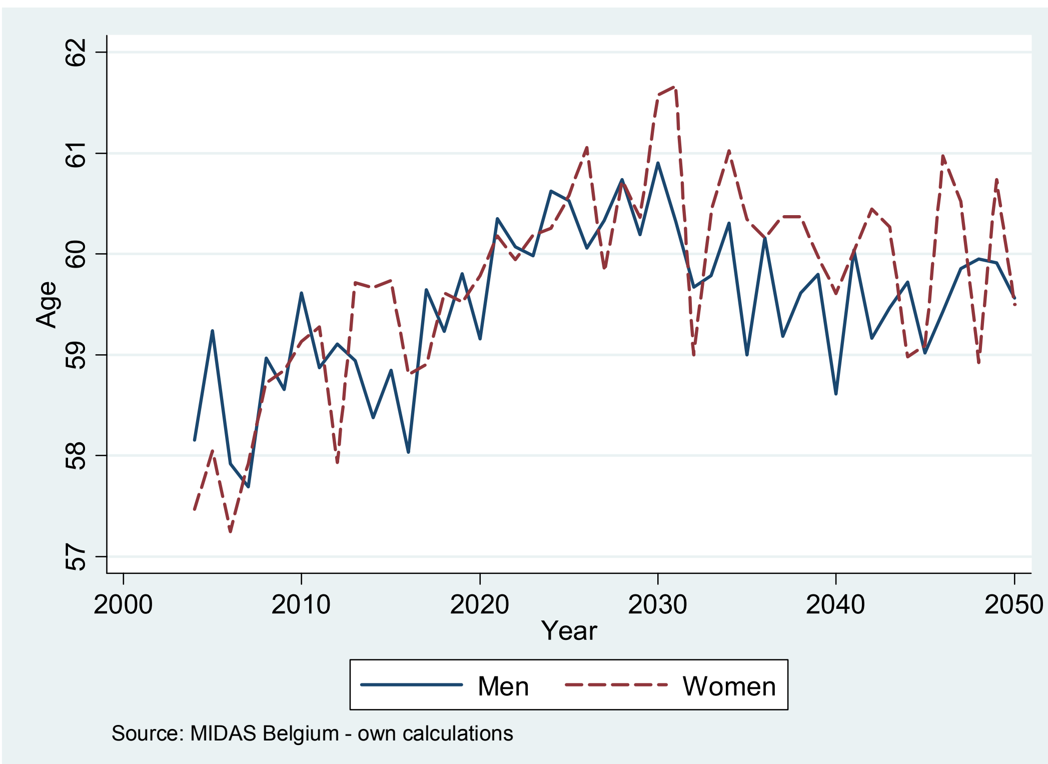
The first problem of too high pension benefits in the starting dataset can be dealt with by explicitly separating those who entered retirement before and after 2002. This is strategy 1.1. The pension incomes of the first group suffer from the aforementioned problem, whereas the incomes of the second group do not. A first possible solution to the second problem –that of mixed careers- is to take together the individual benefit that a retiree receives from the pension systems for employees and civil servants. This strategy 2.1. however has the drawback that both pension systems cannot be analysed separately. A second possible solution (strategy 2.2.) is to limit the analysis to those individuals that did not make a labour market transitions between being a civil servant, an employee (or a self-employed). This last solution also requires that the observed pension income be kept out of the analysis as well, because this observed pension income does not make a difference between employees' or civil servants' pension income. So the combination of strategies 1.2. and 2.2. is not possible.

This analysis will start by analysing pension benefits by separating benefits from various systems, while ignoring those that made a transition (strategy 2.2), and those that retired before the starting year 2002 (strategy 1.1). As a consequence, all graphs of this section will start in 2003, contrary to the other graphs presented until here that started in 2002, the year of last observed values. This will however not allow analysing the adequacy of the Belgian pension system as a whole, and the assessment of adequacy will thus be on all benefits together (strategy 2.1) and taking into consideration those retired before and after 2001 (strategy 1.2)

Before proceeding to the discussion of the simulation results, it should be noted that the current version of the pension module of MIDAS_BE does include the minimum welfare benefits that are provided to those of old age that have an income below the level of subsistence. This is called the GMI (Old-Age Guaranteed Minimum Income) However, the GMI is means-tested, and a simulation of tangible and intangible means of older households is way beyond the scope of this model. Thus, we assume none of these other means. As a result, our simulation results will somewhat overestimate the mean level of benefit as well as the redistributive impact and adequacy of pensions.

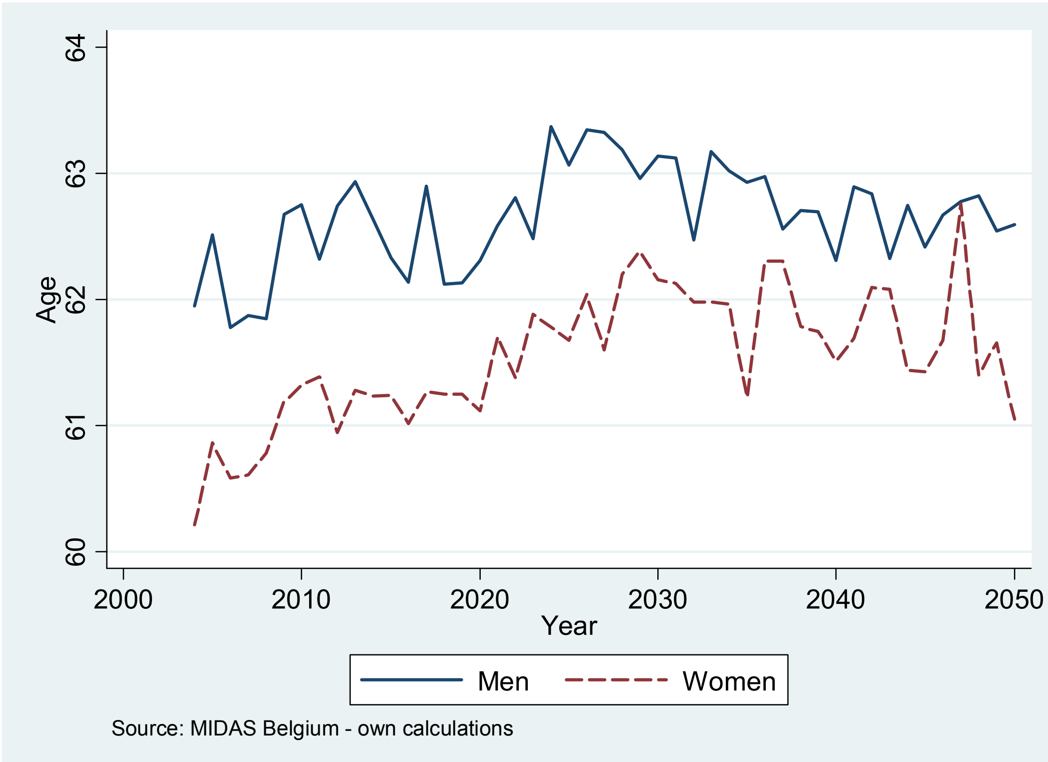
Figure 22 presents the average age of withdrawal from the labour market for men and women. This is driven by the alignment procedure that controls the work force participation. The average age of labour force withdrawal is increasing until around 2025 for men and women. It starts around 58 for men and 57 for women to reach almost 61. After 2025 the trend of the average age of labour market withdrawal becomes slightly different for men and women. The trend for men decreases around 59 to increase at the end of the simulation period to 60. For women, the decrease between 2025 and 2040 is less pronounced.

Figure 22: Average age of labour market withdrawal



The average age of withdrawal from the labour market is obviously equal or below the average age of retirement, as there exist other paths of withdrawal than retirement – mainly disability, unemployment, early retirement or inactivity. Figure 23 presents the average age of retirement. Trends for men and women follow the same evolution. They increase until 2030 and decrease slightly afterwards.

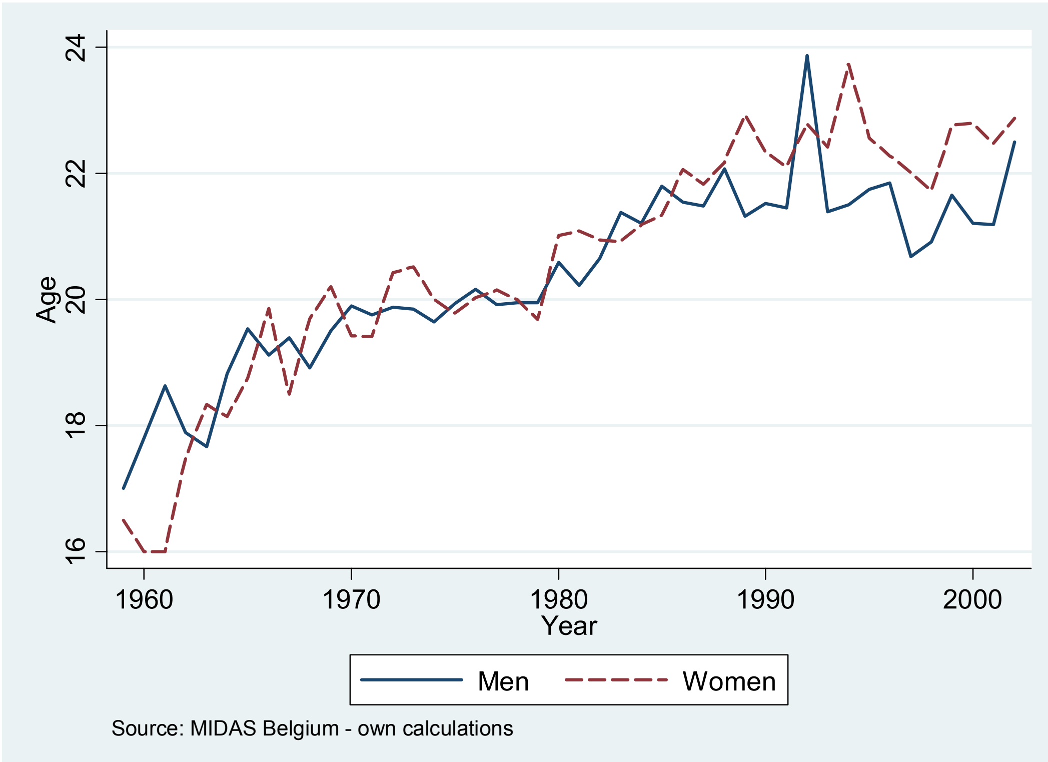
Figure 23: Average age of retirement



As expected, the average age of retirement is higher than the average age of withdrawal. However, apart from that, the figures are quite comparable. This suggests that the main driving force for the age of retirement is the age of withdrawal. Or, putting it differently, the inactive labour market states such as CELS, disability and unemployment, are merely transition states towards retirement.

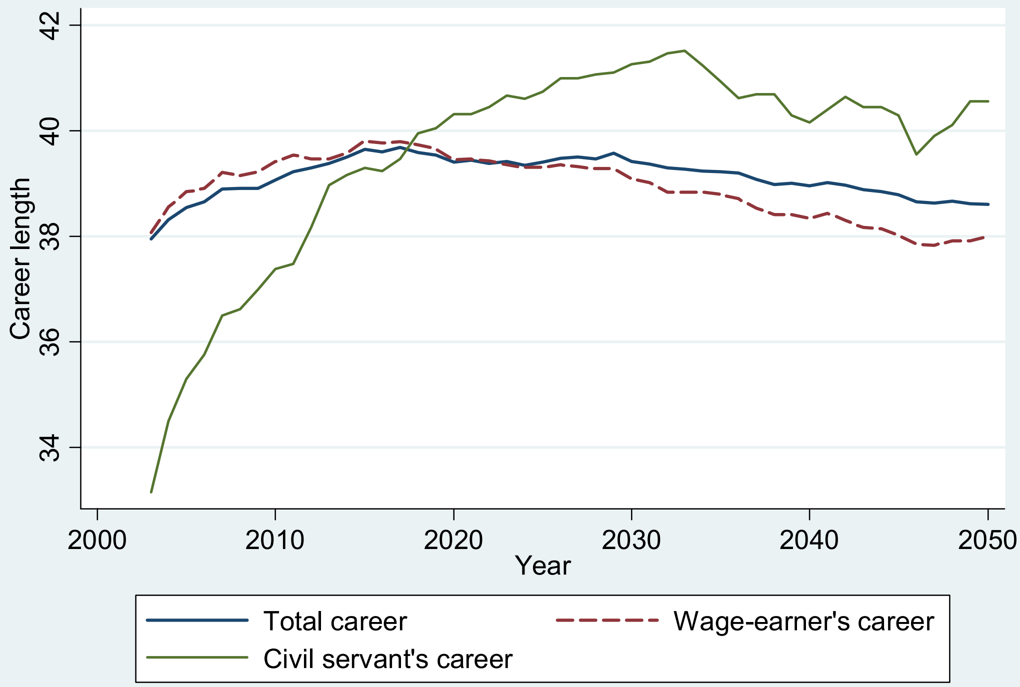
Another important factor in the framework of the retirement benefits analysis is the labour market entry age of individuals that are going to retire during the simulation period. Figure 24 therefore presents the average age of labour market entry in the retrospective data, i.e. from the end of 1950's to 2002, the last observed year. The average age of entry into the labour market is more or less the same for men and women. It evolves constantly from 16 (for women) and 17 (for men) in 1960 to reach 22 in 2000. Trends can be described as that the average age increases from 16 or 17 (respectively for women and men) to 20 between 1960 and 1970. It stays constant until 1980 and increases again of two year on the next decade. Between 1990 and 2000, the average age of labour market entry stays more or less equal to 22. The obvious driving force behind this ever-increasing age of entry is the increasing average educational attainment level of the active population. With this increasing level of education comes an increasing average age of ceasing to be in education, and hence an increasing age of entering the labour market.

Figure 24: Average age of labour market entry



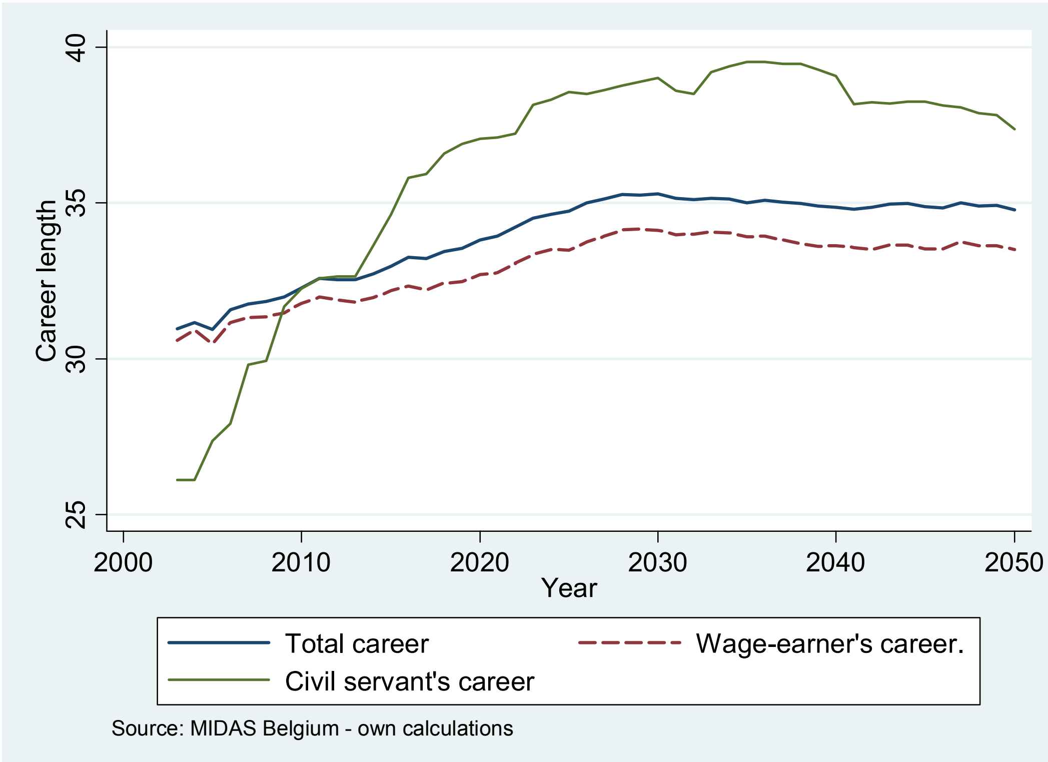
After having analysed the age of entry and the age of retirement, the next obvious step is to assess the simulation results of the average length of career. Figure 25 and Figure 26 present the average career length for all retired men and women, respectively, meaning people who were already retired in the observed 2002 sample but also people who retire during the simulation period, i.e. after 2002. For both men and women, the average length of the career of the employees (either in the private or public sector) is by far the largest group, and this average does not change considerably for men and increases somewhat for women. This last difference may be caused by the slightly higher average age of labour market withdrawal for women than for men. The average length of the career of civil servants however increases, and this goes at the expense of the average length of the career of the self-employed. This development is obviously caused by the increasing proportion of civil servants, which seems to be accompanied by a decreasing probability of ceasing to be a civil servant.

Figure 25: Career length – All retirees - Men



Source: MIDAS Belgium - own calculations

Figure 26: Career length – All retirees - Women



Career length of male civil servants increases from 33 in 2003 to almost 42 around 2030. Afterwards it decreases and stabilises around 40. The large increase in the beginning of the simulation period is partly due to the way the work force participation of civil servants has been modelled. Indeed, in Belgium exists different possibilities to withdraw from the labour market before the legal age of retirement through particular programs (especially for special categories like teachers or military). The Belgian version of MIDAS however only models the main retirement program of civil servants. As a consequence, every civil servant in the simulation will at least work until 60 years old, what will obviously have an impact on the length of the career. The last decrease results from the fact that less and less individuals stay in the same regime during the entire career, and the public sector is not an exception. Before the end of the simulation period, there are no more new pure civil servant retirees. It remains therefore only old retirees who had shorter career.

Career length of male wage earners increases until 2015. After that, a constant decrease sets in and continues until the end of the simulation period. This trend is partly determined by those of the age of entry and the one of the age of retirement. Indeed, as the age of entry into the labour market is constantly increasing on past decades and the age of retirement is decreasing on the second half of the period, it is normal to see the career length decrease on this part of the period.

For the first half of the period, it has to be noted that the career length of people already retired into the base dataset are also taken into account and tend to decrease the average.

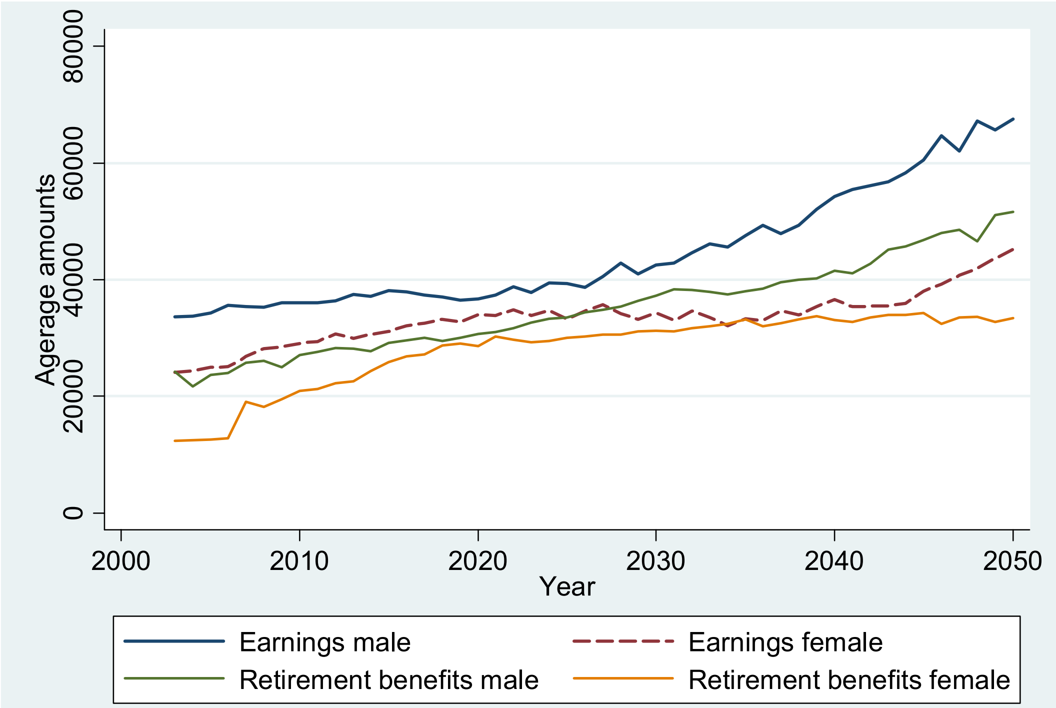
Career length of female civil servants is comparable to those of male civil servants, but with a stronger increase at the beginning and a lower fall at the end. As to career length of female wage earners, it increases until 2030 and stay constant until 2050.

Next we turn to the simulated levels of retirement benefits. Following the discussion pertaining to Table 1 the figures below ignoring those that made a transition (strategy 2.2), and those that retired before the starting year 2002 (strategy 1.1). So, we concentrate on 'pure' civil servants (those who have worked only as civil-servants.) and employees that retired after 2002.

Figure 27 includes simulated gross retirement benefits for retired civil servants together with the simulated gross earnings of active civil servants. Retirement benefits of women rise sharply until 2020 and continue to rise at a lower pace until the end of the simulation period. It starts around €12,000 to more than €33,000. This evolution is, in large part, explained by the evolution of career length. Indeed, as we have seen here above, career of civil servant women increases a lot until 2020. After that date, it continues to increase slightly until 2040 and decreases slightly afterwards.

Retirement benefits of men know a different trend as those of women. Their benefits increase less strongly than those of women in the first half of the period, but this increasing stay constant all along the simulation period.

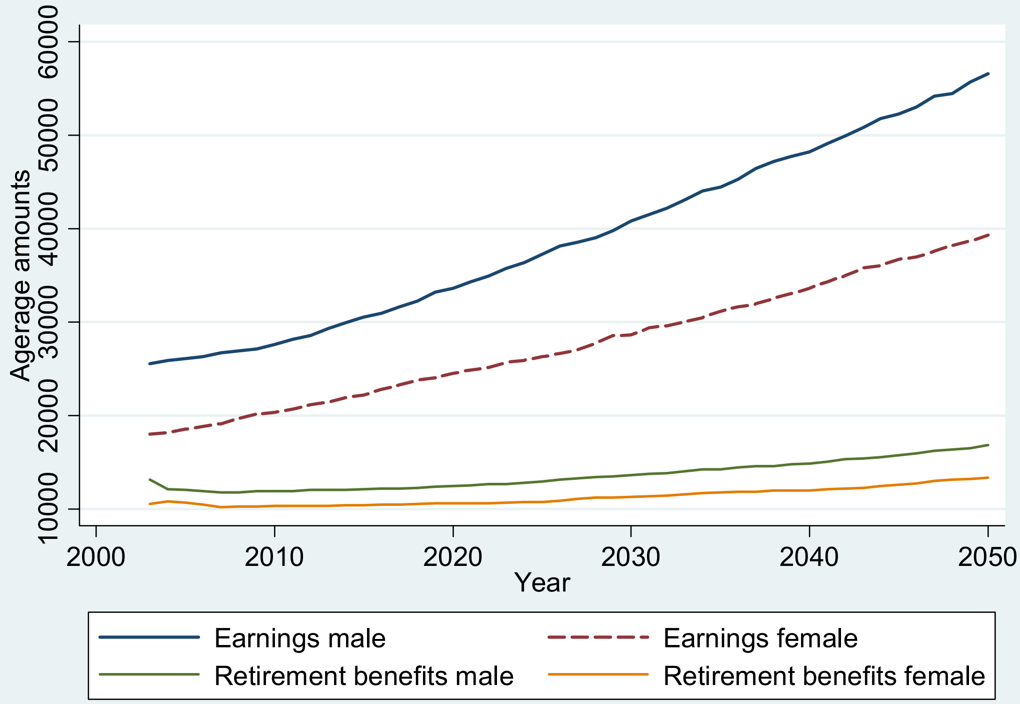
Figure 27: Gross earnings and simulated retirement benefits for civil servants with pure career, retired after 2002



Source: MIDAS Belgium - own calculations

Figure 28 presents gross earnings and retirement benefits of wage-earners that were employees throughout their entire career.

Figure 28: Gross earnings and simulated retirement benefits for wage earners with pure career



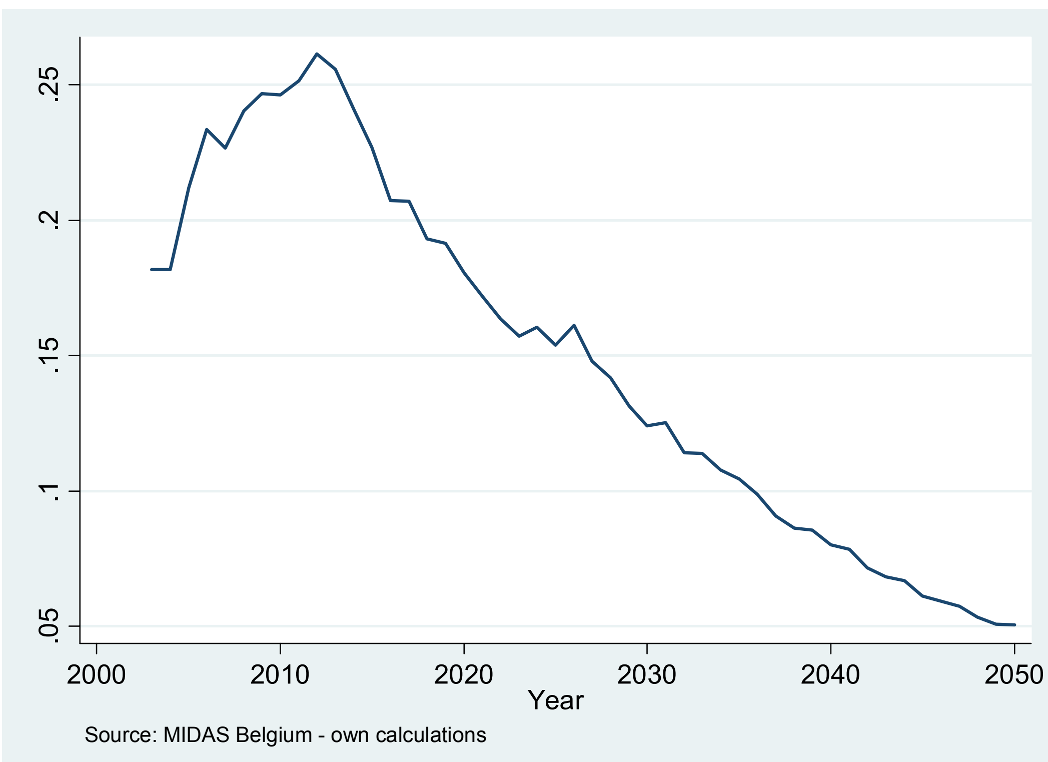
Source: MIDAS Belgium - own calculations

Retirement benefits for men and women show a limited growth pattern during the whole simulation period. We see three reasons that explain why retirement benefits do not increase at the same pace as earnings. First of all, even if an adaptation to living standards (welfare adjustment) exists, it is under the productivity growth rate. As a result, we can expect that more and more "old" retirees do not benefit fully from this productivity growth. We will however see later that this is a toot simple line of reasoning. A second reason is that the career length of male wage earners decreases, as shown in Figure 25. This is due to the age of labour market entry that is increasing while the age of retirement does not follow the same trend (see Figure 23 and Figure 24). The third and last reason is partly linked to the household composition: Less and less couples get married. When this is combined with the increase of full women's career, less and less pensions are paid at the household rate. This is illustrated by Figure 29 below.

As explained in chapter 4, wage-earners can benefit from a "household rate" pension when their spouse is not entitled for a personal retirement benefit or when the sum of spouse's benefits is smaller than the pension computed at the household rate. This "household pension" is 25%

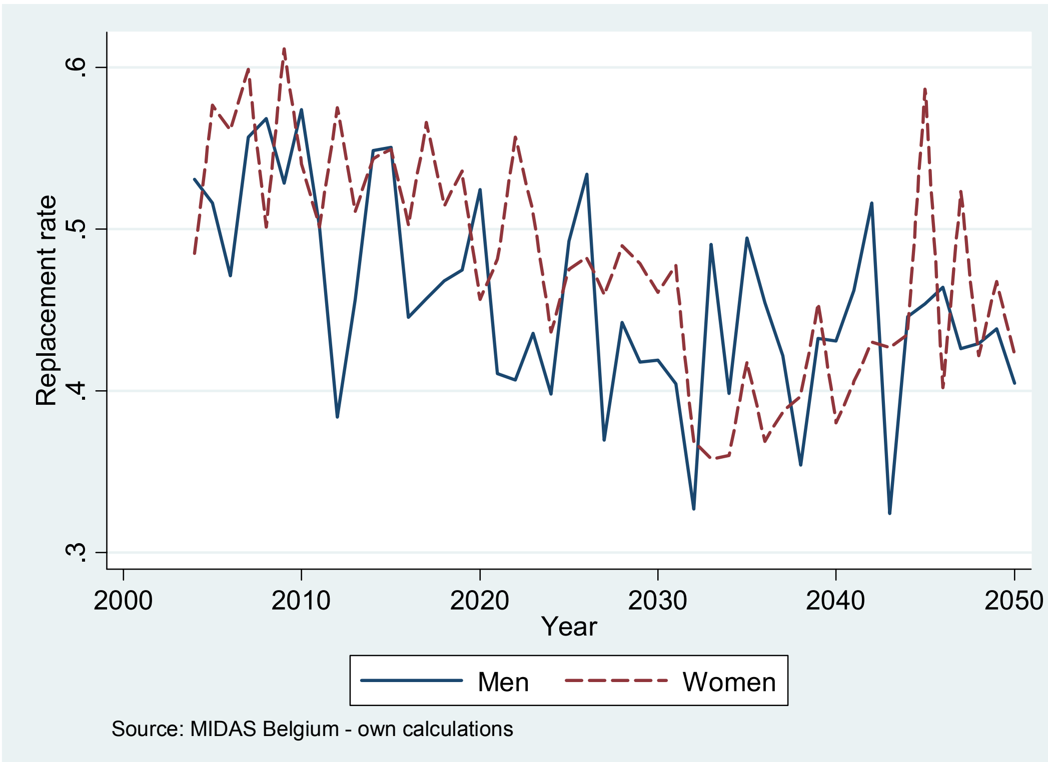
higher than the “single rate” pension. Figure 29 shows how evolves the proportion of wage-earners households benefiting from the “household rate”. The stock of wage earners households increases on the first decade of the simulation and then decreases from 0.25 to 0.05. The first increase until 2010 is probably due to a delay effect: Men can obtain the “household rate” pension only if their wives are retired or inactive. As a consequence and as only households retired after 2002 are considered here, some men have to wait some years that their wife become retired or inactive before becoming entitled to the family pension. In addition, the reform that increases the female legal retirement age until 2009 postpone the retirement of some women and therefore increase the delay of obtaining the “household rate” pension. The decreasing after 2010 is explained by two main factors. The first one is the household structure of retirees that is described by Figure 11. We see the household size decreasing after 2015. More and more household are composed of only one retiree who, by definition, benefits from the single rate pension. The second factor is the increasing length of women’s career. More than in the past, women will be entitled to a personal pension that is larger than the difference between the “household rate” pension and the “single rate” pension of the spouse.

Figure 29: Proportion of households benefiting from the “household pension rate”



The last measure of retirement benefit level that will be presented in this section is the replacement rate. Figure 30 shows that the replacement rate decreases with increasing speed until 2030 after which an increases sets in. Trends for men and women are quite similar.

Figure 30: Replacement rates



Note that the development of the replacement rate is somewhat erratic, due to the sometimes low numbers of people actually making the transition into retirement. Next, the replacement rates depicted in this figure are lower than the percentage by which the wage-base should be multiplied to get to the employees' pension benefit. This is 60% for an individual pension, and 75% for a family pension (see section 4.3.1.). The reason for this is that the replacement rate confronts the pension benefit with the *final* wage, whereas the employees' pension benefit is based on the average wage. Given that wages increase with age and experience, the former is higher than the latter.

Next, we consider the development of the replacement rate over time. This can easily be explained by looking at the evolution of the proportion of households that benefit from the "household rate" shown by Figure 29. Less and less pensions are allocated at the household rate and as it is most of the time the man who receive this family pension, it is not surprising to see the replacement rate of men decreasing. It has to be noted that wives of men who receive the family pension are not included in these figures.

The growth rates of productivity that the AWG assumes for Belgium also explain the trends in the replacement rate. However, as pensions of new retirees are based on past growth rates, the replacement rate will show an opposite development. The AWG assumes that the growth rate of productivity will increase from 1.5 (the years up to 2010) to 1.8 (from 2010 to 2030) and this implies a lowering of the replacement rate from 2010 on. From 2030 on, the assumed growth rate decreases somewhat, namely from 1.8 to 1.7, and the replacement rate hence starts to catch up from that year on.

Figure 30 also shows that the replacement rate is generally higher for women than for men. This is because men generally have a higher wage than women. This implies that the annual wage of men more often than women exceeds the ceiling, thus resulting in a proportionally lower pension benefit. Furthermore, women more often than men see their pension being brought up to the minimum, implying their pension then increases proportionally to their wage.

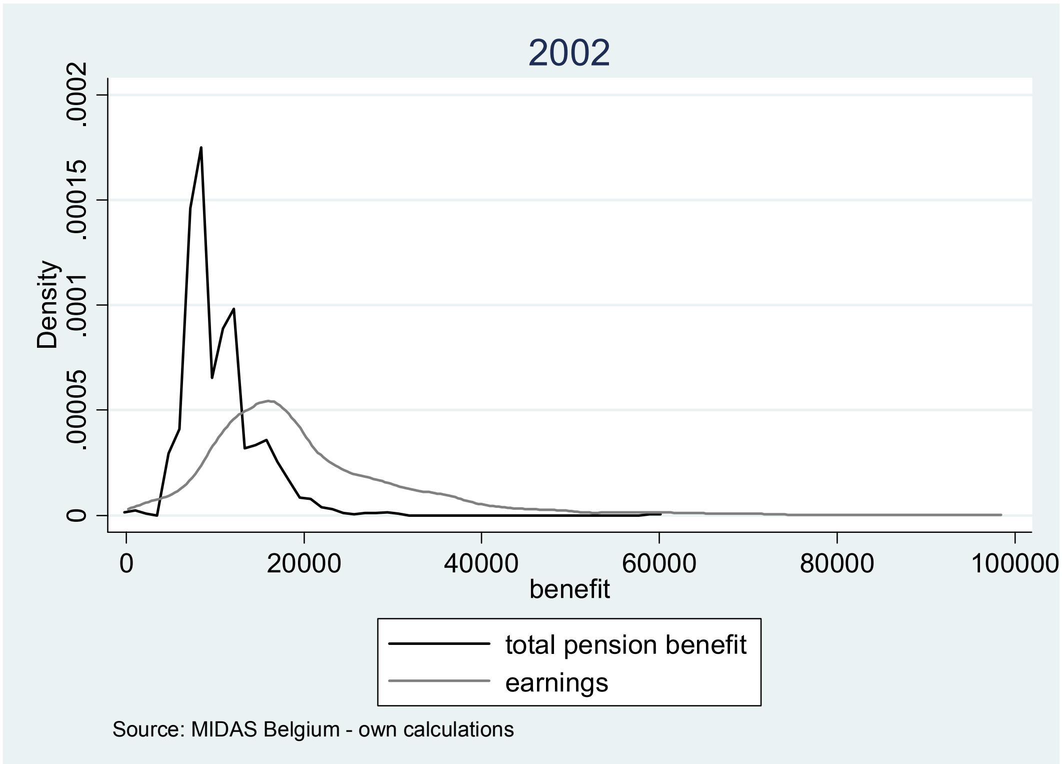
5.1.4. Inequality, poverty and the adequacy of pensions

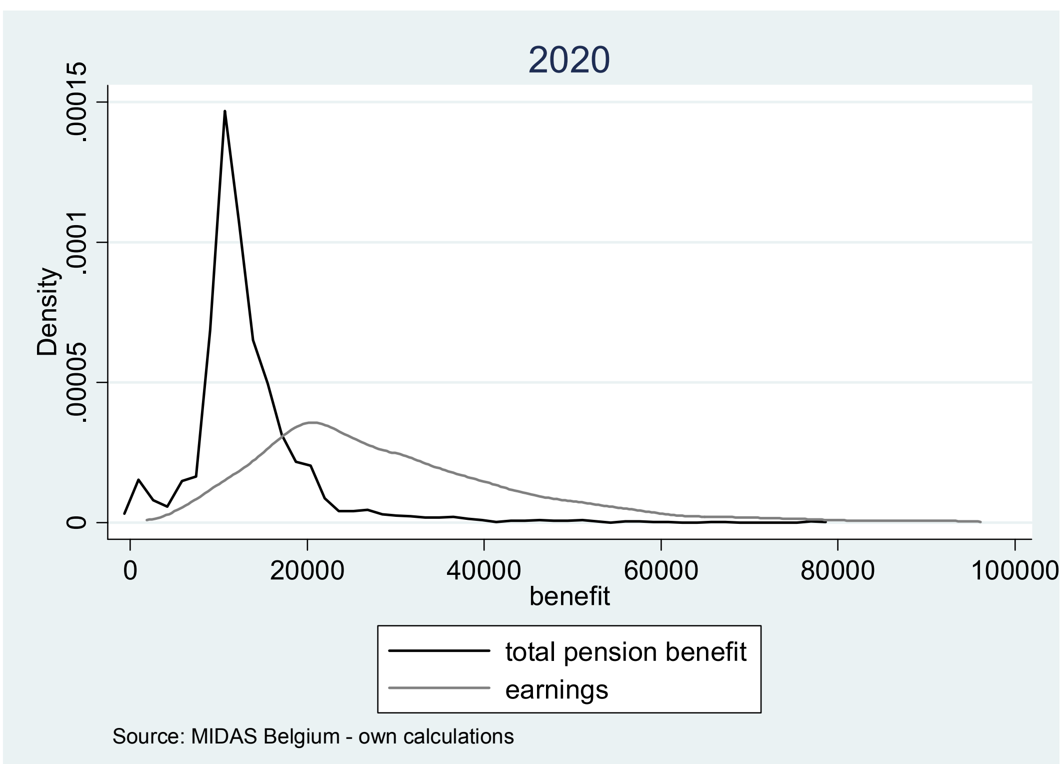
This section analyses the adequacy of pensions by considering the effect of pension income on inequality and poverty. In the previous discussion of the simulated levels of various retirement benefits, we ignored those that made a transition (strategy 2.2), and those that retired before the starting year 2002 (strategy 1.1). The previous figures mostly concentrate on 'pure' employees and civil servants (those who have worked only as employees or civil-servants.) and those that retired after 2002. This allowed a separate analysis of the development of different pension benefits. In this section, we want to assess the overall adequacy of pensions. Thus, we need not only the benefits of those retiring after 2002, but also before that year. The price that we pay for this is that we no longer can make a difference between various pension benefits (strategies 1.2 and 2.1).

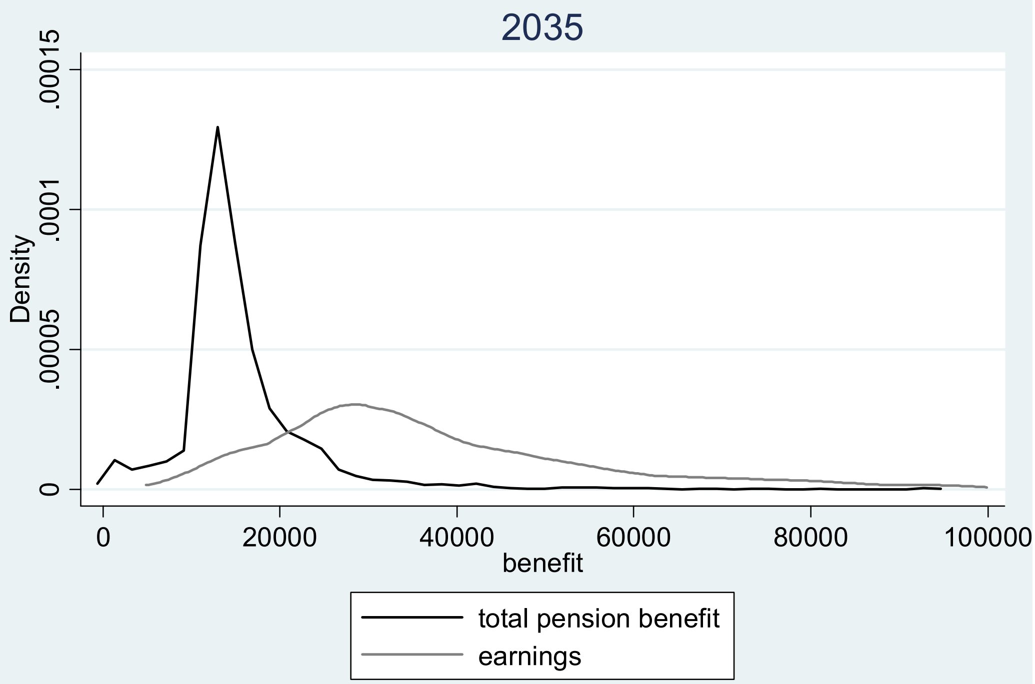
a. Inequality

A first and most simple way of visualizing inequality is by considering the Kernel density estimator of the distribution of a variable. Figure 31 shows the KDE's of earnings and pension benefits in 2002, 2020, 2035 and 2050.

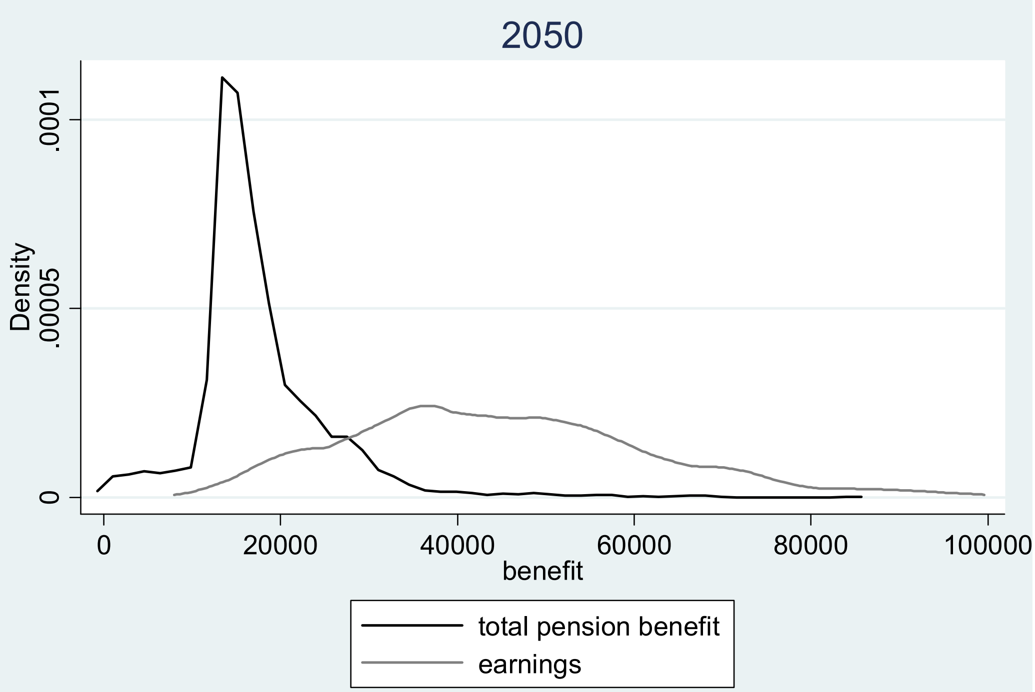
Figure 31: Kernel density estimator of gross earnings and retirement benefits in selected years







Source: MIDAS Belgium - own calculations

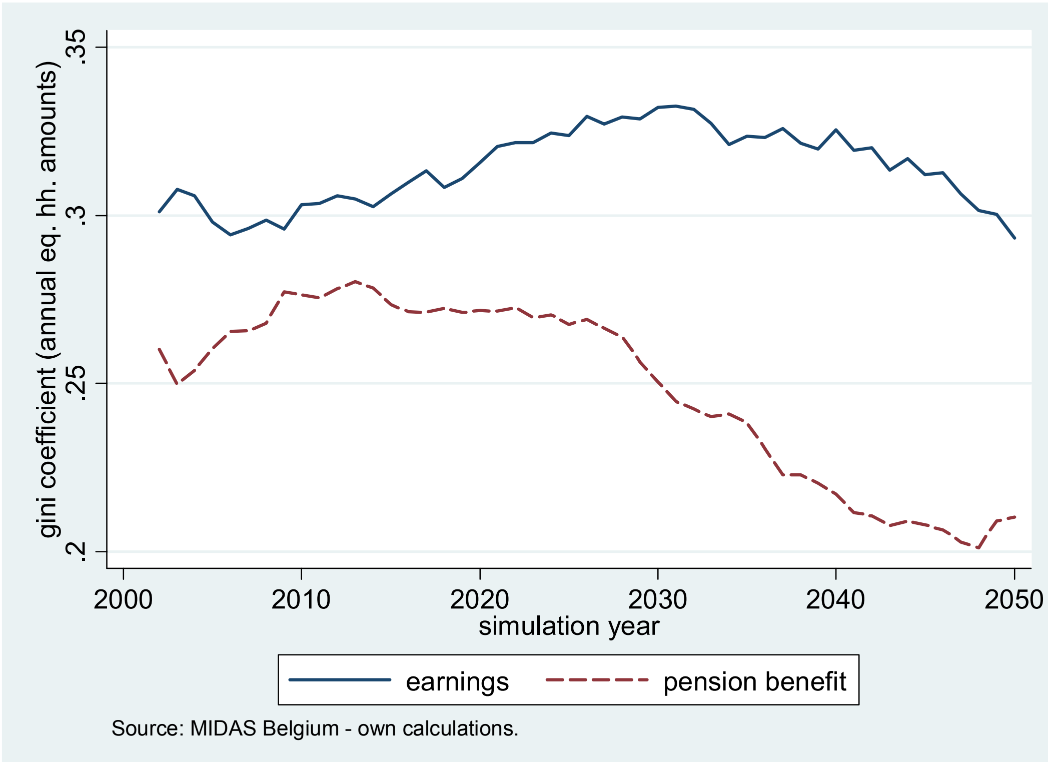


Source: MIDAS Belgium - own calculations

Not surprisingly, the median level of pension benefit is in all years below the median earnings, which confirms the conclusions from Figure 30. Furthermore, the above KDE's suggest that pension benefits are more equally distributed than earnings, and that this difference increases over time, especially as the inequality of earnings increase. By itself, this is not surprising, given the various redistributive elements embedded in the Belgian system of first-pillar pensions. These include a minimum pension benefit, a minimum right per career year, a wage-ceiling, and so forth. However, earnings and benefits in these KDE's are individual and not-equivalent, and as their means differ, the measure of inequality should be neutral to this difference. Furthermore, the widening density and shifting mean could be the result of proportional increases of incomes, such as caused by the adjustment of earnings to the AWG growth rate. In this case, income inequality measures such as the Gini would not change, because of the "income scale independence" or homogeneity property of these measures. So, it is too soon to draw the above conclusions on the redistributive impact of pensions on the basis of the above KDE's. For this, we need to consider indicators of inequality.

Figure 32 contains the development of the Gini of earnings and pension benefits in all years between 2002 and 2050. Note that where the previous figures were based on individual incomes, these Gini's are based on the equivalent household income of the individual, using the well known modified OECD equivalence scale (1, .5 and .3).

Figure 32: Inequality of gross earnings and retirement benefits: Gini



In general, the inequality of retirement benefits is considerably lower than that of earnings, meaning that retirement benefit redistributes income away from the tails of the distribution towards its centre. This confirms the discussion of Figure 31. The above figure however also suggests that this redistribution increases after 2020. A first explanation starts by considering again the observed pension benefits to those already retired in the starting year 2002. These ongoing observed pension benefits are not from the first pillar alone, but from all three pillars. We can expect the pension system of the first pillar to be redistributive, as explained earlier, but these vertically redistributive elements are much smaller or even completely absent in the pension benefits from the second and third pillar. In the first years after 2002, the majority of retired individuals were already retired in 2002, and their benefit is therefore on average too high and most likely too unequal. The redistributive element of the first pillar of the pension system is thus 'polluted' by benefits of the second and third pension pillars. As time goes by, however, these existing retirees with observed benefits are gradually replaced by cohorts of new retirees that retired after 2002 and whose pension benefit is therefore of the first pension pillar alone. The inequality of pension benefits can therefore be expected to decrease over time.

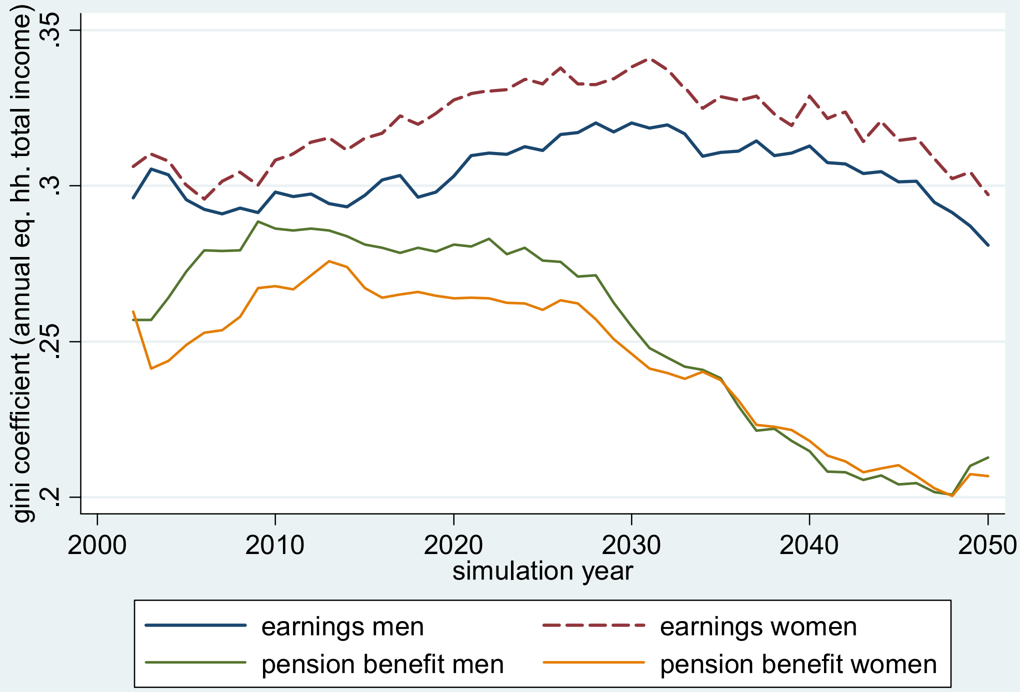
A second reason pertains to the comparison of the linkage between wages and benefits before and after the start of the simulation. Following the assumptions of the AWG, we assume that benefits lag behind the development of wages. The difference between the growth rate of pension benefits, for example, and that of wages is assumed 1.25 percent. Fasquelle et. al. (2008: 2) show that this lag was on average 1.8 percent between 1956 and 2002. Thus, the assumptions used by the AWG –and hence by MIDAS- imply a reinforcement of the link between wages and pension benefits. This decreasing lag implies that the benefit of those that retired before, will converge towards the benefit of those that retire later. Put differently, if the link between wages and pensions is reinforced then the relative decrease of the benefit of older retirees is slowed down, not only relative to workers but also relative to younger retirees (who retired later). As a result, the inequality of pension benefits will ceteris paribus decrease over time.

A third and last reason that explains this decreasing inequality starts by emphasizing that the model takes only earnings and pension benefits into account. This not only means that the levels of inequality are most likely too high (since most –but not all- other sources of income have a negative effect on inequality; see Dekkers and Nelissen (2001)), but what is more important in the context of this paper, is that this omission may make the simulation results depending on the structure of households. Indeed, the larger the household, the higher the probability of observing other types of income. Or, the more individuals in the household, the more the simulation results of MIDAS will overestimate actual inequality[35]. Consequently, when the average number of individuals in the household decreases, then the overestimation would become smaller in size, and we therefore can expect inequality to decrease as well. Figure 11 indeed shows that the average number of individuals in households – restricted to households whose at least one individual is retired - is first slightly increasing until 2020 and therefore decreases a lot until the end of the period. This development coincides with the Gini index of pension benefits in Figure 32. Indeed, we see this inequality index increase until 2020 and decrease thereafter.

Next, Figure 33 specifies the redistributive impact of pensions to gender.

[35] Note that households that have income other than earnings and pension benefits are hence ignored. It is however obvious that ignoring other sources of income, as MIDAS does, has no impact on the conclusions pertaining to the redistributive impact of pensions.

Figure 33: Inequality of gross earnings and retirement benefits: Gini to gender



Source: MIDAS Belgium - own calculations.

The inequality of earnings is higher for females than for males because the proportion of part time workers and workers that work only a limited number of months is higher for the former than for the latter. However, the inequality of pension benefits is lower for females than for males, and the redistributive effect of pensions is therefore stronger for the former than for the latter. As the average pension benefit is lower for women as well, these pensions more often are confronted with the various minimum benefits. As a result, the inequality is lower. Furthermore, retired men more often than women receive a pension benefit from the second or third pension pillar. Even though the effect of this is diminished by the fact that we use equivalent household income, we can expect this to increase the inequality of the pension benefit of men at least up to 2020.

b. Poverty

Next, we turn to poverty and the effect of the total pension benefit on poverty. The most well-known indirect measure of poverty is developed by Foster, Greer and Thorbecke (1984) and is written as $FGT(\alpha) = \int_0^z \left(\frac{z-x}{z}\right)^\alpha f(x)dx$, or in its discrete form $FGT(\alpha) = \frac{1}{n}\sum_{i=1}^{p}\left(\frac{z-X_i}{z}\right)^\alpha$. The X is the equivalent household income of individual i, and z is an exogenous poverty line, in this –and most-cases equal to 60% of equivalent median income of the household where individual i lives in. The variable α represents the sensitivity of the index to the depth of poverty. If α=0, then it does not take depths into account at all. FGT(0) is also known as the headcount-ratio and represents the proportional size of the sample that lives in a poor household. This is also described as the "poverty risk" or incidence of poverty. If α=1 then FGT(1) is known as the poverty gap ratio, adds up proportional depths of poverty. This variable reflects the intensity of poverty.

The poverty-reducing effect of pensions

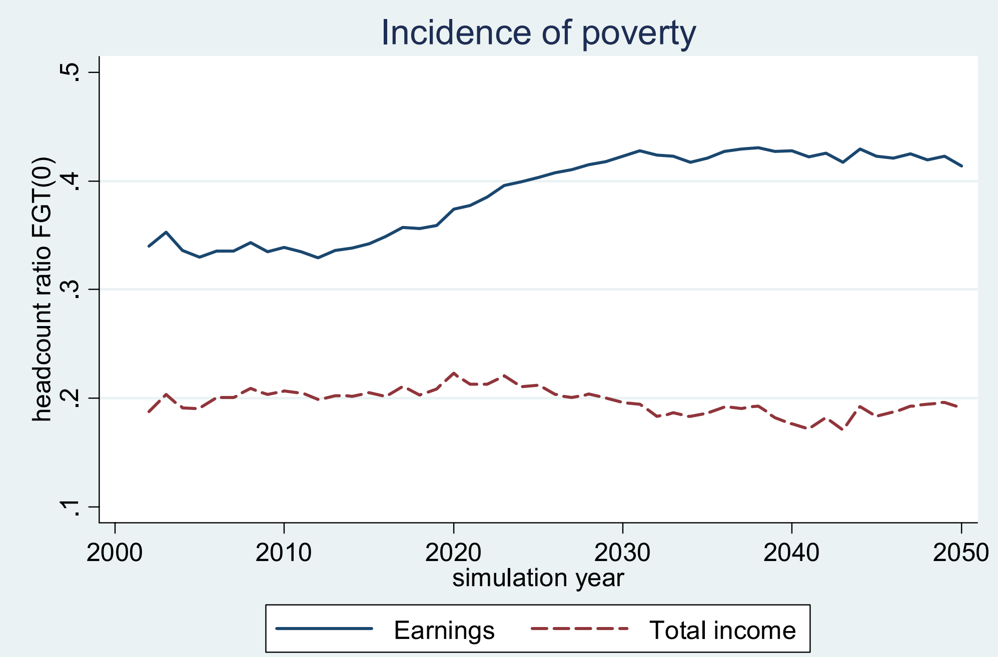
The next figures show the marginal impact of all retirement benefits to reducing the incidence or intensity poverty. They are calculated using the poverty line based on median total income for each year separately. So the marginal negative effect of retirement benefits on poverty incidence or intensity is reflected as the difference between the poverty incidence or intensity of earnings and total income. Another way of interpreting it is that the poverty rate of earnings is that overall poverty rate that would exist if pension benefits were not to be. If this poverty rate is higher than the poverty rate of total income (earnings and pensions), then pensions reduce poverty.

Compared to the poverty pertaining to only earnings, the lower poverty pertaining to adding retirement benefits to earnings (resulting in total income) is caused by i) individuals living in households with only a retirement income to no longer have a zero income, and ii) the median income to increase relative to the poverty line[36].

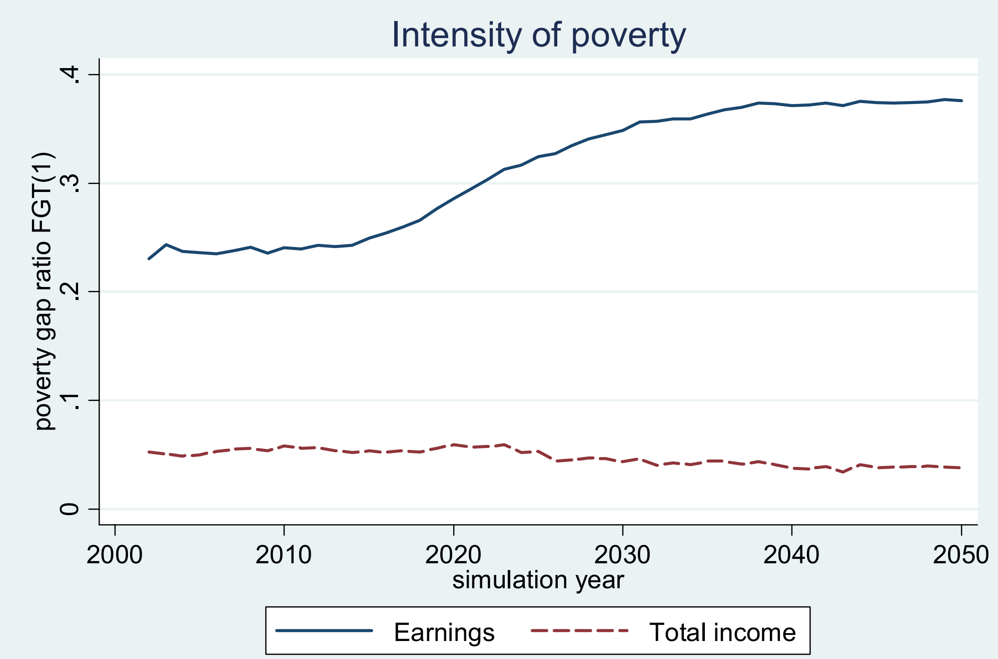
Figure 34 shows the poverty risks (FGT(0)) and intensities (FGT(1)) pertaining to earnings and total incomes for the period between 2002 and 2050.

[36] To include this effect, the poverty line used for the two rates is the same, namely 60% of median total equivalent income (i.e. earnings plus pension benefits). Put differently, the higher poverty pertaining to earnings alone is caused by those who do not have earnings, and the lower median earnings relative to median total income. These poverty lines are however derived for each year separately.

Figure 34: Incidence and intensity of poverty pertaining to total income and earnings: the marginal effect of retirement benefits



Source: MIDAS Belgium - own calculations.



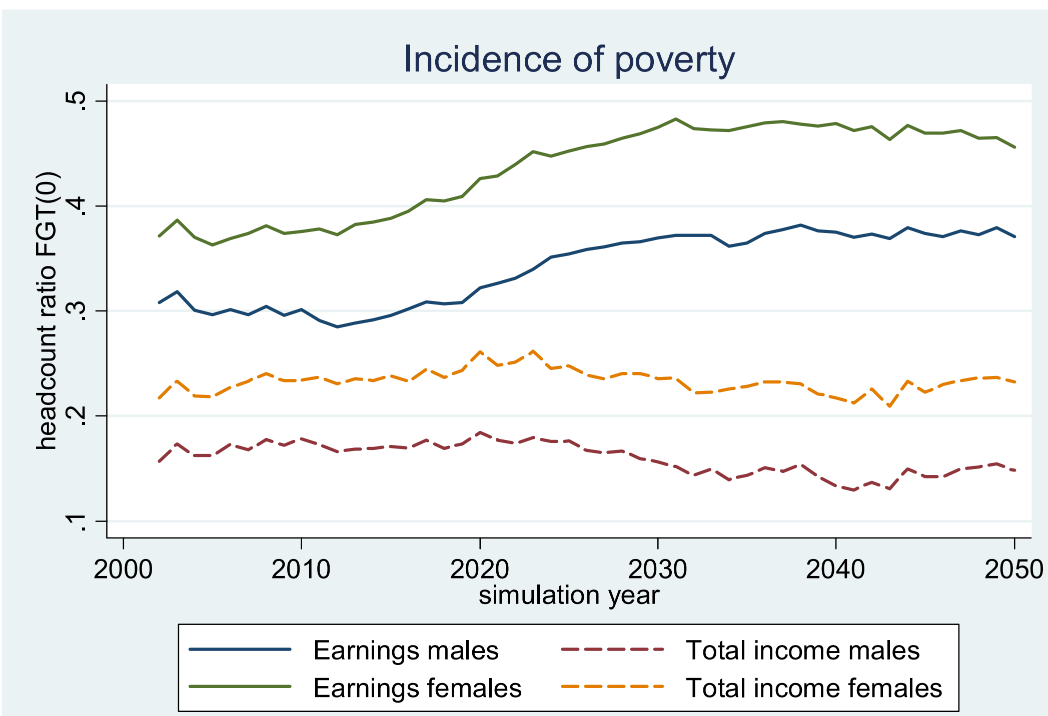
Source: MIDAS Belgium - own calculations.

First of all, this figure shows that retirement benefits have a considerable impact on poverty, an impact that is even increasing from about 2020 onwards.

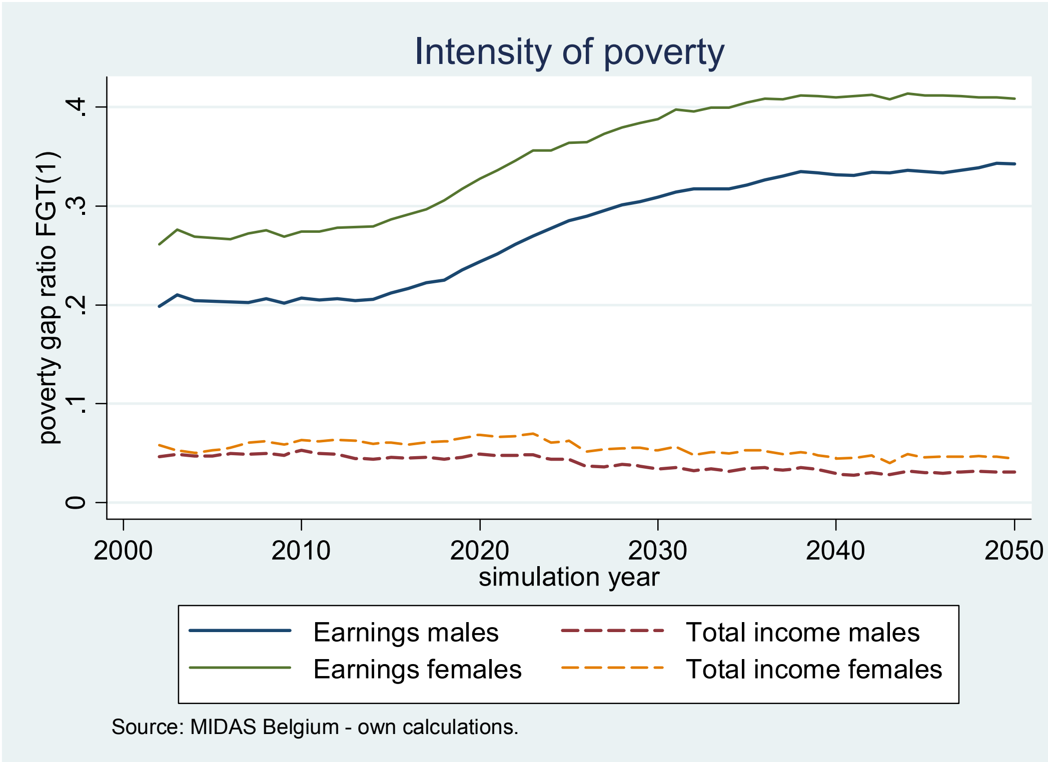
Given the redistributive elements in the various retirement benefits systems, the poverty-reducing contribution of pension benefits may not come as a surprise. Indeed, the upper pane of Figure 34 shows that, over the simulation period as a whole, the incidence as well as intensity of poverty pertaining to total equivalent income is considerably below that of earnings. Furthermore, this poverty-reducing effect of pensions increases drastically after about 2020. A first reason for this obviously is that the proportion of wage-earners decreases (hence the increase of poverty pertaining to earnings alone), because of the increase of the proportion of retirees (see Figure 20 and Figure 21). A second reason is that the redistributive effect of pensions increases, as shown by Figure 32. Third, both the risk and intensity of poverty among individuals receiving a pension benefit increases from the early 2020's on, and gradually increases again from the late 2030's on. This will be shown in Figure 36.

Before closing this section, let us take a quick look at how these results differ between men and women. This is shown in Figure 35.

Figure 35: Incidence and intensity of poverty pertaining to total income and earnings to gender



Source: MIDAS Belgium - own calculations.

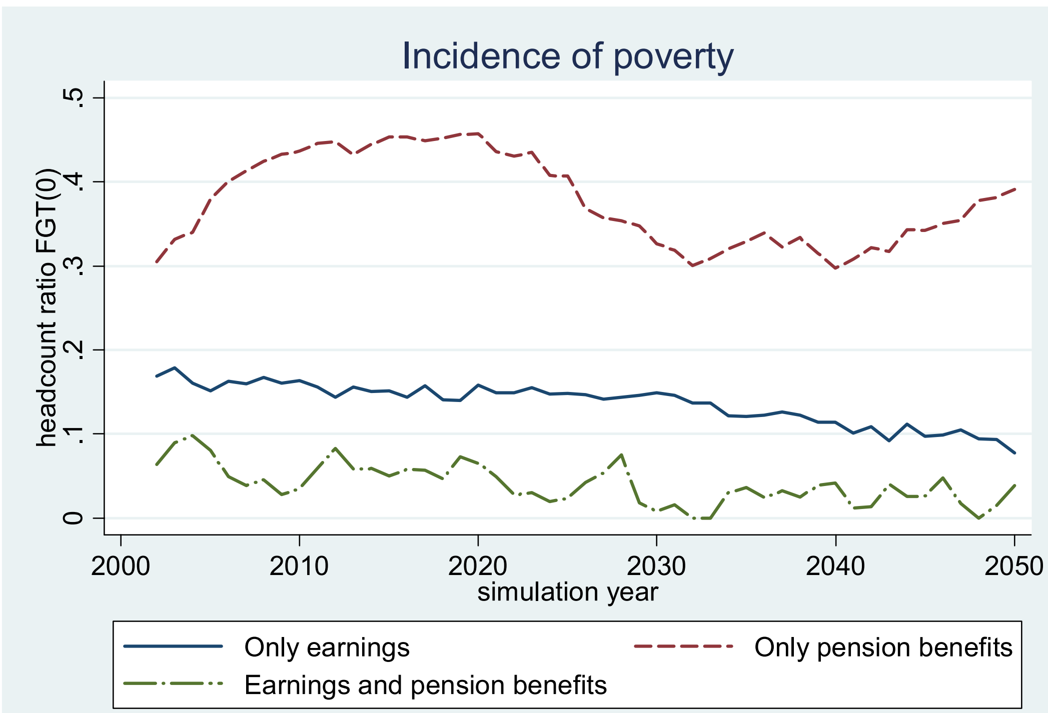


The overall conclusion is that the patterns seen in Figure 35 do not differ very much between men and women. This is not surprising, since the pension system is in principle gender-neutral and since married and cohabiting partners share the same household income. However, especially the risk as well as intensity of poverty pertaining to earnings is consequently higher for women than for men, among other things caused by their higher proportion of part-time workers and those that do not work the whole year round. The risk and intensity of poverty pertaining to total income is therefore higher for women than for men as well, so pensions reduce the risk of poverty proportionally only slightly more for women than for men. The intensity of poverty pertaining to total equivalent income is however almost the same for men and women, whereas it differs considerably when only earnings are considered. This means that the marginal effect of pensions on the intensity of poverty is larger for women than for men. A possible reason for this is the Old-Age Guaranteed Minimum Income (GMI). Due to their lower earnings (lower activity rates, a lower hourly wage-rate, the higher proportion of women who work part-time or a reduced number of months,…) women have a higher risk of having their pension being lower than this minimum. Their pension is then brought up to this level, which however by itself is still below the poverty line (Dekkers and Debels, 2007). So the marginal effect of this minimum is stronger on the intensity than on the risk of poverty, and this is more the case for women than for men.

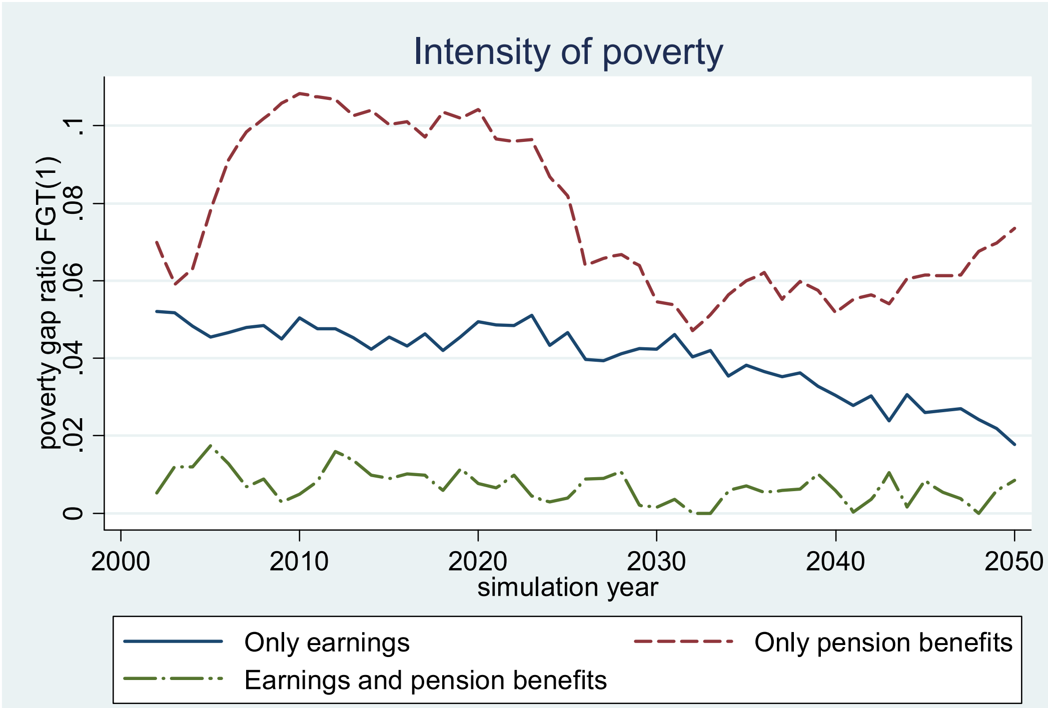
The poverty-situation of workers and pensioners

The poverty reducing effect of pensions paints only a part of the picture, however. This is because it compares poverty rates with and without taking into account pension benefits. In the first case, the assumption underlying the poverty pertaining to earnings is that those individuals that live in households that do not work, have no income. This of course is not realistic, and another way of describing the adequacy of pensions is by not looking at its poverty-reducing effect, but by comparing the poverty situation of individuals in households with and without earnings. This way, the possible vulnerable position of those individuals that form part of retired households, becomes visible. Figure 36 shows the incidence and intensity of poverty among individuals with households that have only earnings, only retirement benefits, or both.

Figure 36: Incidence and intensity of poverty pertaining to individuals from working and retired households



Source: MIDAS Belgium - own calculations.



Source: MIDAS Belgium - own calculations.

In contrast to previous figures, the differences between poverty rates and intensities in Figure 36 are not the result from households without earnings or pension benefits. Indeed, households are classified to whether their total income equals earnings or pension benefits alone, and households with mixed income.

The first conclusion from Figure 36 is that those who live in households that have both earnings and pension benefits, have a lower risk and intensity of poverty as compared to the other categories. This may be because these individuals have best of both worlds: they benefit from the high but unequal earnings, as well as the lower but highly redistributive pension benefits.

The advantageous position of those having both earnings and pensions relative to others who live in households with only earnings can furthermore be explained by noticing that those that live in 'mixed households' often are older than those that live in households that have only earnings as income. This means that their income from work is usually higher (since age is an important determinant of earnings). Also, their households are usually smaller in size since children more often than average have left the household. The equivalence scale is therefore lower, and welfare is ceteris paribus higher.

The lower risk and intensity of poverty of those that have household earnings relative to those that receive just pensions can be explained by the fact that one common poverty line has been used in all previous figures. The lower mean pension benefit compared to earnings (see the replacement rate in Figure 30) thus results in a higher poverty risk for those having only a pension benefit. However, due to the redistributive element within the retirement system, the two categories differ more in poverty risk than in the poverty intensity.

Next we consider the development of poverty risks and intensities over time in Figure 36. This shows a rather grim picture where both the risk and intensity of poverty of those having earnings remain more or less the same, while both the risk and intensity of poverty of those receiving only a pension benefit go up fast and remain high in the first decade. This suggests that the increase of poverty in the first decade is again the result of a technical characteristic of the model that was discussed at length before. The observed pension benefits in the starting year 2002 indeed consist of benefits from not only the first, but also the second and third pillar of the pension system. As new generations of individuals enter retirement, the observed retirement benefits become merged with fully simulated retirement benefits. The latter do not include benefits from the second and third pension pillar, and poverty therefore increases. This, obviously, is not necessarily a realistic development, but a technical characteristic.

The effect of this technical characteristic is reinforced by the increase of the proportion of “household rate” pensions until about 2010 (Figure 29). Indeed, couples benefiting from “household rate” pensions are worse off than couples benefiting from two pensions or even than single households with a single pension, since the proportional difference between the “household rate” and the “single rate” (being 25%) is lower than the increase of the equivalence scale (50%). So if this proportion increases, so does the risk of poverty.

Furthermore, Figure 29 shows that the proportion of “household rate” pensions stays quite high before 2020-2025, which can also explain this high and constant level of poverty amongst pensioners. Finally, Figure 11 shows that the number on individuals in retired households stays roughly constant until 2020 and decreases afterwards. This explains of course that the proportional size of “household rate” decreases but it has also a direct impact on poverty measures: All other things being equal in term of earnings, the more individuals in a household, the higher the probability is to be under the poverty line.

Ignoring the increase of poverty among the pensioners in the first decade of the simulation period, a contradiction between the poverty among pensioners and the replacement rate becomes visible. Between about 2025 and 2020 (for the incidence and intensity of poverty, respectively), and the first half of the 2030’s, the position of retirees will meliorate relative to that of the other categories. This development seems in contradiction with the ongoing decrease of the replacement rate in Figure 30. Furthermore, poverty among pensioners in Figure 36 increases again from the 2030’s on, which is just when the replacement rate in Figure 30 has reached its minimum and is again increasing! So the development of the poverty position of the elderly seems somewhat in contradiction to the development of the replacement rate.

A first answer lies in realizing that the replacement rate represents 'only' the income fall at retirement. It hence represents only the youngest cohort of retirees and not all those that retired earlier. Indeed, the higher the average age of the pensioners, the lower the value of the replacement rate in explaining poverty among pension beneficiaries. This suggests that the age development of pensioners could explain the development of poverty in Figure 36. Figure 37 presents the average age of those living in a household receiving a pension benefit.

Figure 37: Average age of pension benefit recipients

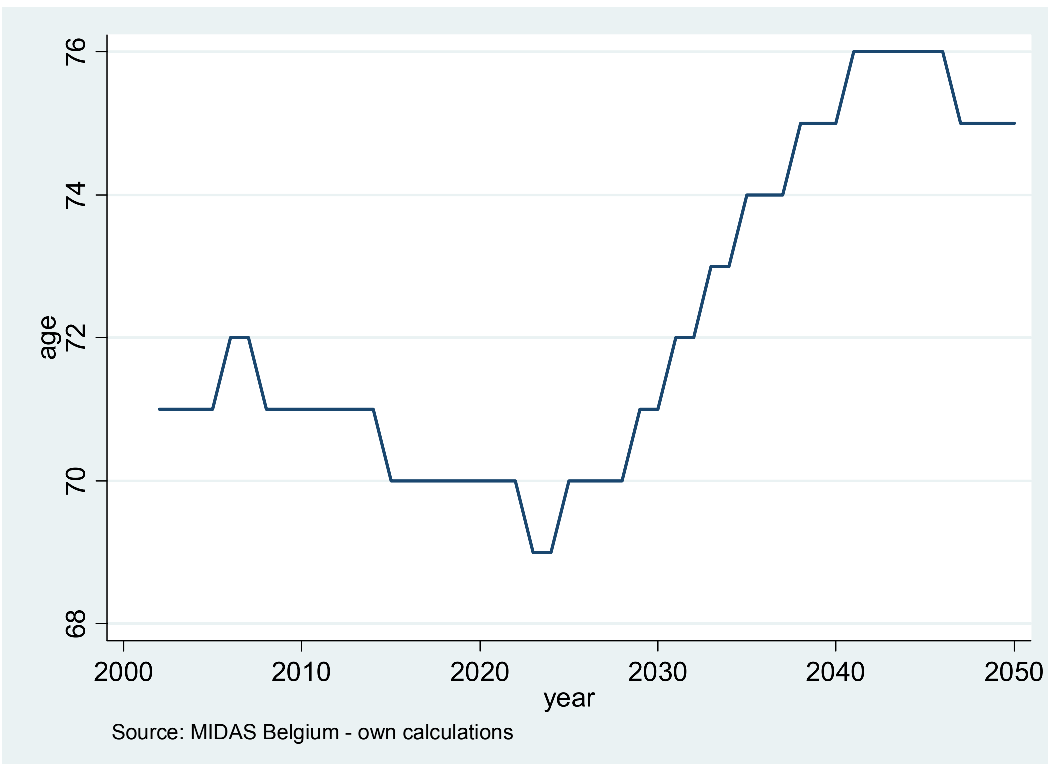


Figure 37 reveals that the average age of the recipients of (equivalent) pension benefits decreases somewhat in the first half of the simulation period. But from the mid 2020's on, it increases considerably. Ongoing pension benefits are only partially linked to the development of wages – even though this linkage is stronger in projection than it was in the past- so a strong increase of the average age of recipients in Figure 37 explains the increase of poverty among the recipients of pensions in Figure 36. This line of reasoning obviously suggests that older cohorts of pensioners *ceteris paribus* have a higher risk and intensity of poverty. The Figure 39 will see whether this is indeed the case.

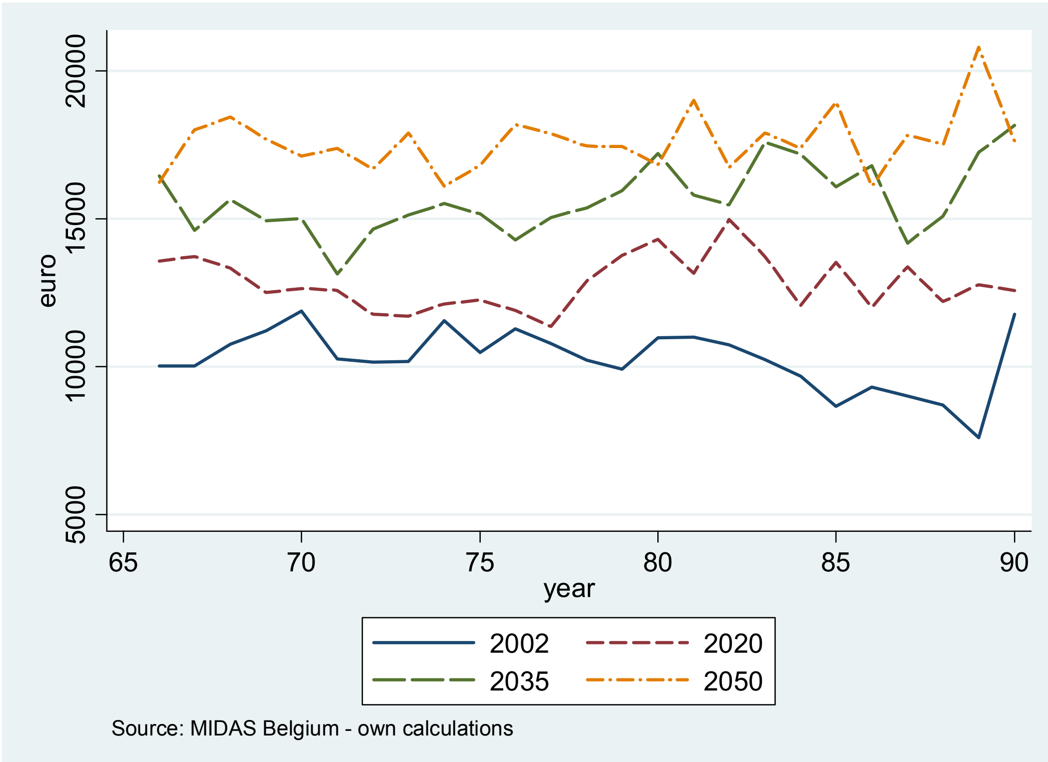
Another reason for the decrease of poverty among pensioners in the 2020's is the proportional decrease of the "household rate" pensions (Figure 29) and the redistributive impact of pensions catching up from about 2010 on (Figure 32). This in turn is explained by the fact that the linkage between pensions and wages is stronger in projection than it was in the past. This increased redistribution obviously has a first and immediate effect on the intensity of poverty. It is only after a couple of years that this redistribution has become so strong that it starts to lift people above the poverty line, hence decreasing the incidence of poverty. Nevertheless, by itself, this does not seem enough to explain the decrease of the poverty rate among pensioners between 2020 and 2030. Furthermore, poverty among pensioners in Figure 36 starts to increase in the 2030's, and this is not caused by a decreasing redistributive impact of pensions. So there must be another cause for poverty among pensioners to decrease first and increase after that.

To close this chapter, we take a closer look at some 'traditional' group of vulnerable pension recipients, insofar as meaningfully possible within the Belgian version of MIDAS. Given the previous discussion, we first take a look at older retirees.

Older versus younger retirees

Common knowledge identifies older retirees as being a category of elderly who are the most vulnerable, and who have the highest risk of poverty. This is usually based on the idea that the less-than-unity linkage between the growth of wages and pension benefits implies a relative drop in pensions, the longer one is retired, i.e. the further the first year of retirement lies in the past. This suggests that older pensioners may have a higher incidence and intensity of poverty. The following Figure 38 shows the relation between age and equivalent pension benefit in 2002, 2020, 2035 and finally 2050.

Figure 38: The average pension benefit to age



Note that the graph starts at the age of 65 to prevent zero pensions of those not yet retired to distort the average. In 2002 and certainly from about 75 years of age on, the mean pension benefit decreases with age. In later years, however, this is no longer the case and from 2020 on, pension benefit even seems to increase with the age of the recipient. This suggests that the above line of reasoning, even though obviously true, is a too simple explanation.

First of all, today's pensions are a function of the development of past wages, wage ceilings, minimum pensions, …, just as future pensions are a function of today's wages, wage ceilings and minimum pensions. Now we have a situation where the lag between the growth rates of wages and pensions is smaller in the projections than in history (see the discussion of Figure 32). As a result, the quasi-concave relation between benefits and age becomes less outspoken. In the extreme, if the lag is absent and all pensions follow the growth rate of wages, then the relation between age and benefit would be a straight line. But in later years (2035 and 2050), the situation is reversed and the average pension benefit even seems to increase with age! This is because the pension benefit in a certain year is not only a function of past wages, but also of the development of the wage-ceiling and the minimum pension. As the wage-ceiling lags behind the development of wages, the growth of the pension benefit given age (i.e. the vertical differences between the lines) slows down. Furthermore, at each point in time, the wage ceiling is proportionally lower, and thus more restrictive, for younger than for older retirees. Or inversely, the mean pension benefit increases with age.

This development is reinforced by the development of the Guaranteed Minimum Income (GMI) over time. Indeed, this minimum follows wages more closely than the welfare adjustment does. So over time, more and more pension recipients become eligible to this minimum, and the overall growth rate of pension benefits hence increases with age.

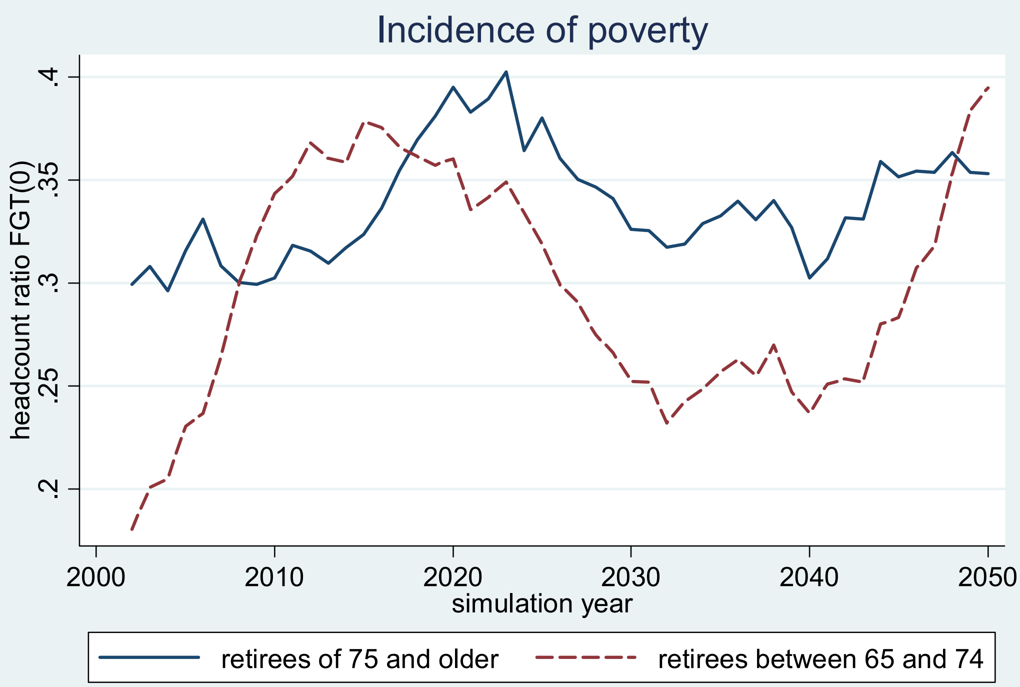
Furthermore, the average length of the career decreases slowly over time. Even though this development is limited, it will have an additional decreasing effect of the pension benefit over time. Or, again inversely stated and in the second half of the simulation period, the average pension benefit increases with age.

Finally, as age increases, the proportion of widow(er)s increases. These can cumulate pensions up to 110% of the previous old-age benefit. Hence the average pension benefit increases with age.

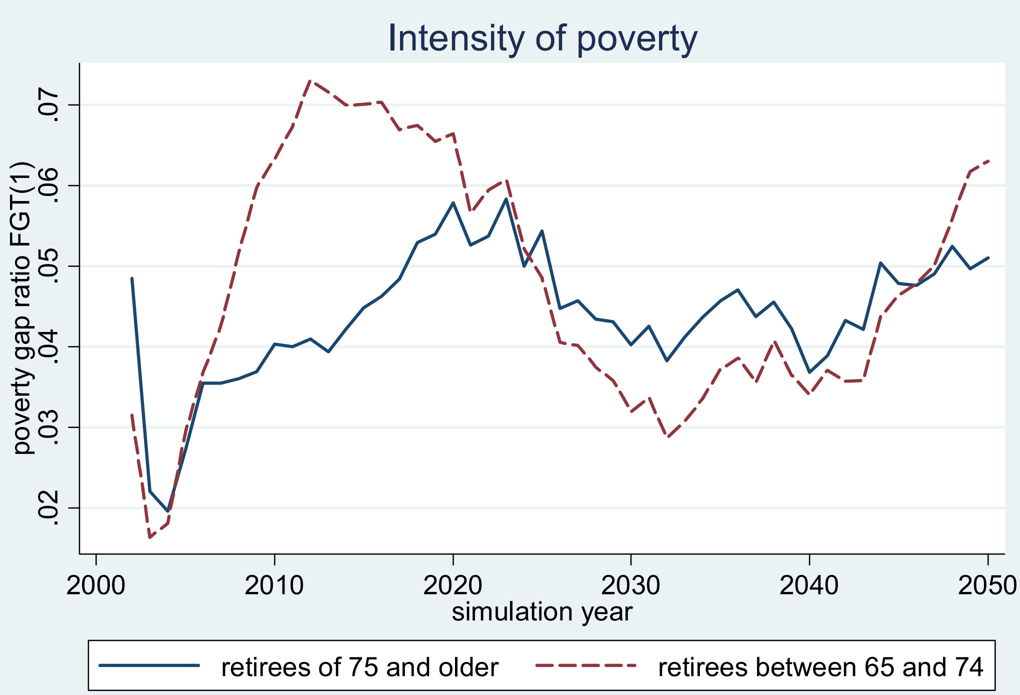
To summarize, there are several effects at play. First, the lag between wages and ongoing pension benefits cause pensions to decrease with age. However, the fact that this lag becomes smaller in projection than in the past implies that this effect becomes smaller. Secondly, the continuous lagging of the wage ceiling and the minimum pension benefit causes benefits to increase with age. Third, the average length of the career decreases over time while the proportional size of widow(er)s increases with age. This causes the benefit to increase with age as well. As a result of all this, the average pension benefit decreases with age in the starting year of the simulation, but this decrease becomes smaller over time, and is even reversed.

The main conclusion therefore is that the general notion that older pensioners are more vulnerable may be a too simplistic view. Furthermore, when basing poverty on equivalent incomes, the difference between age groups in terms of pension benefit is diluted by the use of household income. Figure 39 shows the incidence and intensity of poverty for pension beneficiaries older and younger than 75, using total equivalent household income.

Figure 39: Incidence and intensity of poverty pertaining to individuals older and younger than 75



Source: MIDAS Belgium - own calculations.



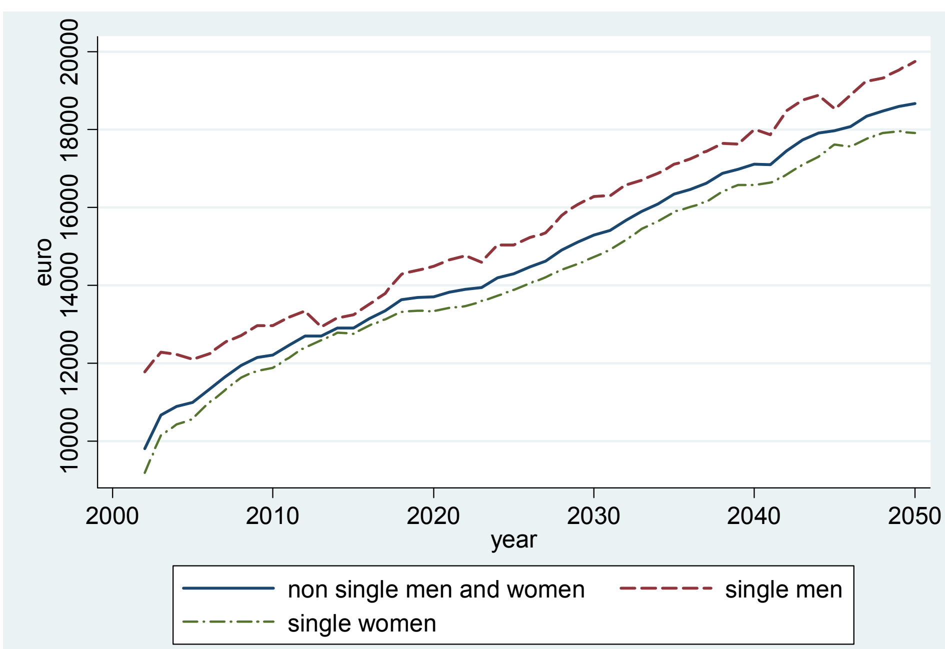
Source: MIDAS Belgium - own calculations.

The upper pane of Figure 39 shows that the incidence of poverty is higher for older than for younger pensioners in the whole simulation period, save for the period between 2008 and 2018. The reason for this counterintuitive higher poverty rate among younger retirees is that poverty among younger retirees rises much faster than among older retirees. This again confirms the suspicion that the increase in poverty results from the pension benefits observed in the starting year includes benefits from the first, as well as second and third pillar. Indeed, these pillars today are more important than they were in the past. So in 2002, the older the retirees are, the lower the effects of the second and third pillar on the level of the pension can be expected to be. In the years after 2002, simulated pensions cover only the first pillar, so the effect of the second and third-pillar pensions wear off as generations of 'observed' pensioners are replaced by simulated pensioners. Since these new generations of pensioners by definition are younger than 75, we cet. par. can expect poverty among younger retirees to increase relative to poverty among older retirees.

Single women

The latest report of the Study Committee on Ageing (High Council of Finances, 2008: 62) again confirms that single elderly and women have a higher risk of poverty than couples and men. This section briefly compares the simulated development of incidence and intensity of poverty among single women, single men and couples. Figure 40 shows the development of the average (non-equivalent) individual pension benefit of the three categories under consideration.

Figure 40: Pension benefit of single women, single men and non-single men and women

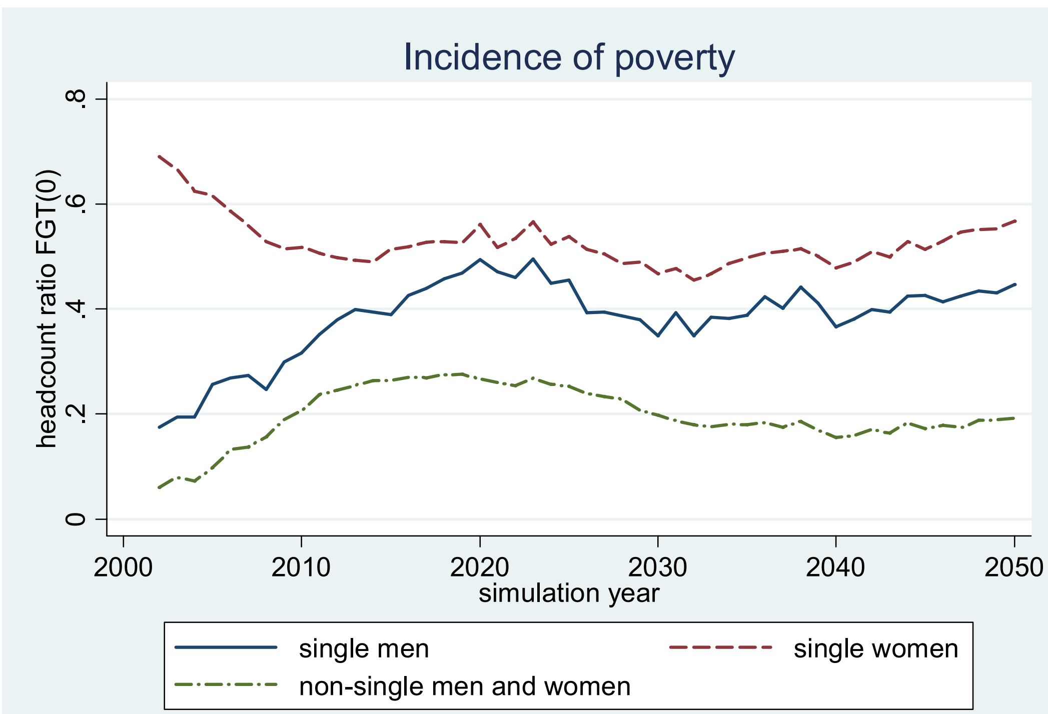


Source: MIDAS Belgium - own calculations

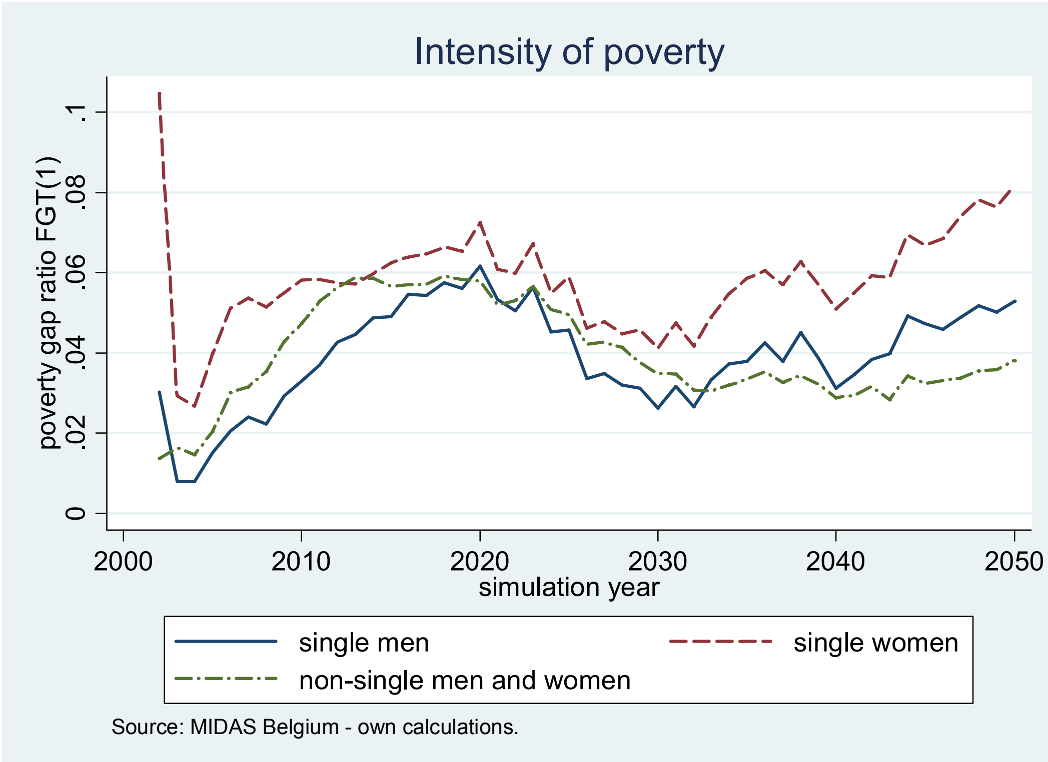
Women have a lower activity rate (Figure 13), work lower hours (Figure 17) and less than a full year (Figure 18). As a result, their gross annual wage is lower (Figure 19). These differences are to a limited extend reflected in the positive difference between the pension benefit of male and female singles. Non-single beneficiaries can both be male or female, and it may therefore come as no surprise that the average individual pension of this category lies somewhere in between that of male and female singles.

Next, Figure 41 shows the poverty position of single women, men and non-singles. In contrast again to Figure 40, poverty rates are based on total equivalent income for all those of 65 and older.

Figure 41: Incidence and intensity of poverty among singles compared to couples



Source: MIDAS Belgium - own calculations.



Note again that Figure 41 is based on equivalent total household income, where Figure 40 reflects the individual and non-equivalent pension income. It is surprising that, even though the average (non) equivalent pension benefit of single men is the highest, their poverty risk is not the lowest. Indeed, the poverty risk of non-singles is lower. There are two reasons for this. The first reason pertains to the fact that the measure of poverty is based on total income, including earnings. Contrary to singles, where there is no partner, non-singles older than 65 may have a partner who is still at work, and whose earnings add to the equivalent household income. Figure 36 already led to conclude is that those who live in households that have both earnings and pension benefits, have low risks of poverty: they benefit from the high but unequal earnings, as well as the lower but highly redistributive pension benefits. A second reason is that, for non-singles, the pension benefits of both partners are added up. Now unless the pension benefit of the woman is lower than 50% of the pension benefit of the man, this will increase welfare, and hence decrease poverty. Over time, the labour market position of women gains strength, if not absolute then relative to men. The length of career increases (Figure 26), they proportionally work more often as an employee (Figure 14) and a civil servant (Figure 16) than before. This will cause the poverty risk of single women to lower towards the poverty risk for single men in Figure 41, as well as a further divergence between the poverty risk of single men and non-single men and women.

5.1.5. Alternative scenarios

In addition to the base case scenario, two alternative scenarios have been simulated for Belgium. These two scenarios differ from the base case only in social policy hypotheses, all other assumptions –including demographic ageing, labour market developments and productivity growth rates, are being kept constant.

The Solidarity Pact between Generations recently implemented an automatic partial adaptation of ongoing pensions to the development of wages. This automatic adaptation is implemented in the base case scenario for Belgium. A straightforward way to assess the impact of this automatic adaptation on the adequacy of pensions is by comparing the simulation results of the base variant with a "lower variant", that assumes no welfare adjustment for those receiving a retirement benefit. Hence, benefits are indexed on prices only. Only Civil servants' retirement benefits continue to be indexed on wages in this "lower scenario".

The "lower scenario" actually represents an even worse situation than existing before the introduction of the Solidarity Pact between Generations. Indeed, even if automatic welfare adjustment did not exist, pension benefits were irregularly and on an ad-hoc basis uprated. The "lower scenario" hence represents the pre Solidarity Pact situation in terms of adaptation to living standards, without any ad hoc adjustment.

The second variant, called the "upper scenario", assumes a full linkage between the development of wages and benefits. Benefits from the employees' pension scheme are fully indexed on wages, just like those from the civil servants' scheme, and all retirees therefore benefit from economic growth.

The table 2 below summarizes the three different scenarios envisaged here. Every item is defined as a difference with productivity growth.

Table 79: Social policy hypotheses

	Base case scenario	Lower scenario	Upper scenario
Wage ceiling	Difference of 0.5%	Zero growth	Difference of 0.5%
Welfare adjustment	Difference of 1.25%	Zero growth	Difference of 0.5%
Civil servants' benefits	Difference of 0.5%	Difference of 0.5%	Difference of 0.5%
Lump-sum benefits	Difference of 0.75%	Zero growth	Difference of 0.5%
Minimum right by career year	Difference of 0.5%	Zero growth	Difference of 0.5%

Notes: Social policy hypotheses are defined as a difference compared to the productivity growth rate. See Appendix 1 for hypotheses on the productivity growth rate.

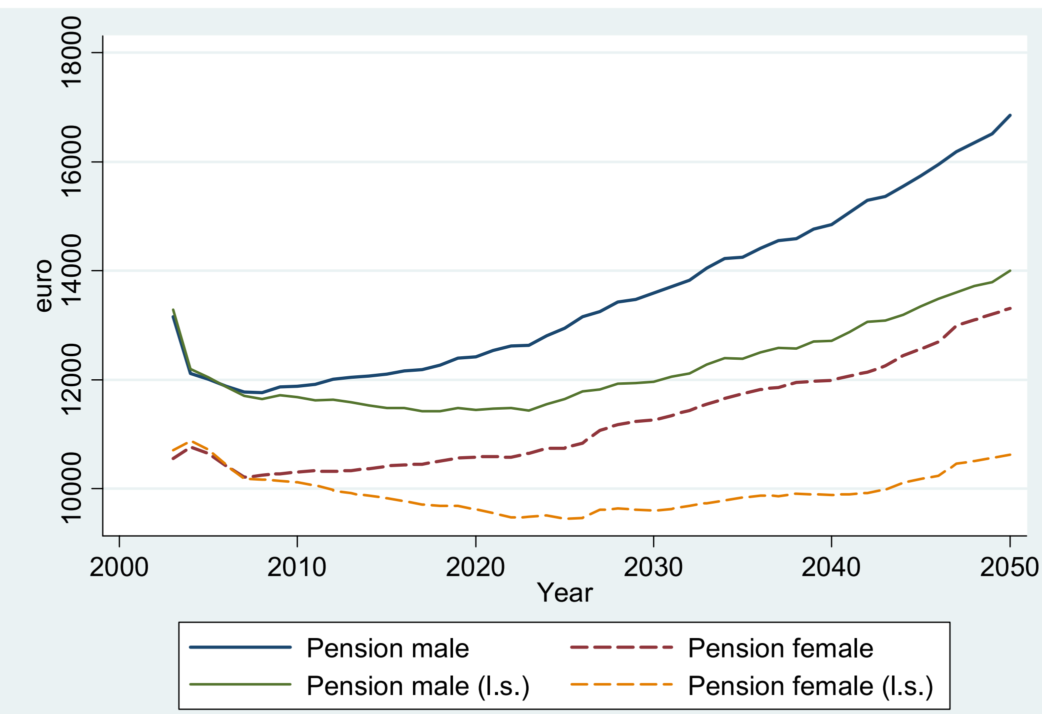
The results of both simulation variants will be presented relative to their counterparts from the base case scenario. The discussion is restricted to figures that show the level of wage-earner's retirement benefits (civil servants' one staying constant) as well as inequality and poverty indicators. In the below figures, the abbreviation "u.s." and "l.s." stand for "upper scenario" and "lower scenario".

a. The "lower scenario"

The goal of the lower scenario is to assess the impact of the automatic adaptation on the adequacy of pensions. Hence, and by contrast to the base variant, the lower variant assumes no welfare adjustment for those receiving a retirement benefit. Benefits therefore indexed on prices only.

Gross earnings are not affected in these simulation variants because no change has been brought to wages assumptions. Figure 42 therefore presents only simulated retirement benefits for wage earners with pure career. Contrary to the base scenario, where retirement benefits of those already in retirement did partially follow the development of wages, retirement benefits, now show a trend that is almost flat. The only effect of wages on retirement benefits now comes from those entering retirement. Hence, the development of the replacement rate (see Figure 30) slowly and gradually affects the average pension benefit to decrease first, and increase in the second half of the simulation period. But even then is the growth rate lower than in the base scenario.

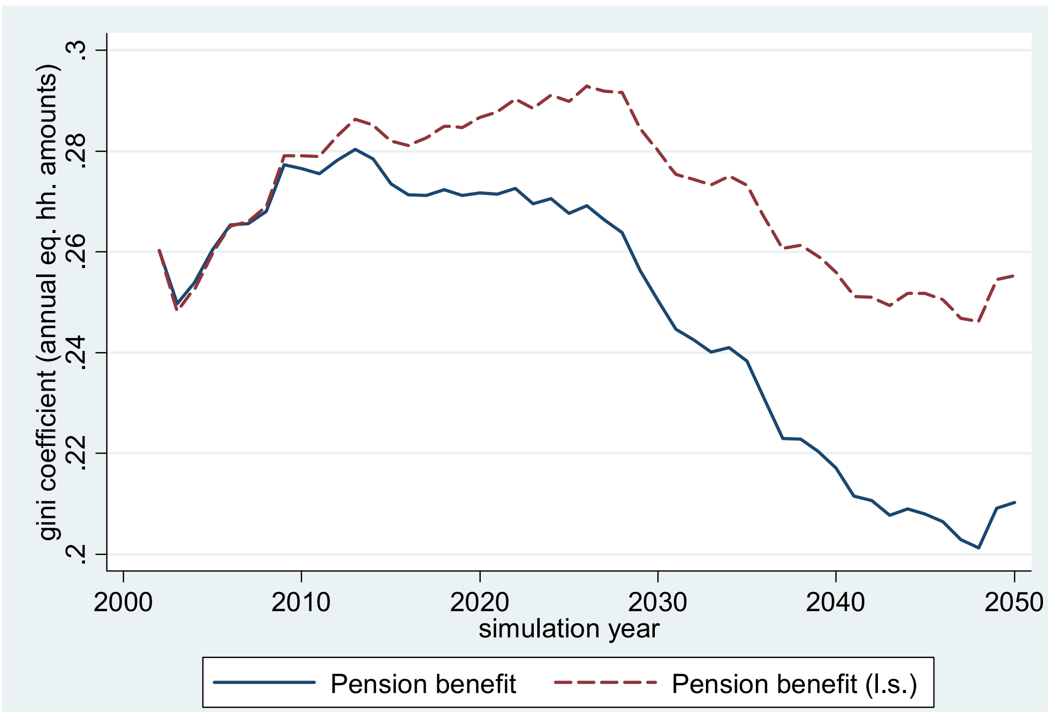
Figure 42: Lower scenario - Simulated retirement benefits for wage earners with pure career



Source: MIDAS Belgium - own calculations

As those receiving a pension benefit from the employees' scheme do not benefit anymore from the growth of wages, the gap between new retirees and old ones will increase over time. As a consequence, the inequality between retirees is expected to grow and it is what can be seen in Figure 43. After about 2010, the Gini index follows another trend than in the base case. Instead of starting a slow descent, it gradually increases until about 2030. Then it starts to decrease, as in the base case, but at a slower pace. The level of inequality remains higher as a result of abolishing automatic indexation, and the difference itself increases continually throughout the simulation period.

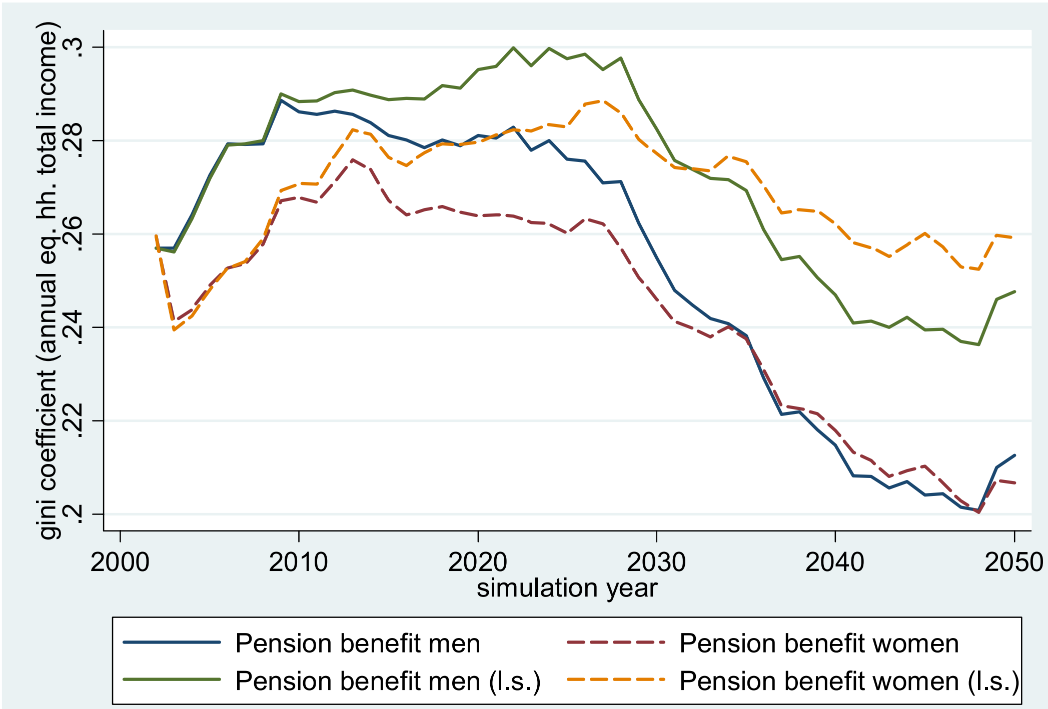
Figure 43: Lower scenario - Inequality of retirement benefits: Gini



Source: MIDAS Belgium - own calculations.

Figure 44 shows the impact of this scenario on the inequality by gender.

Figure 44: Lower scenario - Inequality of retirement benefits: Gini to gender



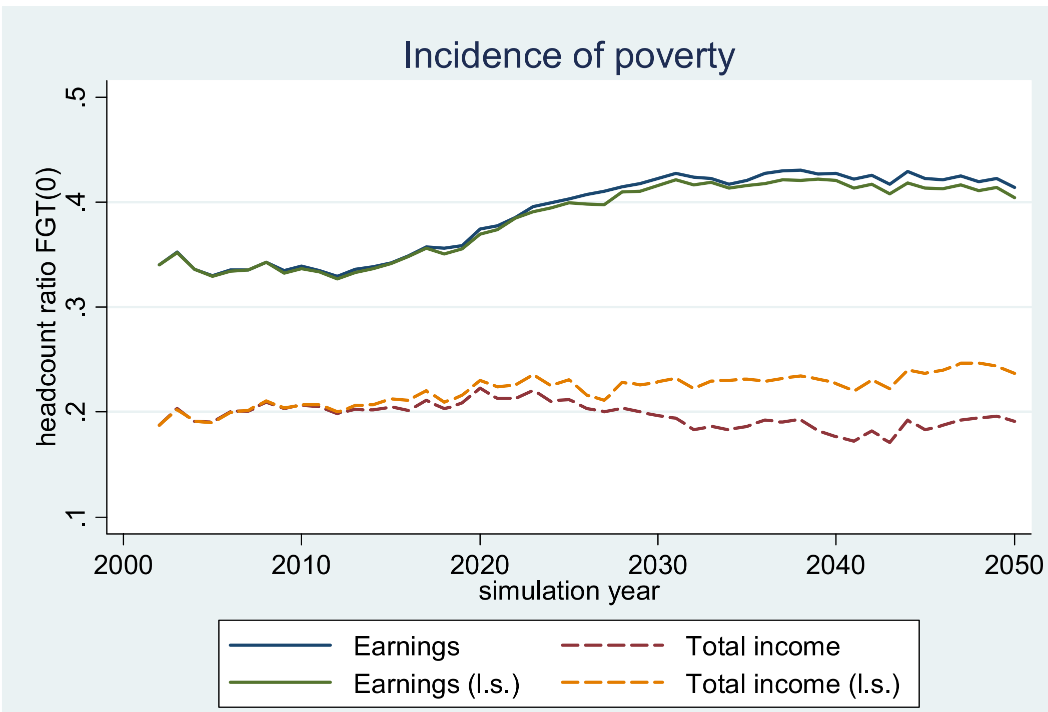
Source: MIDAS Belgium - own calculations.

The full and dotted lines represents inequality of pensions for male and female recipients, respectively, and this for the base scenario and lower scenario. As with Figure 43, inequality in the lower scenario is higher than in the base scenario, meaning that the abolishing of the partial linkage between benefits and wages would cause inequality among female as well as male pensioners to increase. However, this effect is larger for retired women than for retired men. The inequality amongst retired women even becomes larger than among retired men after 2030. In the base case, the inequality of women is reduced trough the impact of the minimum pension and the minimum right by career year. Proportionally more women than men have incomplete careers and therefore see their pension upraised to the minimum. This has a decreasing effect on inequality. In the lower scenario, these minimum pension mechanisms do not perform with the same strength. Indeed, minimum pension and minimum right by career year are eroded through the non-adaptation to welfare changes. They slowly become so low that they do not play their inequality reducing role. This causes inequality to increase, and this affects retired women more than men.

One may expect the automatic adaptation of pensions to the development of wages to prevent poverty among pensioners. Inversely stated, the abolishment of welfare sharing in this lower variant should increase poverty. This is confirmed by Figure 45. The incidence of poverty stays more or less the same than in the base case until around 2010 but, instead of decreasing after about 2020, it continues a slow increase. The intensity of poverty shows the same pattern.

The abolishment of the automatic indexation has a small but negative effect on poverty among those receiving earnings. This may seem contradictory at first, as the simulation variant only affects pensions and not wages. However, poverty risk here is defined as a relative concept, and the poverty line is therefore computed on all incomes. If the level of one source of income –here pensions- decreases, poverty risks pertaining to the other sources of income –here earnings- will decrease, through the decreasing poverty line.

Figure 45: Lower scenario - Incidence and intensity of poverty pertaining to total income and earnings: the marginal effect of retirement benefits



Source: MIDAS Belgium - own calculations.

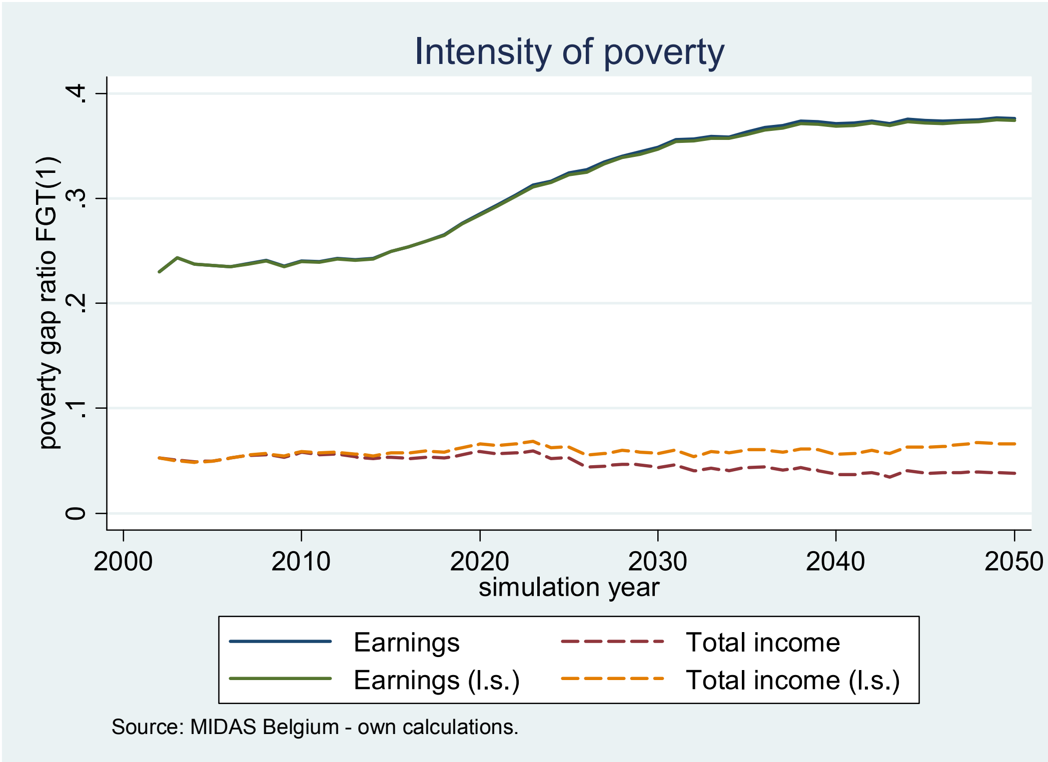
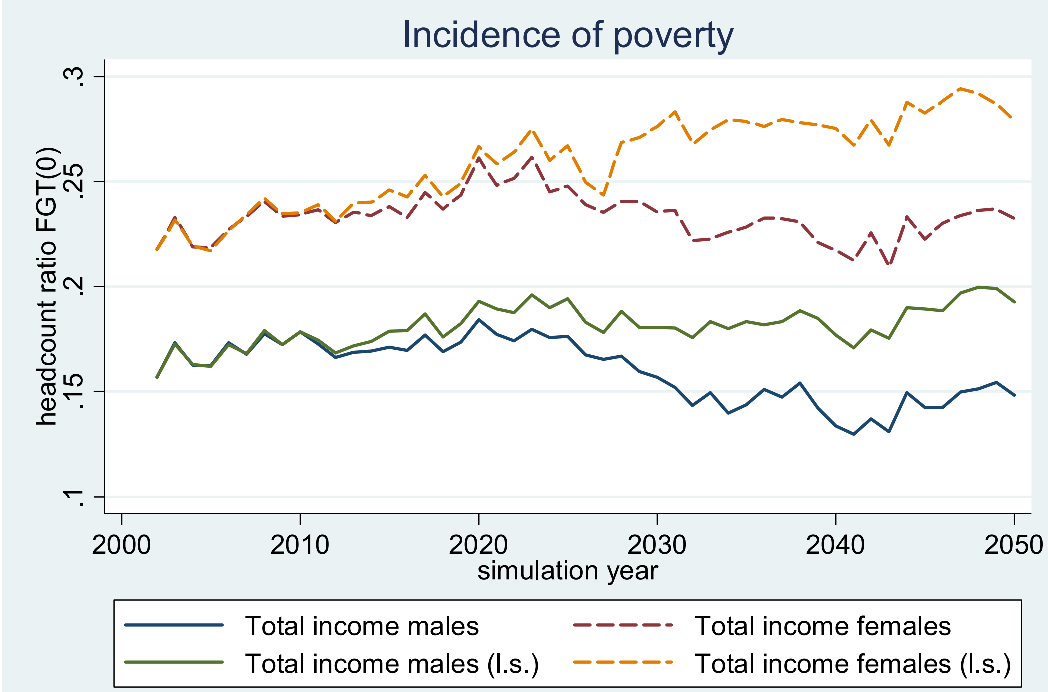
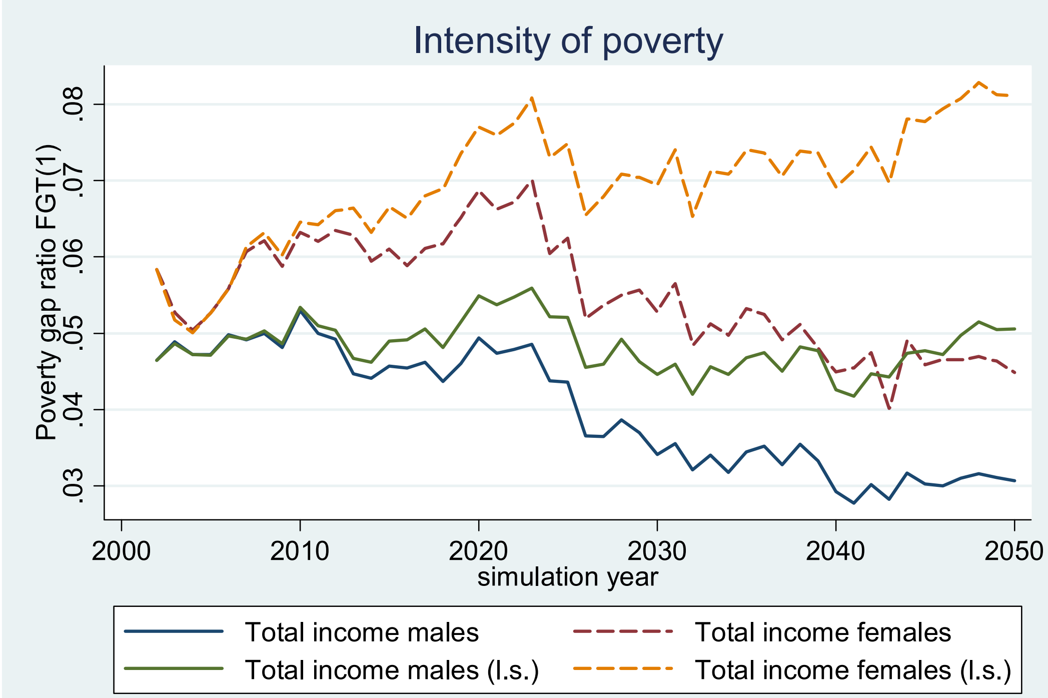


Figure 46 shows the impact of the lower variant on the poverty by gender. To keep this figure readable, it contains only the poverty rates and intensities pertaining to total incomes (i.e. earnings and pension benefits). In line with Figure 45, poverty among both male and female retirees increases when the automatic indexation is abolished. But, as it was the case concerning the inequality, retired women seem to be more heavily affected by this variant scenario than retired men. This is especially so pertaining to the intensity of poverty. This stronger effect of the "simulated reform" on retired women than retired men is probably due to the high number of women that receive a minimum pension, as outlined in the discussion of Figure 44.

Figure 46: Lower scenario - Incidence and intensity of poverty pertaining to total income to gender



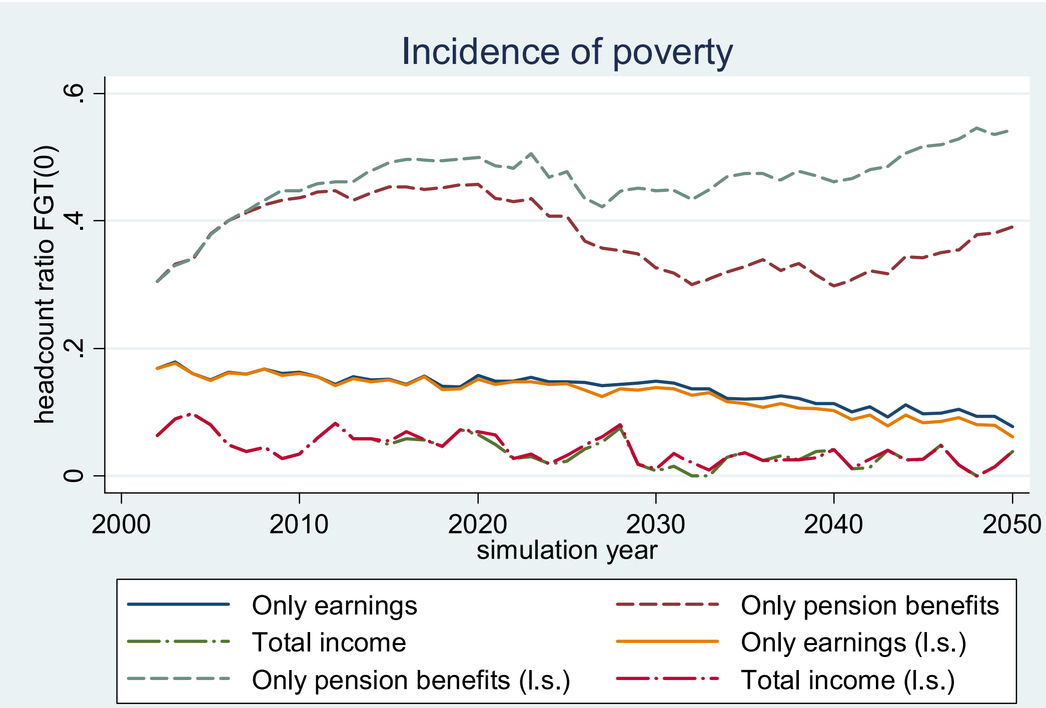
Source: MIDAS Belgium - own calculations.



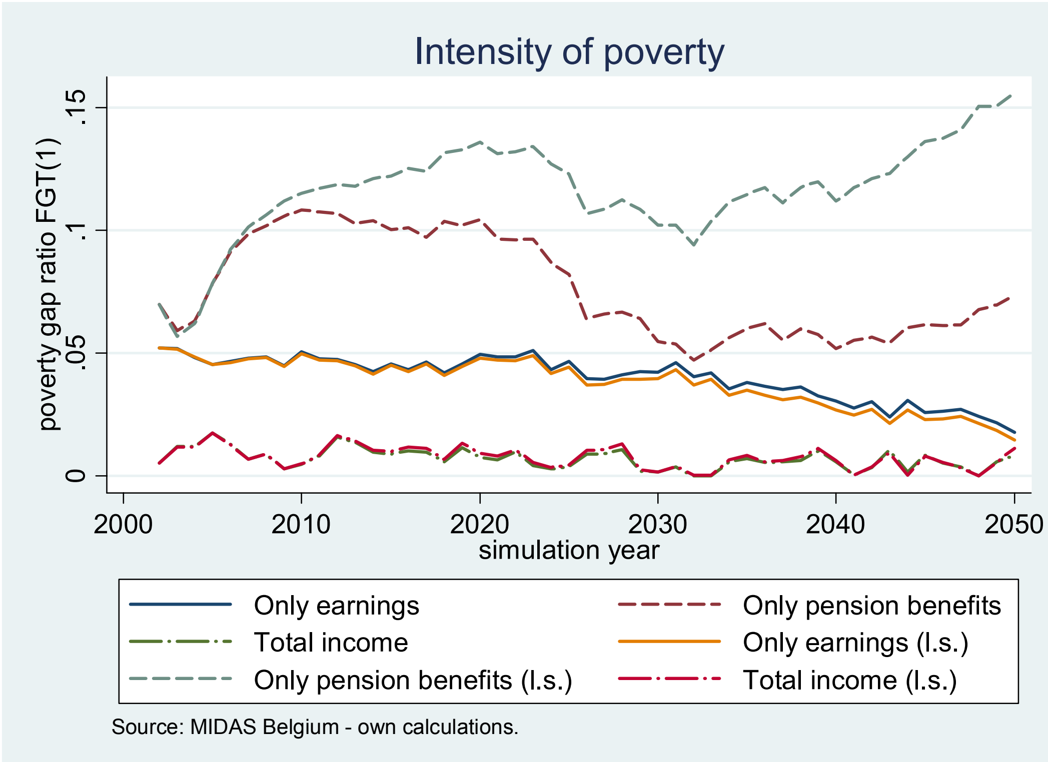
Source: MIDAS Belgium - own calculations.

Contrary to Figure 45 and Figure 46, Figure 47 isolates people that live, on one side, in pure working households and, on the other side, in pure retired households. The situation of retirees in the lower scenario obviously is the strongest because these retirees have only retirement benefits as the source of income.

Figure 47: Lower scenario - incidence and intensity of poverty pertaining to individuals from working and retired households

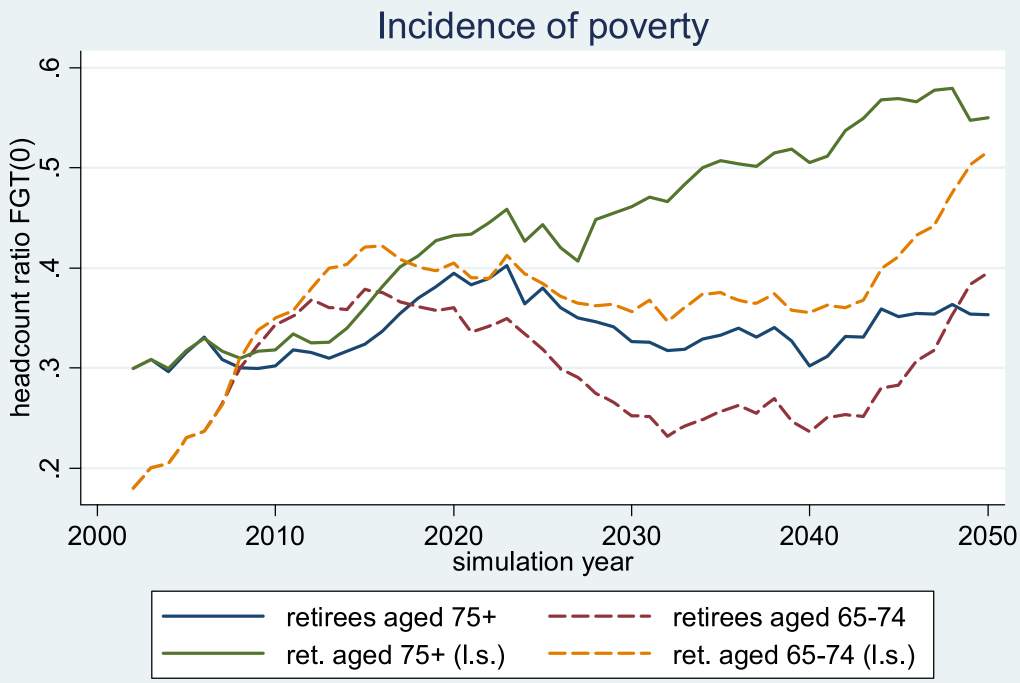


Source: MIDAS Belgium - own calculations.

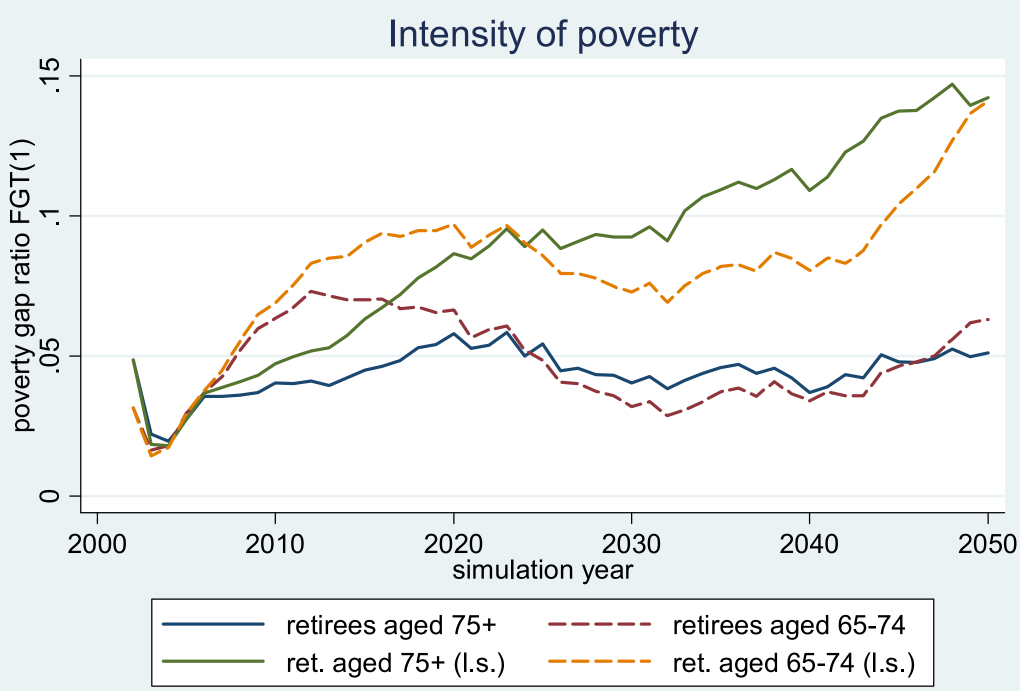


The previous Figure 42 shows that the system of automatic partial indexation of pensions to the development of wages prevents the ongoing pensions to lag behind wages as the pensioner ages. Thus, the impact of this system should obviously be more important as the retiree gets older, i.e. as the average number of years since retirement increases. It is thus relevant to discern the effect of abolishing the indexation, as done in the lower simulation scenario, to younger and older retirees. Figure 48 makes the difference between pensioners older and younger than 75 years. It immediately confirms that the effect of abolishing the automatic indexation is much more severe for older than for younger retirees. While in the base scenario the headcount ratio for retirees older than 75 varies between 30 and 40%, in the lower variant scenario it increases up to almost 60%. As to retirees younger than 75, as they are closer to their retirement date, their poverty risk increase but with a lower amplitude. The difference between the two age-categories is smaller when the intensity of poverty is considered.

Figure 48: Lower scenario - incidence and intensity of poverty pertaining to individuals older and younger than 75



Source: MIDAS Belgium - own calculations.



Source: MIDAS Belgium - own calculations.

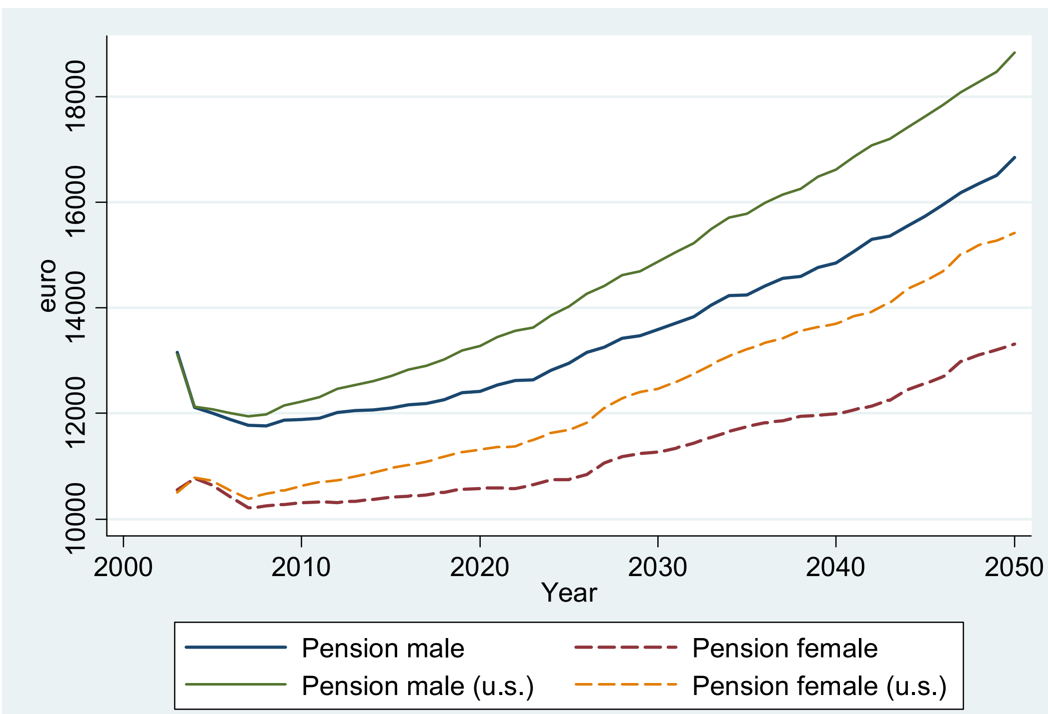
In conclusion, the introduction of the automatic welfare adjustment included in the "Solidarity Pact between Generations" has a considerable impact on the adequacy of pensions. It prevents an important increase of both poverty and income inequality among retired men and women. Furthermore, this effect is stronger for women pensioners, for those depending fully on retirement income and for older pensioners.

b. The "upper scenario"

Here again, as it was the case for the first variant scenario, the results will be presented by comparing figures of the base scenario with the same figures produced for this variant scenario. Remember that this second variant assumes a complete welfare adjustment. Benefits are fully indexed on wages, and wage-earners in this respect are treated exactly like civil servants. It may come as no surprise that the effects of this full indexation are generally the opposite than those described in the previous section.

Figure 49 show the impact of this variant scenario on the average level of wage earners' retirement benefits. As we can see, the full linkage between benefits and wages has a large impact on the level of benefits.

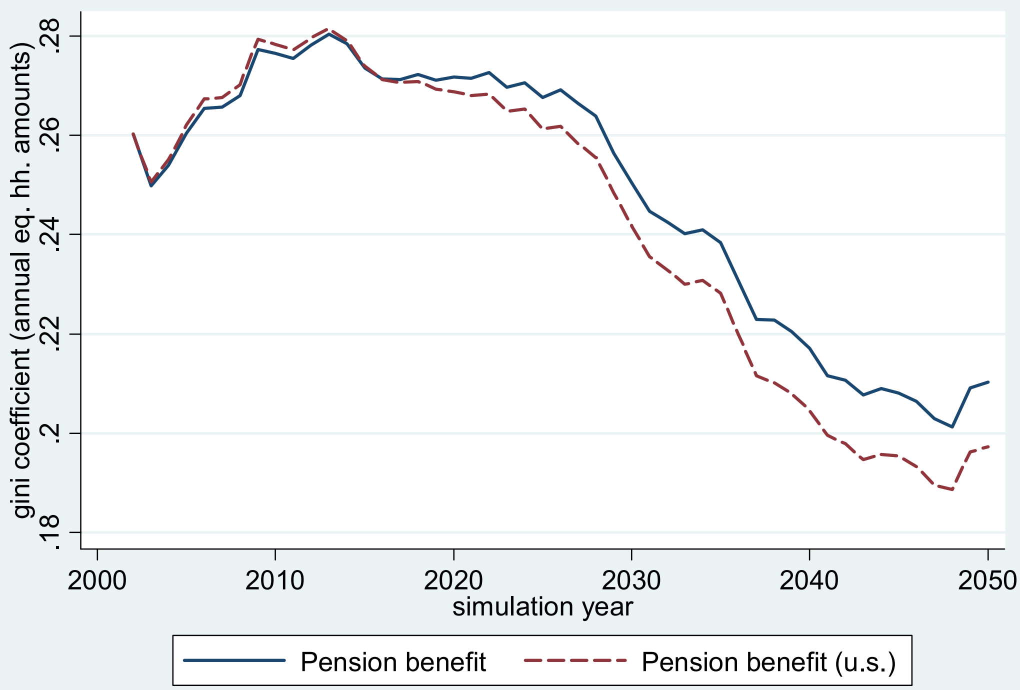
Figure 49: Upper scenario - Simulated retirement benefits for wage earners with pure career



Source: MIDAS Belgium - own calculations

As a result of introducing a full linkage between wages and benefits from the employees' pension system, the inequality of equivalent household incomes obviously decreases. The reason is the inverse as outlined in the discussion of Figure 43. In this case, all pension benefit recipients benefit from the growth of wages, and the gap between new retirees and old ones does not increase over time. As a consequence, the inequality between retirees declines relative to the base scenario. This is confirmed by the simulation results in Figure 50.

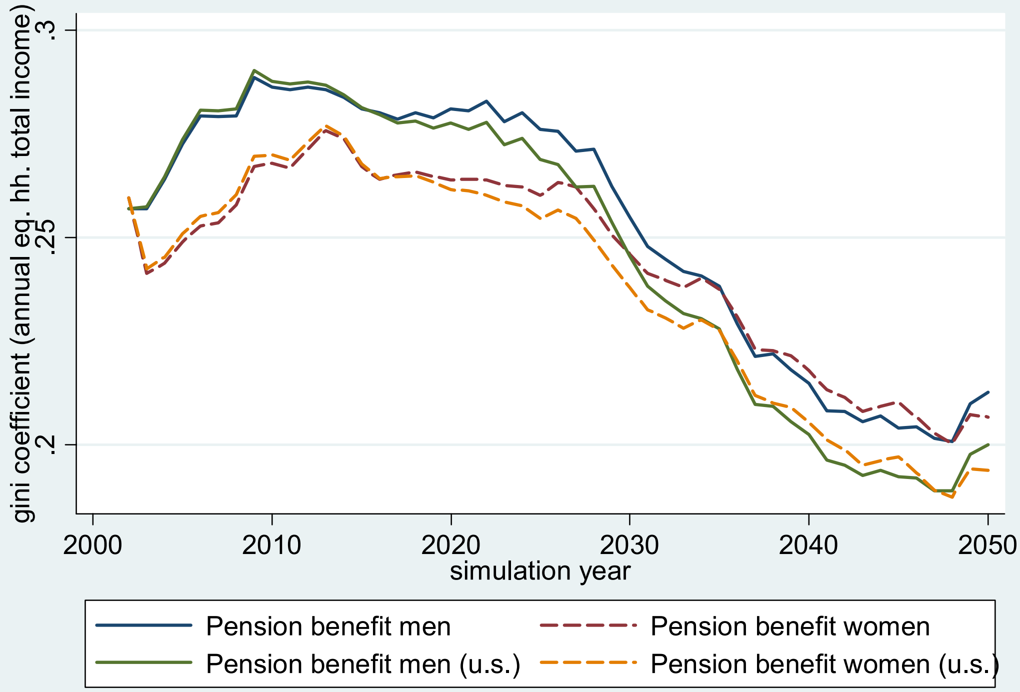
Figure 50: Upper scenario - Inequality of retirement benefits: Gini



Source: MIDAS Belgium - own calculations.

Inequality differentiated by gender (Figure 51) does not seem to be influenced by the upper scenario. The inequality of retired men and retired women stay as close each other as in the base case scenario. In the case of the lower scenario, the stronger effect for women was through the impact of the minimum pension and the minimum right by career year. Contrary to the lower scenario, these minimum pension mechanisms now perform with the same strength as the increase of benefits, and the difference between women and men pertaining to the effect of the full indexation of pensions is therefore limited.

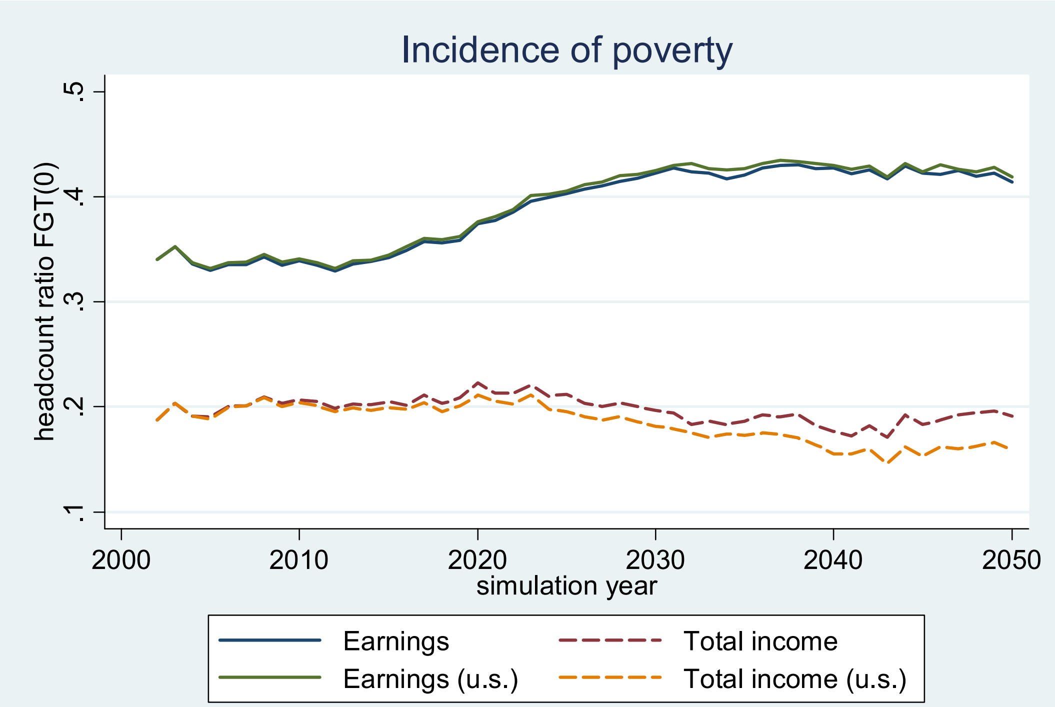
Figure 51: Upper scenario - Inequality of retirement benefits: Gini to gender



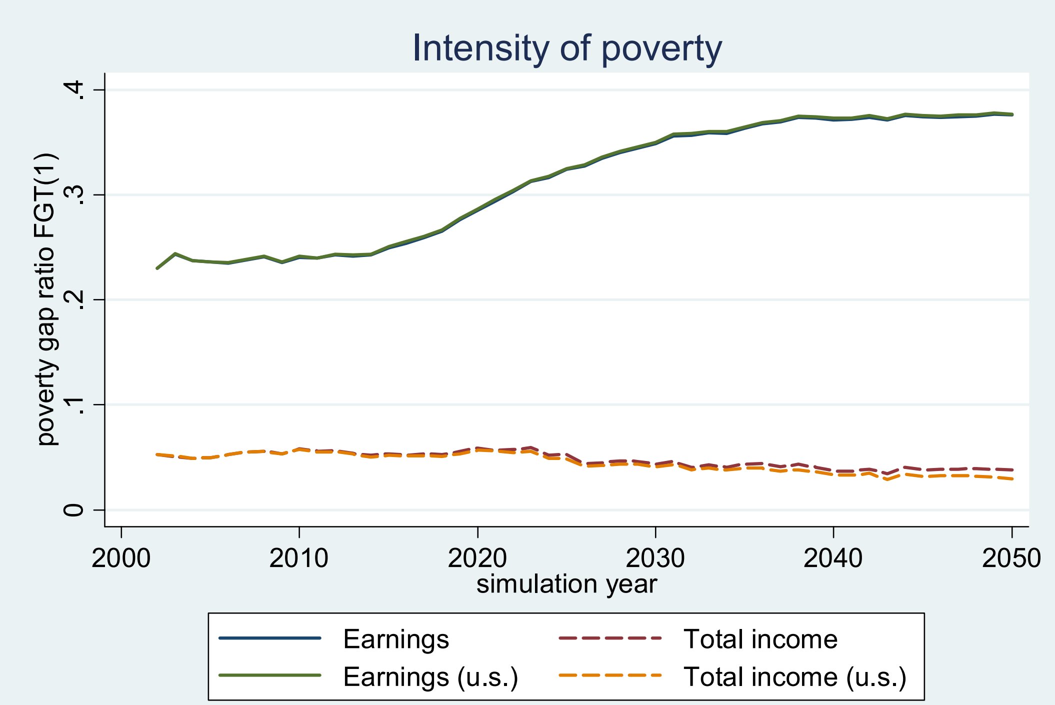
Source: MIDAS Belgium - own calculations.

Figure 52 shows the effect of introducing full indexation of benefits to wages on the risk and intensity of poverty. It is not surprising that poverty decreases, as the pension benefits increase (see Figure 49). The reason for the effect of this upper scenario being smaller than that of the lower scenario, both compared to the base scenario, is simply that the base scenario already contains a partial indexation of benefits to wages. The difference between the lower and base scenario (no indexation versus partial indexation) seems more important than the difference between the upper and the base scenario (full indexation versus partial indexation).

Figure 52: Upper scenario - Incidence and intensity of poverty pertaining to total income and earnings: the marginal effect of retirement benefits



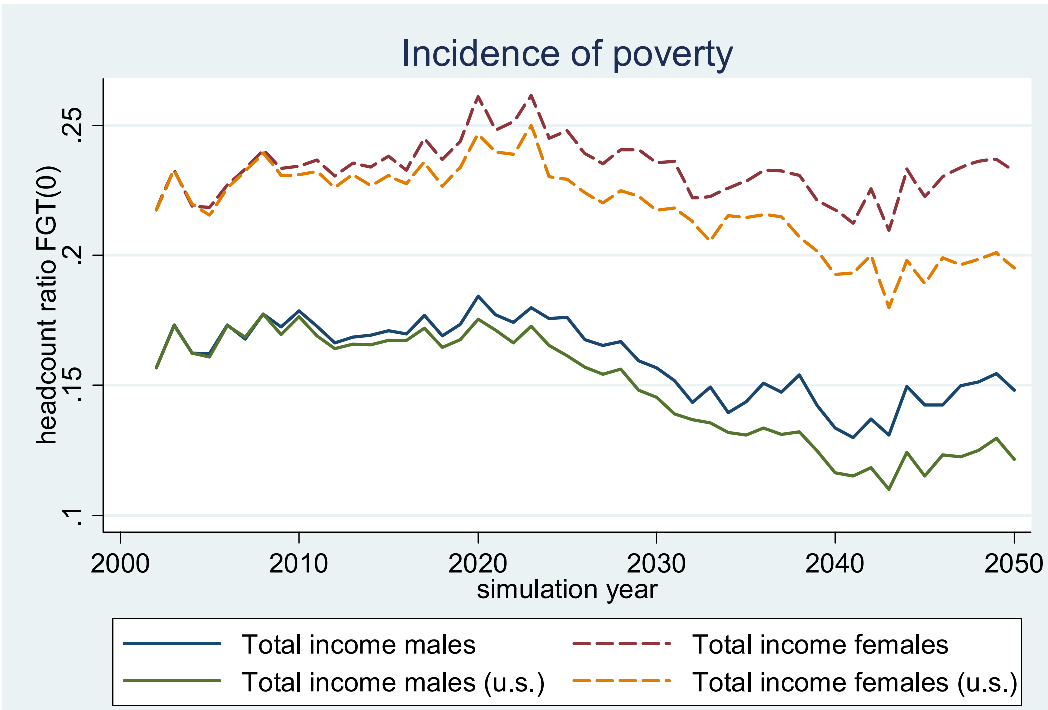
Source: MIDAS Belgium - own calculations.



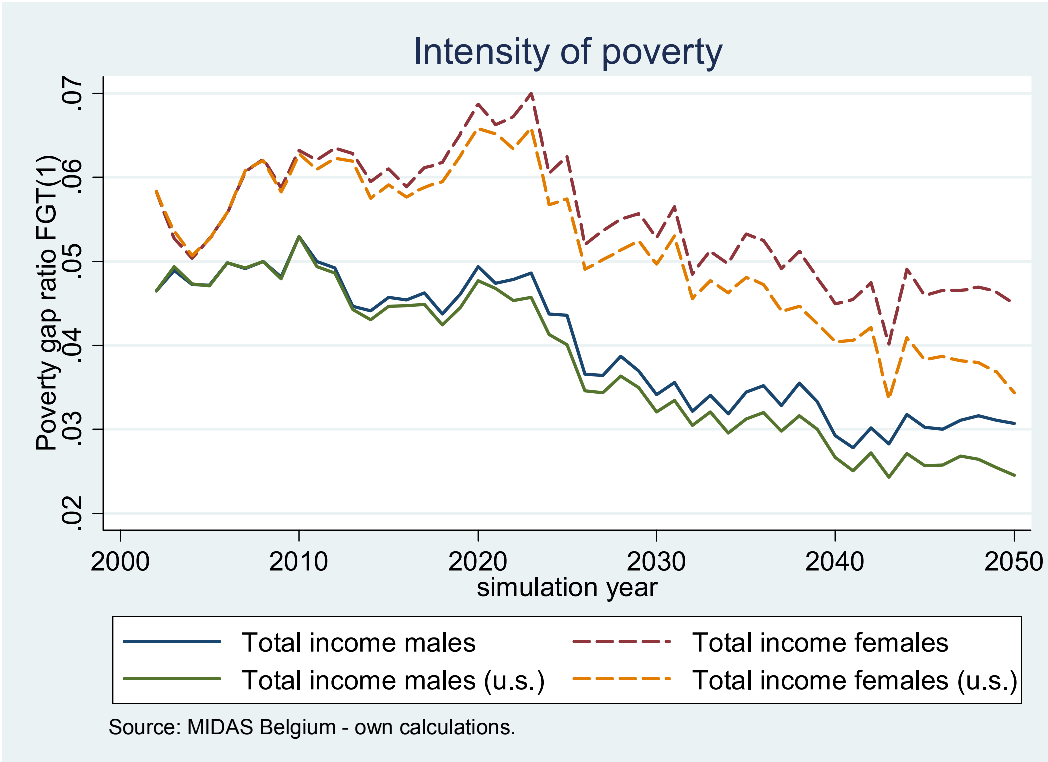
Source: MIDAS Belgium - own calculations.

As it was the case with inequality, the effect of introducing a full indexation in the upper scenario on the risk and intensity of men and women is comparable. This is shown in Figure 53 here below.

Figure 53: Upper scenario - incidence and intensity of poverty pertaining to total income to gender



Source: MIDAS Belgium - own calculations.

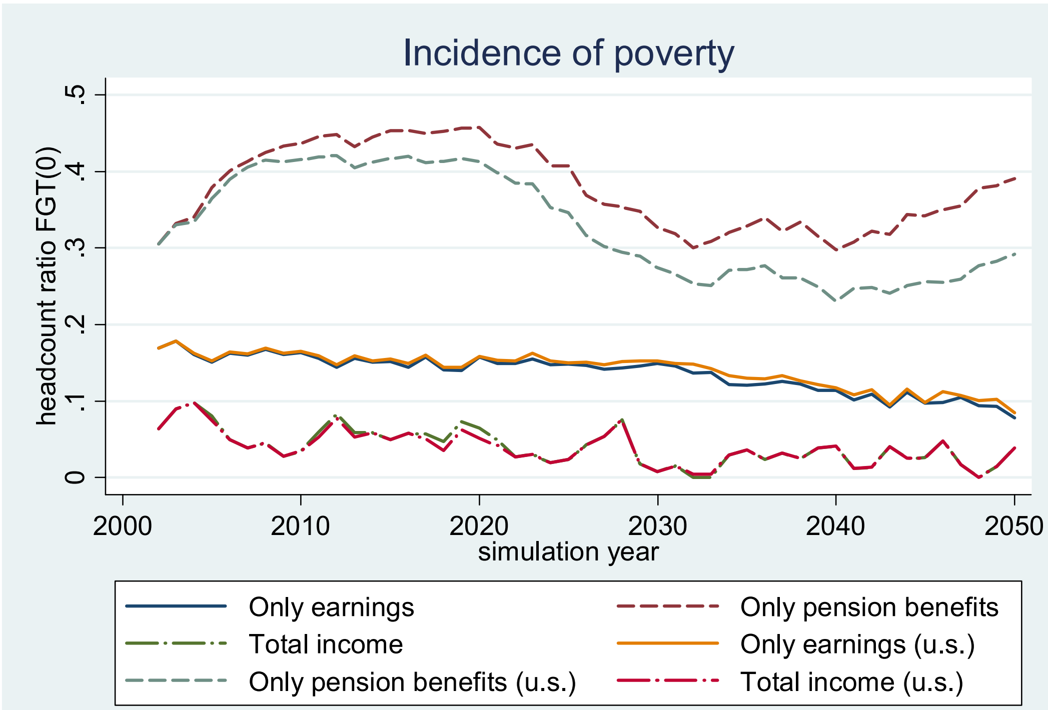


Source: MIDAS Belgium - own calculations.

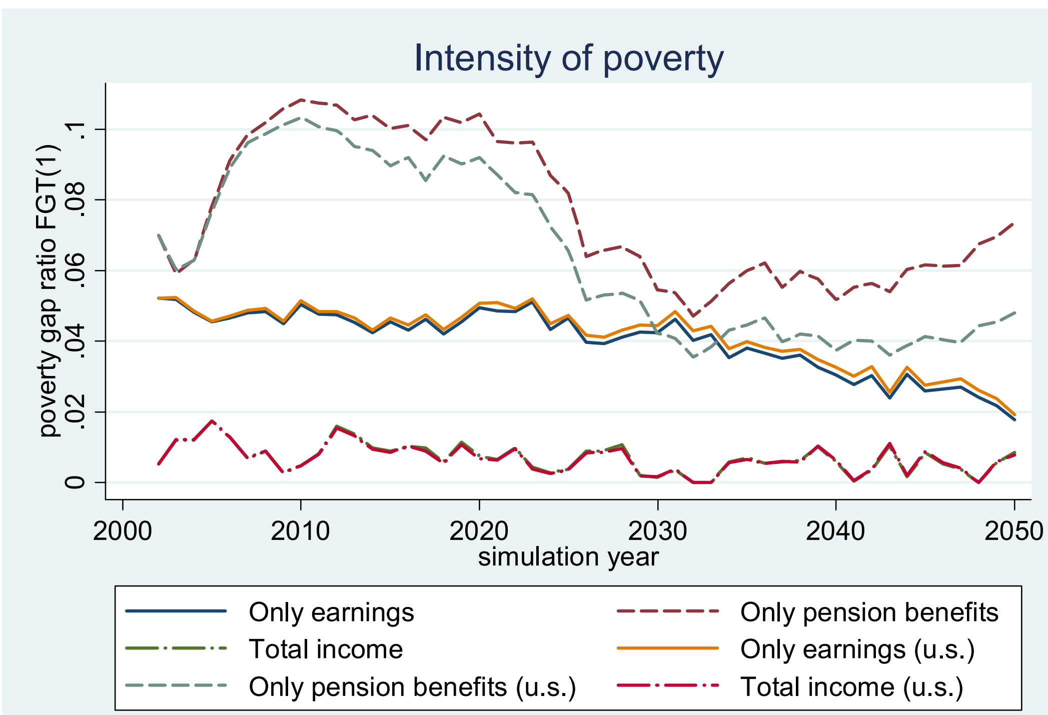
As already mentioned here above and as it was expected, the poverty of those who receive only retirement benefits is slightly lower under the upper scenario than under the base case scenario. More surprisingly is the slight increase of the poverty of those who receive only earnings. This slight increase at the end of the simulation period is probably due to the rise of the poverty line that is a consequence of higher levels of retirement benefits.

Figure 54 discerns individuals living in retired, working or mixed households.

Figure 54: Upper scenario - Incidence and intensity of poverty pertaining to individuals from working and retired households



Source: MIDAS Belgium - own calculations.

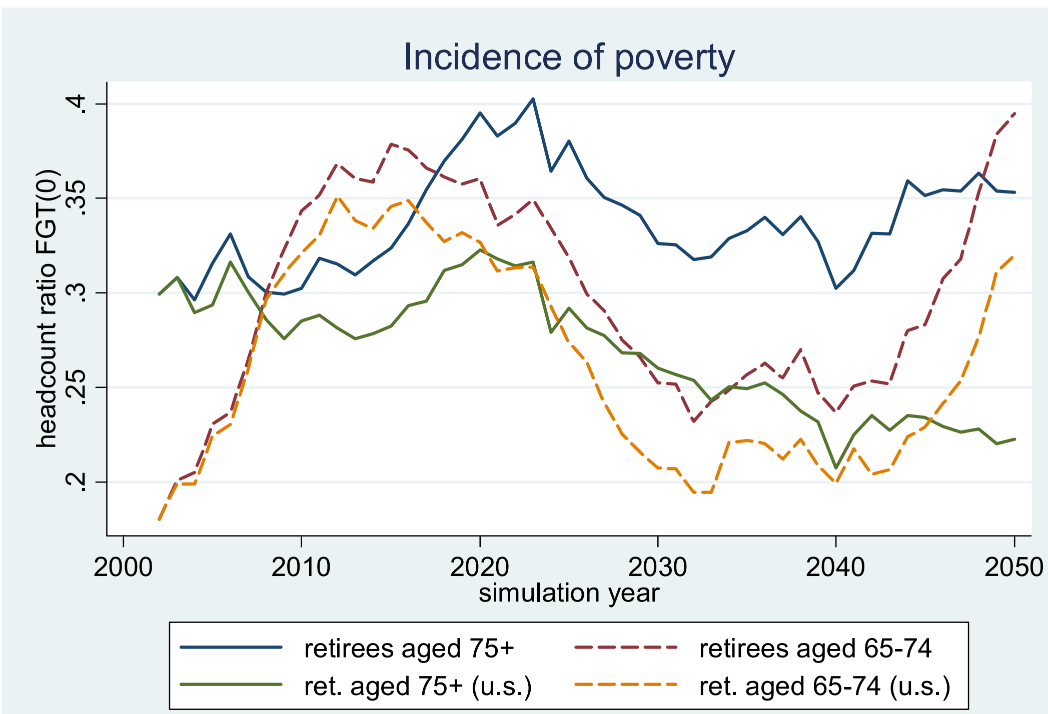


Source: MIDAS Belgium - own calculations.

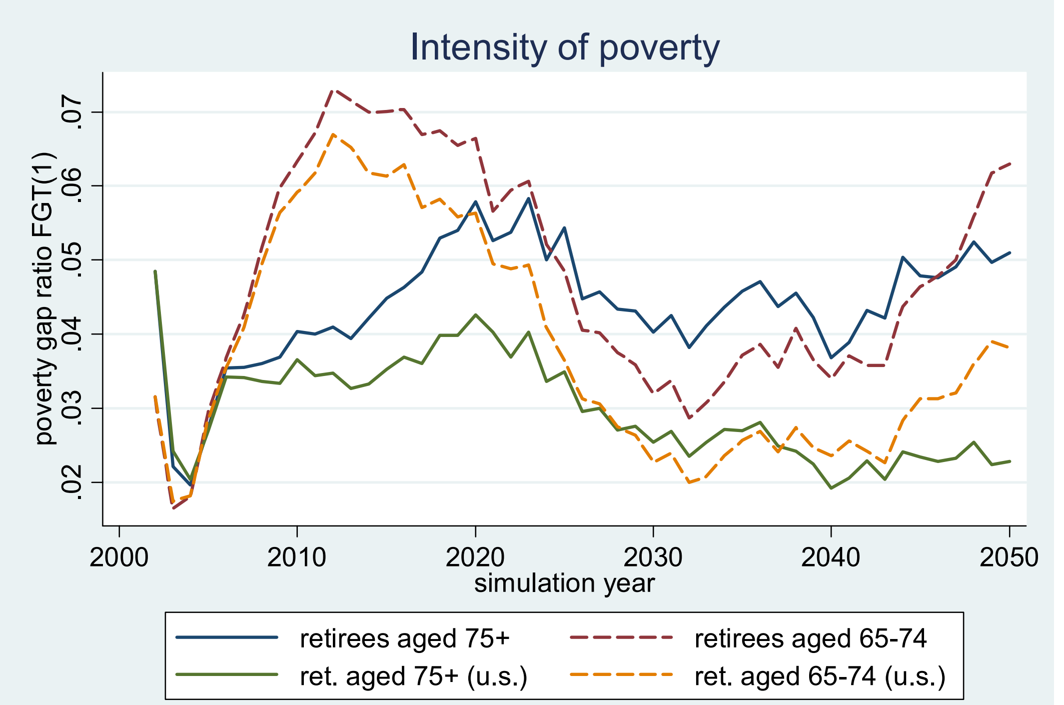
Again and in line with the conclusion from Figure 47, the impact of the upper scenario is the strongest for those living in households that receive only pension benefits. For the other categories, the effect on the risk of poverty is negligible. Only is there a small increasing effect on the intensity of poverty for individuals living in mixed households, and this is due to a small increase of the poverty line. That this 'secondary effect' does not affect working households, is simply because the poverty rate of this last category is so low that there are very few left whose intensity of poverty can change.

Finally, Figure 55 shows the impact of the upper scenario on the incidence and intensity of poverty to age category. For both individuals older and younger than 75, poverty risk and intensity decrease under the upper variant scenario than under the base scenario. In opposition to Figure 48, Figure 55 shows a much stronger effect of the simulation scenario on the incidence and intensity of poverty of older retirees relative to younger retirees.

Figure 55: Upper scenario - Incidence and intensity of poverty pertaining to individuals older and younger than 75



Source: MIDAS Belgium - own calculations.



Source: MIDAS Belgium - own calculations.

In conclusion, the upper scenario produces expected results. The inequality and the poverty among pensioners decrease. This impact is particularly important at the end of the simulation period and on oldest retirees. Compared to the lower scenario, however, the differences between male and female pensioners are less outspoken.

5.1.6. Conclusions

The dynamic microsimulation model MIDAS is a first attempt to acknowledge the obvious fact that the assessment of sustainability of pensions in the light of ageing cannot be done without considering the consequences on adequacy as well. The model is jointly being developed for Belgium, Germany and Italy and aims to 'translate' the demographic and labour market projections and macroeconomic assumptions of the Ageing Working Group AWG into indicators of the adequacy of pensions, including poverty and income inequality.

The above sections presented and discussed the simulation results for Belgium. Even though conclusions should be put into perspective with some technical limitations of the model, the simulation results pertaining to the adequacy of pensions show that the replacement rate will gradually decrease until the beginning of the 2030's, after which it will recover somewhat. This development can be explained by the AWG-growth rates of productivity that steer the development of wages, and by the decreasing proportion of households that benefit from the so-called "household rate" pension benefit. The redistributive effect of pensions (measured by comparing the inequality of earnings with that of pension benefits) will gain strength from the late 2020's on. This is partially the consequence of technical characteristics of the model, but for the largest part caused by the social policy hypothesis of the AWG. The assumed linkage between benefits and wages in the simulation period is more generous than in the past. The difference between older and younger pensioners hence decreases over time, and so does therefore inequality among their pensions. The poverty reducing force of pensions will increase in Belgium, especially from the early 2020's on. This will be because of the increasing number of pension benefit recipients, the increasing redistributive element in the Belgian pension system, and because the decreasing poverty risk pertaining to pensioners. Indeed, the risk and intensity among those receiving pensions alone starts off considerably higher compared to those living in households receiving earnings. Poverty risk and intensity then decreases from the early 2020's on, reaches a minimum in the early 2030's and then increases again.

5.2. Germany

Hermann Buslei, Johannes Geyer

The question this section tries to answer is whether or to what extent the level of old age income of future retirees can be maintained by public pensions. The level of future pensions will be determined by demographic ageing, changes in labour market participation and labour market outcomes, and the changes in the current public pension scheme. Each of these topics will be discussed in turn.

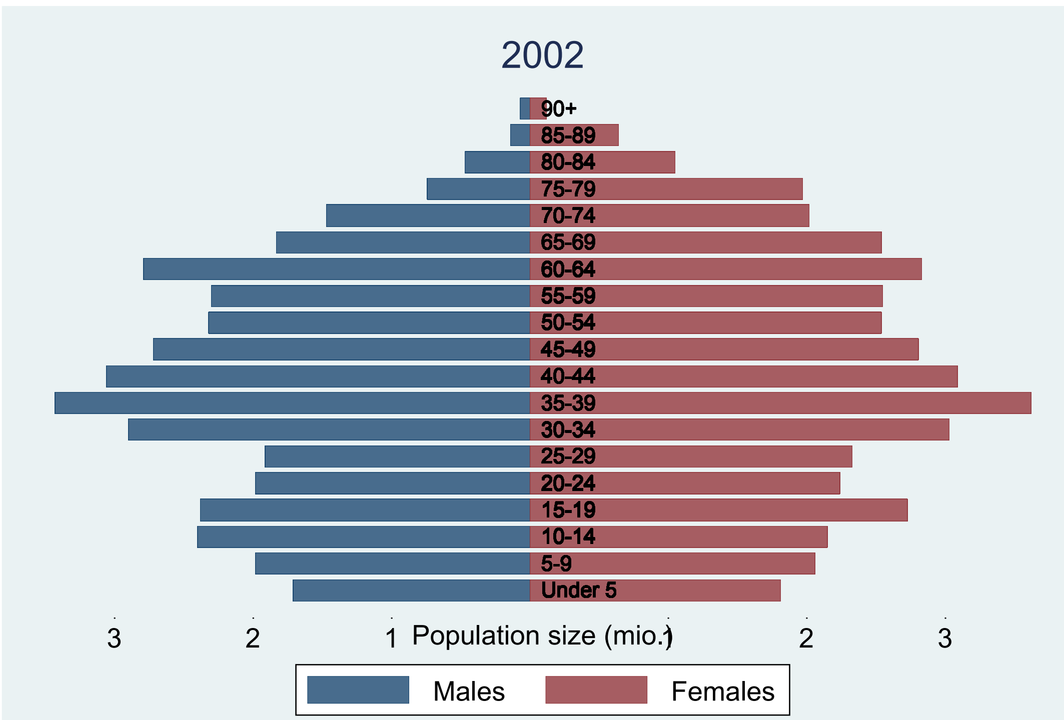
At first, section 5.2.1 illustrates simulation outcomes of the demographic module. Thereafter, the labour market outcomes are presented. The next subsection presents the results of the pension simulations. The section finally presents inequality and poverty indicators with different possible policy variants.

5.2.1. Demographics

The most fundamental processes in MIDAS are birth and death. Both events are fully driven by the alignment which reflects the demographic projections of the AWG. The ratio between men and women remains fairly constant over time. The population consists of about 52% women and 48% men throughout the simulated period.

Due to low fertility rates Germany will experience rapid demographic ageing in the 21st century. This will lead to a shrinking population[37] and is of great importance for the interpretation of simulation outcomes. The following Figure 56 shows this development in the simulated German population. The first graph shows the composition of non simulated data from the GSEOP[38]. The following graphs show the derived simulated population in 2020, 2035, and 2050. The German population shrinks from some 80 million people in 2002 to about 70 million in 2050.

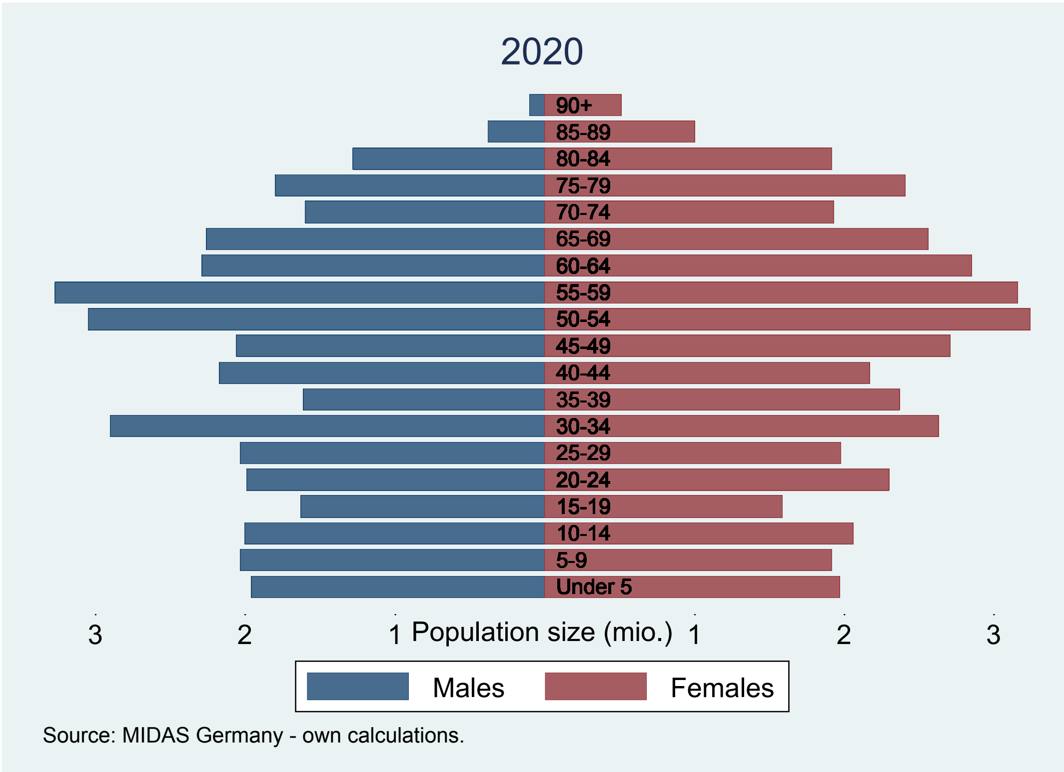
Figure 56: Males and females in age groups in selected years

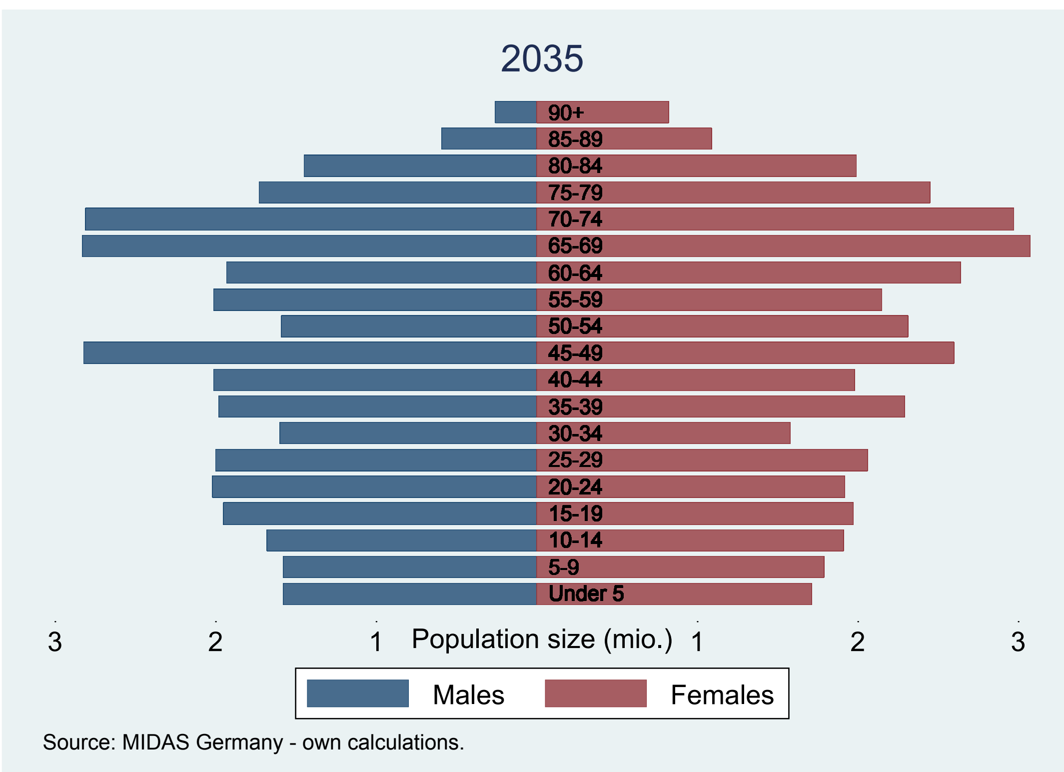


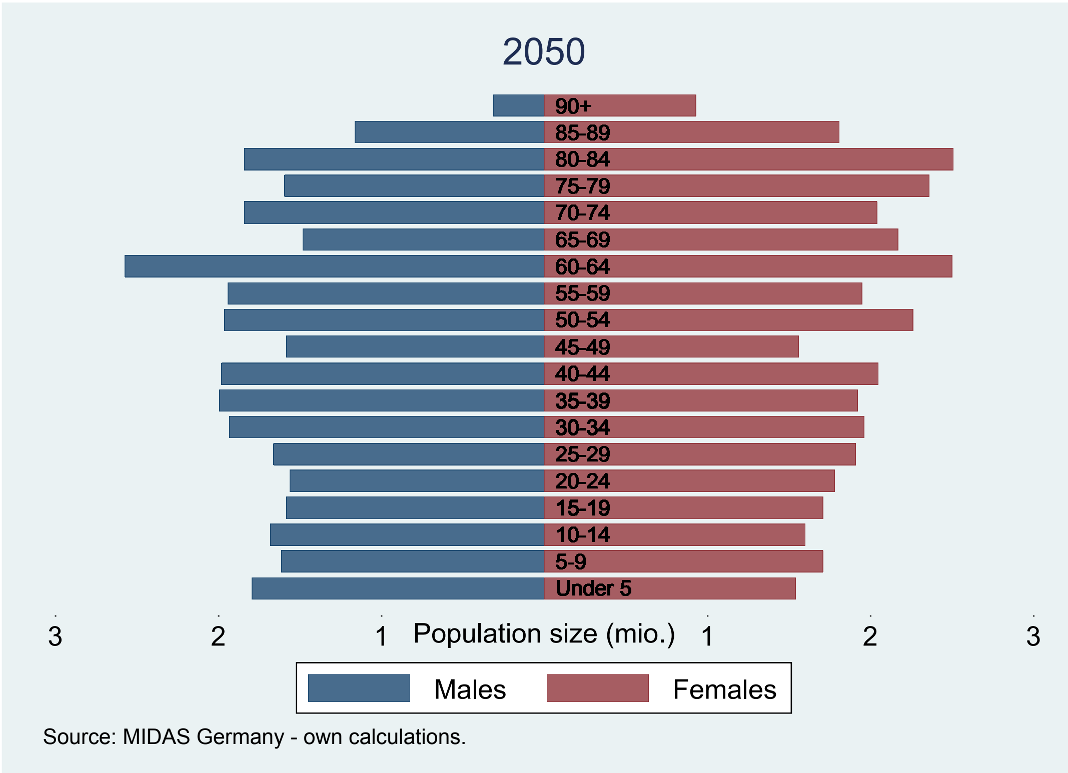
Source: MIDAS Germany - own calculations.

37 Since MIDAS does not take into account immigration the process of demographic ageing is intensified in this simulation. It is generally assumed that net migration is positive and that migrants rejuvenate the population. However, it is very unlikely that immigration will reverse the expected scenario.

38 We included if possible statistics for 2002 in order to compare simulation results with the data base.


2020
90+
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
Under 5
3 2 1 Population size (mio.) 1 2 3
Males
Females
Source: MIDAS Germany - own calculations.

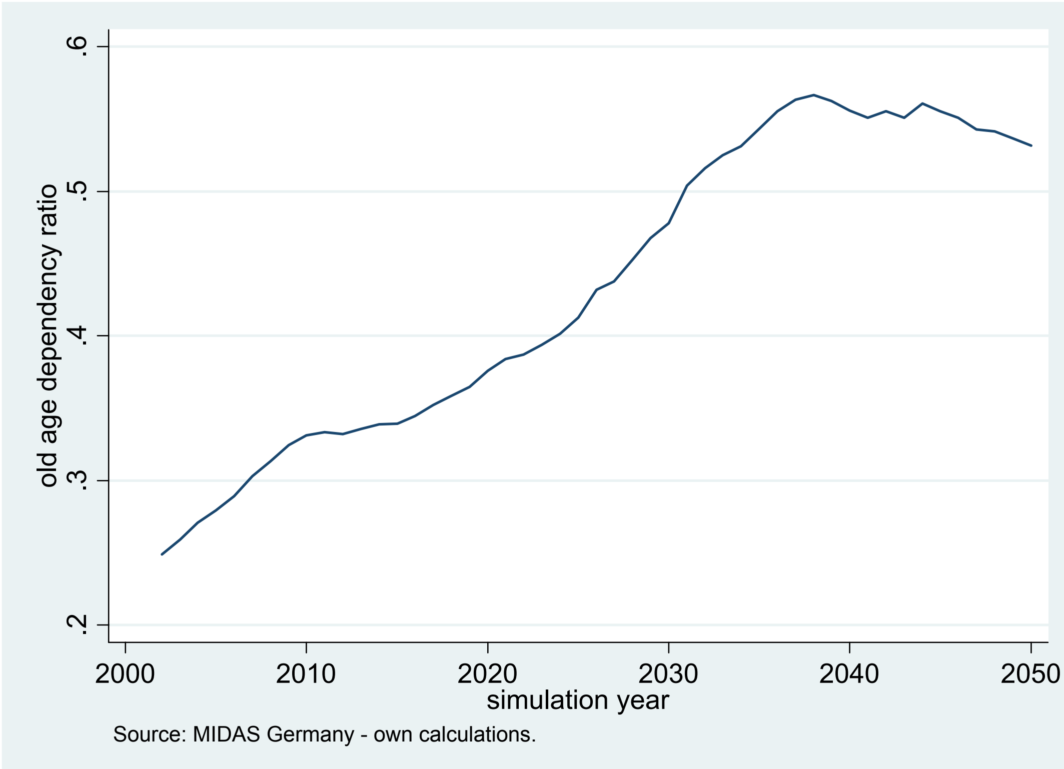

2035
90+
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
Under 5
3 2 1 Population size (mio.) 1 2 3
Males
Females
Source: MIDAS Germany - own calculations.



Furthermore, the age pyramids illustrate well how the age structure changes over time. The most striking development is the increase of the older population. The shape of the population pyramid is no longer pyramid-like and is getting flatter. This implies that age groups tend to be more equal in size in the future. For example, in 2002 we observe only a small number of persons above 90. Their share increases dramatically until the year 2050. In particular for women we observe an enormous increase of the old and very old population.

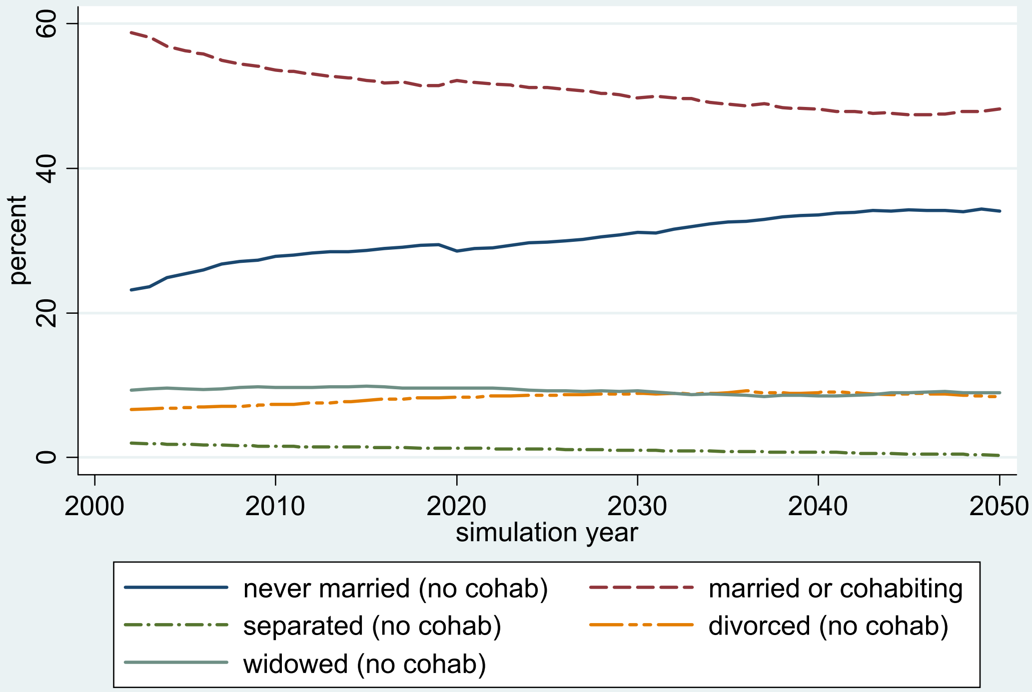
Figure 57 gives a snapshot of the implications of demographic ageing for the working age population and the pay-as-you-go pension scheme. The old age dependency ratio (expressed as the ratio of individuals older than 64 and those between 16 and 64) roughly doubles between 2003 and 2040 from about 25% to more than 50%. That simply implies that the relationship of social security recipients to social security payers will increase.

Figure 57: Old age dependency ratio [age 64+/(age 16-64)]



In contrast to the general development of the population, the behaviour on the marriage market is determined within the simulation. Here we consider the general development of marital states, marriage behaviour and household formation. Figure 58 shows the results for the general marital status. Since we simulate in addition to legal marriage consensual unions the figure depicts their combined share within marital states.

Figure 58: Proportions of marital states (age 18+)

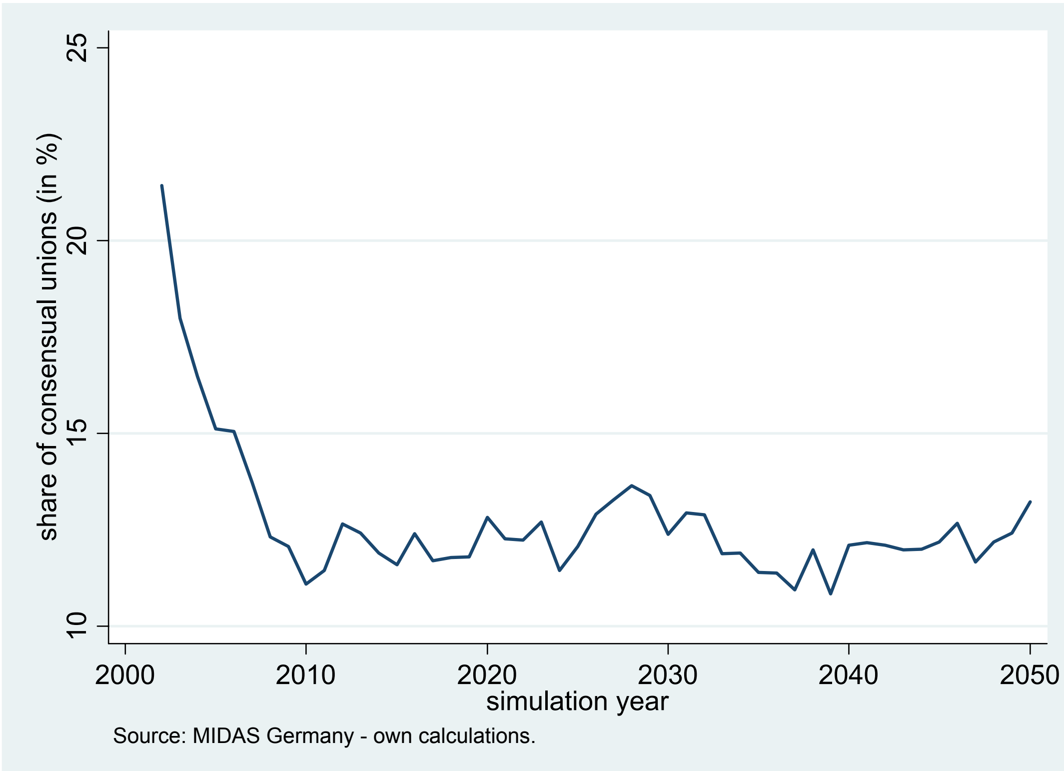


Source: MIDAS Germany - own calculations.

Figure 58 shows foremost that the largest majority of individuals older than 17 are either married or cohabiting, or are single. The proportional size of the other categories (widowed, separated, divorced) clearly are much smaller.[39] As time goes by, we see that the proportion of single individuals increases at the expense of the proportion of married or cohabiting individuals. Furthermore, within couples the share of cohabiting individuals decreases at the expense of the proportion of married individuals. This is shown in Figure 59.

[39] Interestingly, the increase in life expectancy leads to a higher share of male widowers because life expectancy of men is assumed to increases faster than that of women.

Figure 59: Share of consensual unions in partnerships

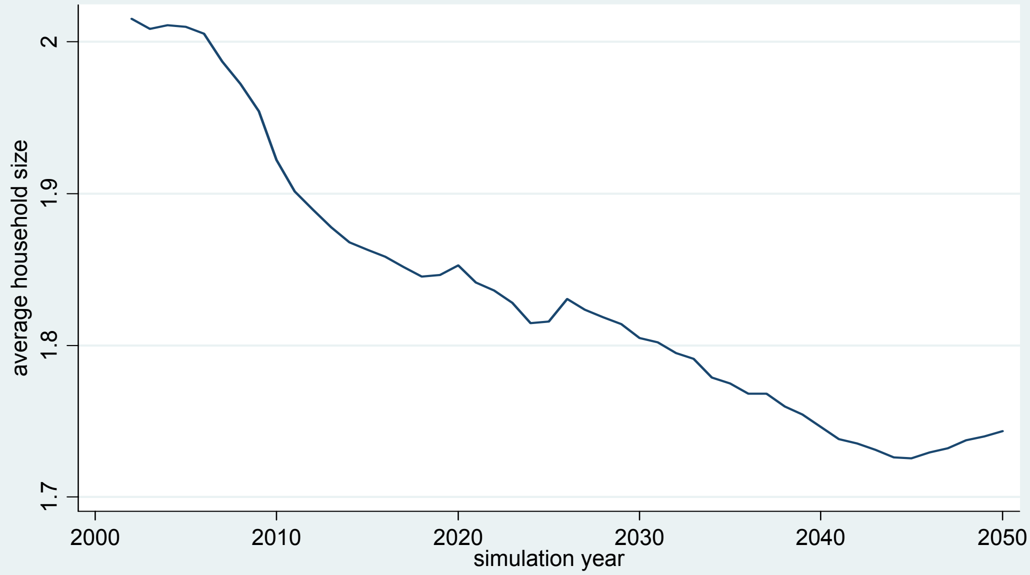


As Figure 59 shows, the proportion of consensual unions within couples decreases strongly in the first years of the simulation. After 2010 it starts to increase again and moves around 12 %.

The two aforementioned developments, demographic ageing and the decrease of couples living together, lead to a marked decrease in average household size which is shown in Figure 60. The average household had more than two individuals in 2003 which declines to less than 1.8 in 2050.[40] The main driving force behind this development is ageing as Figure 61 shows. This graph shows the average household size by age groups of their oldest member. We see that the average size declines in households whose oldest member is between 46 and 60 or between 61 and 75 respectively. The slight increase of household size in the age group of people younger than 31 does not compensate the decline. The decline in household size is associated with the decline in cohabitating couples. However, households with oldest members aged 61-75 or 75 and older have only around 1.5 or less members. Thus, the increase of age groups older than 60 is further an explanation of the decrease in average household size.

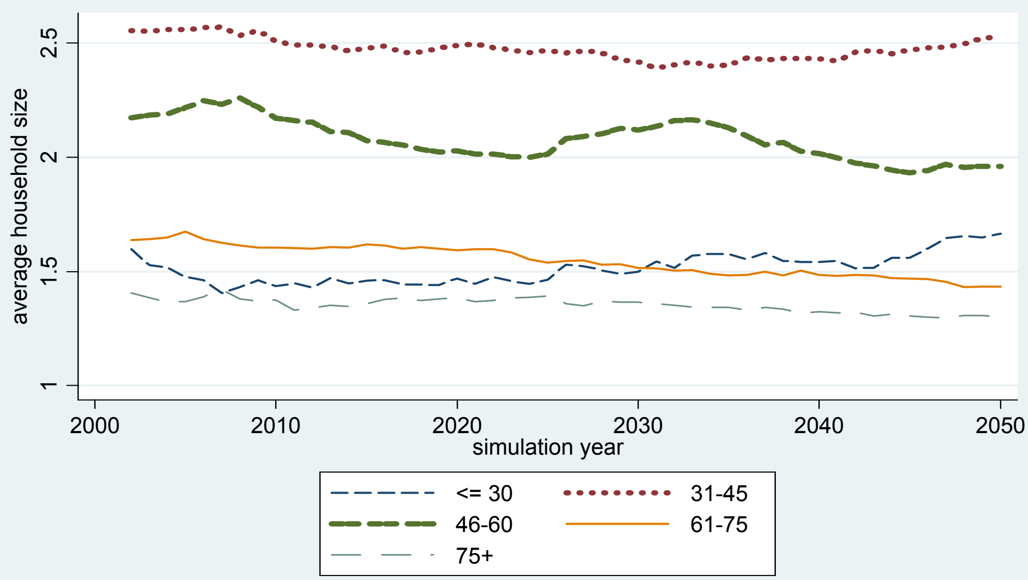
[40] In section 4.1.1. part d and section 5.1.1. it is explained that the simulation does not allow for multi-generational households. That too could account for part of the decrease. However in contrast to Belgium multi-generational households are rather an exception than the rule in Germany. Thus we do not observe a big difference between "older" original households and households which age through simulation processes.

Figure 60: Average number of individuals living in a household



Source: MIDAS Germany - own calculations.

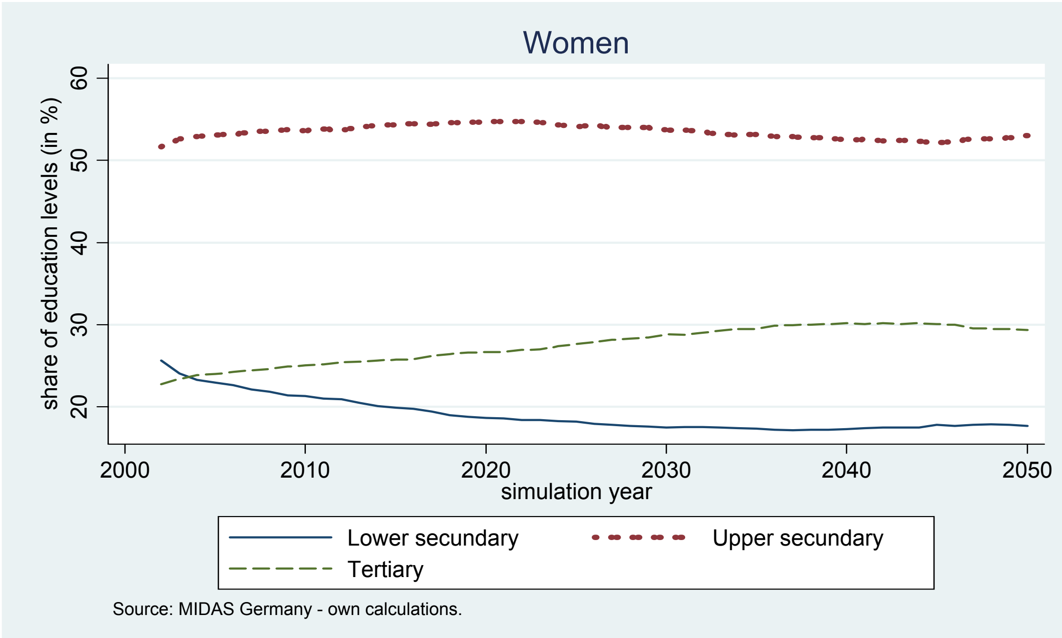
Figure 61: Average number of individuals living in a household by age groups of oldest household member

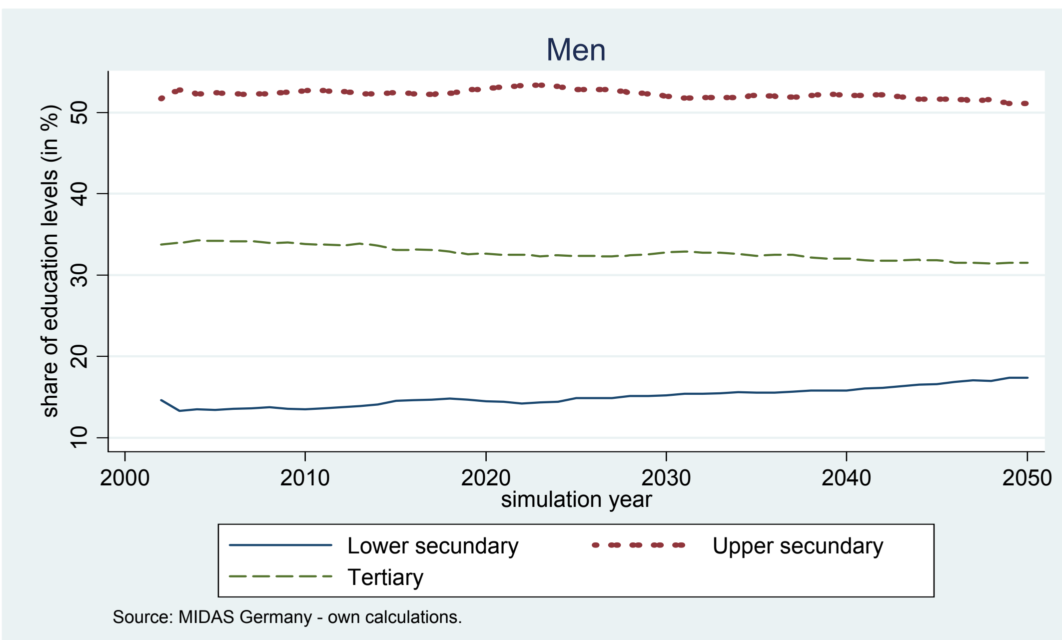


Source: MIDAS Germany - own calculations.

Next, the Figure 62 shows the composition of education attainments in the simulated population for both men and women aged 25 and older.

Figure 62: Shares of educational attainments by gender (age 25 and over)





For men the average level of education remains fairly constant. On the contrary, the average educational attainment of women increases over time.

Educational levels are assigned when the simulated individual reaches the age of 25. This age group is assumed to be representative for the simulated generations. In particular for women average education of younger cohorts has increased so we observe an increase in the simulation [41].

5.2.2. Labour market states and earnings

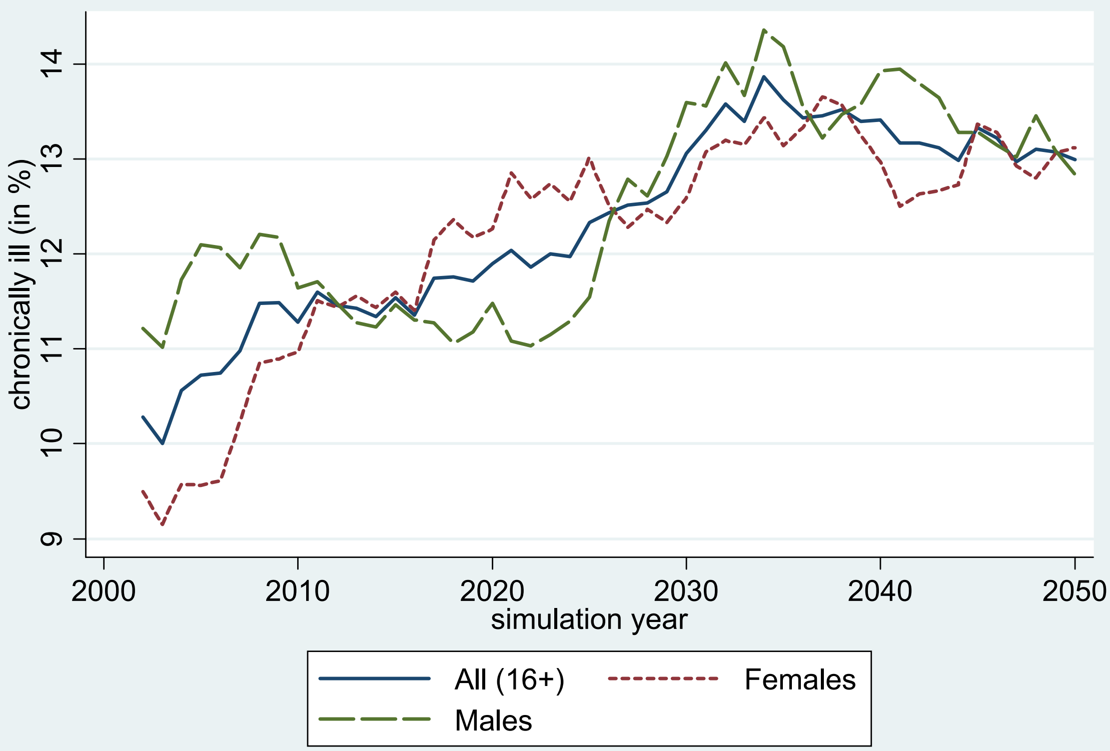
The labour market follows the general sequential logic of MIDAS, the modelling is described in section 4.2.1. At first, this section describes the development of the labour force. The focus of this analysis is dependent employment and public pensions. Self-employed and civil servants are only included in the analysis when they accumulated claims in the public pension scheme (mixed careers), private pension provision is not modelled. When we present wage income and related variables in this section we refer to a scenario without growth to isolate the simulated effects that occur due to modelling (ad hoc adjustments, e.g.) and due to behavioural changes (labour market participation, e.g.). When we compare wage income to pension benefits in the future, growth is taken into account. Finally, this section gives a brief overview of the non-employed population.

The participation decision is the first decision considered in the labour market. However, as already mentioned in the description of the behavioural equations above, we first estimate an equation to determine the general health status (being chronically ill or not). Figure 63 shows that the share of individuals (aged 16 and over) being chronically ill starts off higher for men than for women, even if this changes often during the simulation period. The overall share increases from some 10% to roughly 13% during the simulation.

However, when looking at individuals between 16 and 64 (Figure 64) we do not find a positive trend, the share of both men and women moves between 6 and 8 percent. In other words, the slight increase in the share of chronically ill individuals is caused by the increase of individuals older than 64 – with a higher risk of becoming chronically ill – in the population.

[41] For information on the transition from education into employment see section 4.1.1.d.

Figure 63: Share of persons being chronically ill (age 16+)



Source: MIDAS Germany - own calculations.

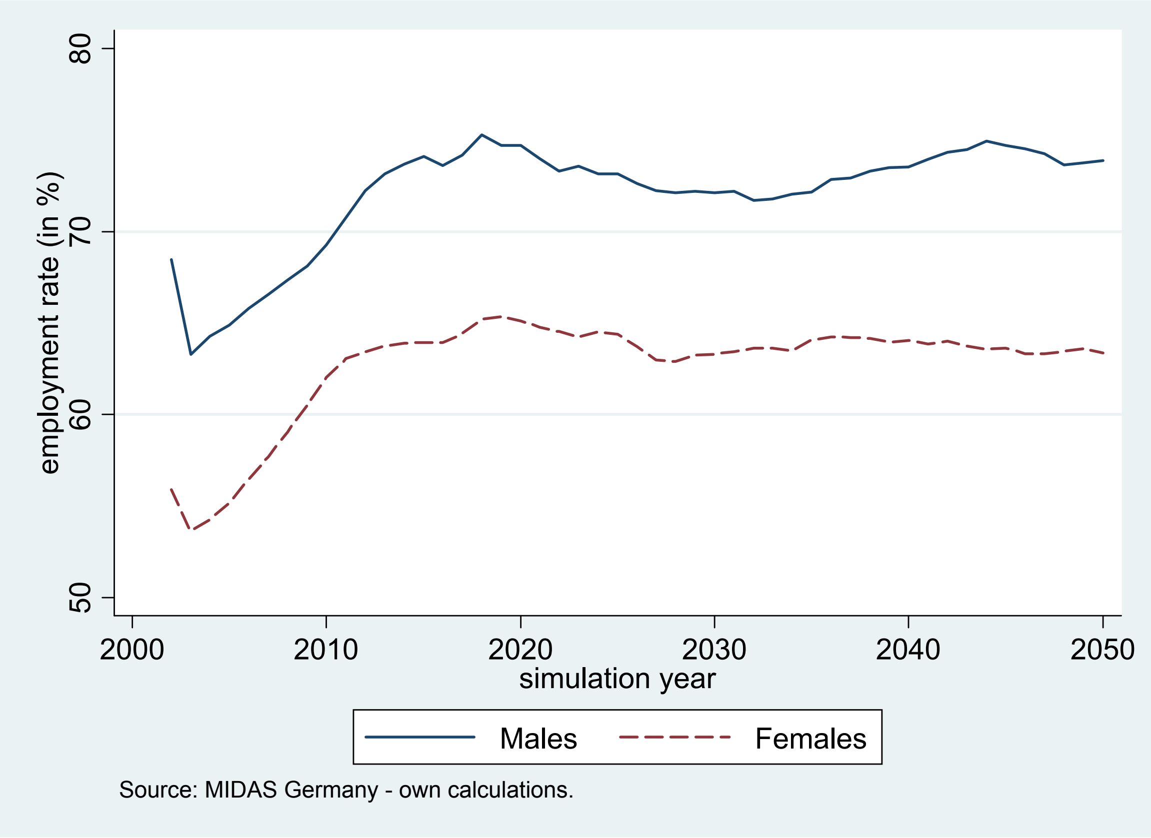
Figure 64: Share of persons being chronically ill (age 16-64)

Source: MIDAS Germany - own calculations.

The central assumption of the labour market module in MIDAS is that it adopts the AWG projections to align the employment rates (i.e. the employment status). This alignment leads to a strong ad-hoc adjustment during the first simulated year which can be seen in Figure 65. The calculated employment rates in 2002 (SOEP) do not match exactly those of the AWG. In the subsample of the SOEP used as the starting data base for the simulations, an average employment rate of 68% for men and 56% for women is found. This declines to roughly 63% for men and 54% for women in the year 2003.

The following increase in employment rates of both men and women between the year 2003 until about 2020 is a result of the assumptions made by AWG.

Figure 65: Employment rates by gender (age 16 – 64)

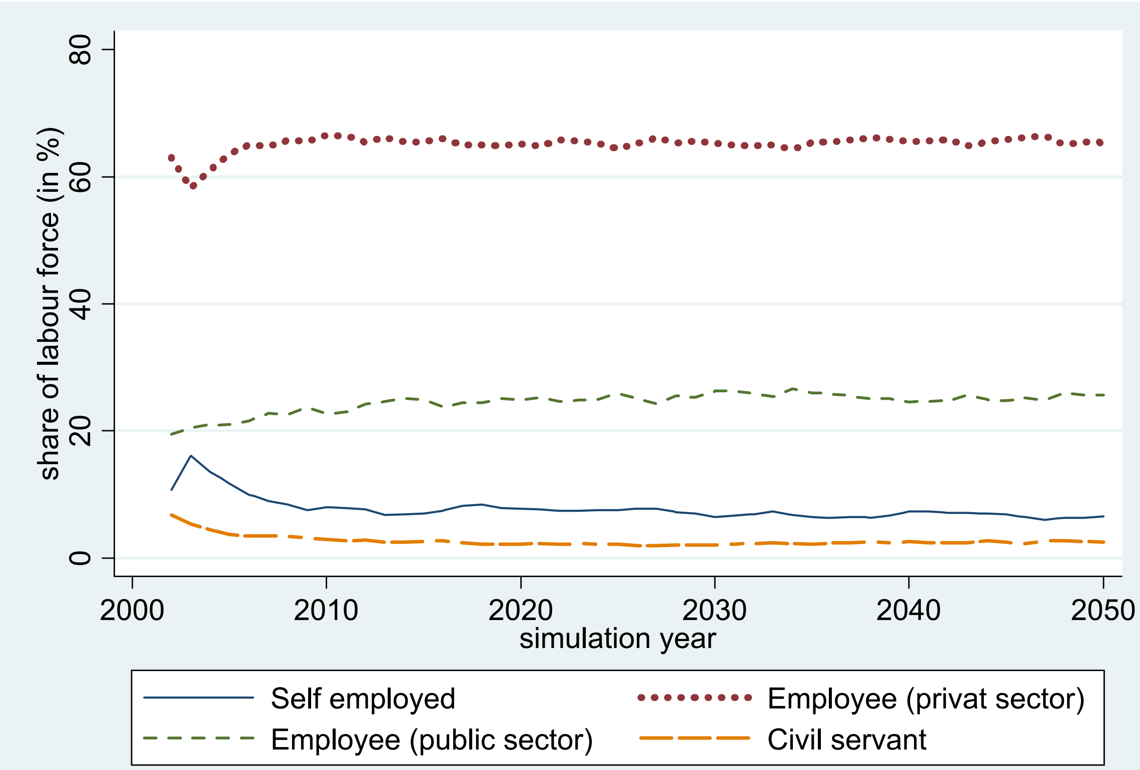


As described before (section 4) the employment status is distinguished between working self-employed or as an employee; and if working as an employee, whether the person works in the private or public sector and whether she is a civil servant. Figure 66 shows the shares of the respective states within the working population until 2050.[42]

The shares of different employment categories develop relatively even. The only exception is the state of self employment and employees in the private sector during the first years of the simulation. We observe an ad hoc adjustment: Within the employed population about 11% were self employed in 2002. This figure increases to about 18% in 2003. Then it starts to decline and converges to a level of about 9%. This deviance is caused by the alignment to AWG projections and the ad hoc adjustment of the employment status in 2003.

42 Note that self-employment is modelled as a residual state: all persons in work who are not employees work as self-employed by definition.

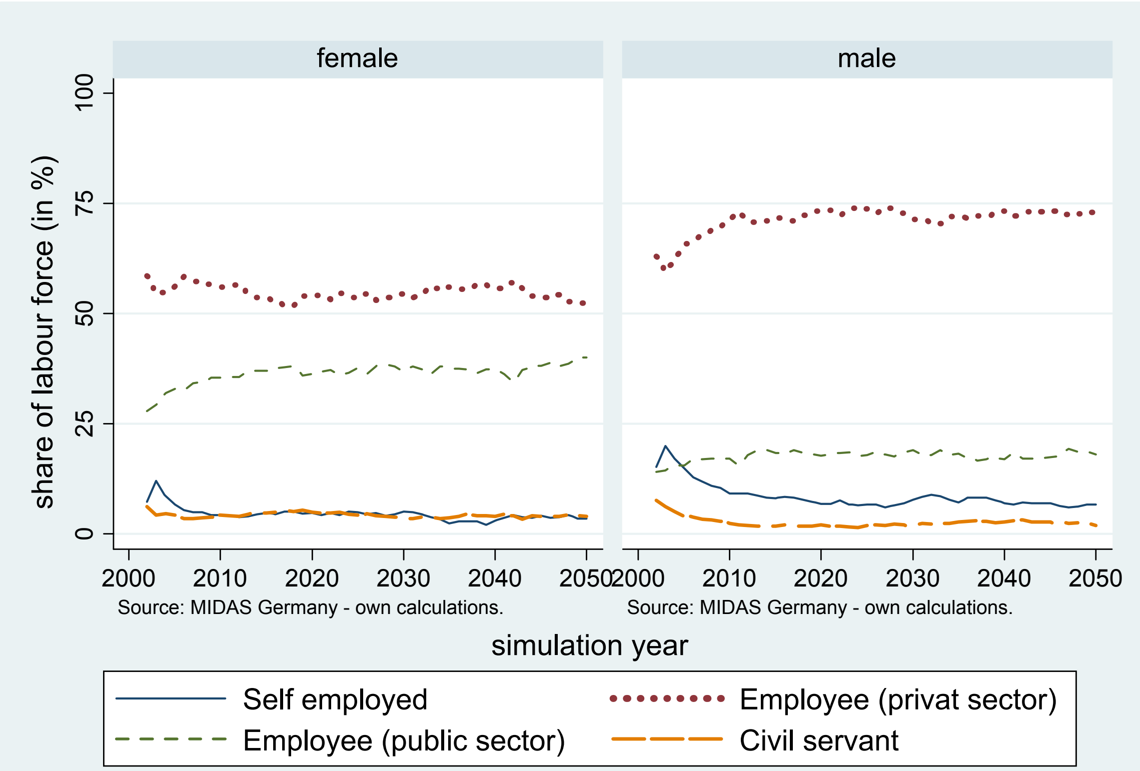
Figure 66: Share of labour market activity types within the working population (age 16 – 64)



Source: MIDAS Germany - own calculations.

Figure 67 shows the same statistics stratified by gender. This graph clearly shows that the above mentioned development is not gender specific. The increase in self employment and the decrease of the share of private sector employees is equally observed for women and for men. However, Figure 67 illustrates also another development, the increase of public sector employees among women. Figure 66 already shows that the share of public sector employees increases and Figure 67 clarifies that this is due to an increase of female employees in the public sector. The overall increase is only 2 percent, from 26 to 28 percent, but for working women this share rises from 31 to 38 percent.

Figure 67: Share of labour market activity types within the working population, by gender (age 16 – 64)



Source: MIDAS Germany - own calculations.

Having established some information about the labour market structure – the most important development is the assumed increase in employment rates – we turn to the income of the working population. Annual earnings are the product of hourly wages, weekly working hours per month and the number of months worked per year. In the simulation of each of these variables we applied a variance projection which aims to preserve the distributional characteristic of each variable.

First of all, the average number of months worked are shown in Figure 68. We observe a small positive ad hoc adjustment for women. However, after that adjustment the average amount of months worked remains fairly stable with about 11.3 months for men and 10.8 for women.

Figure 68: Average number of months worked per year by gender (employees, age 16-64)

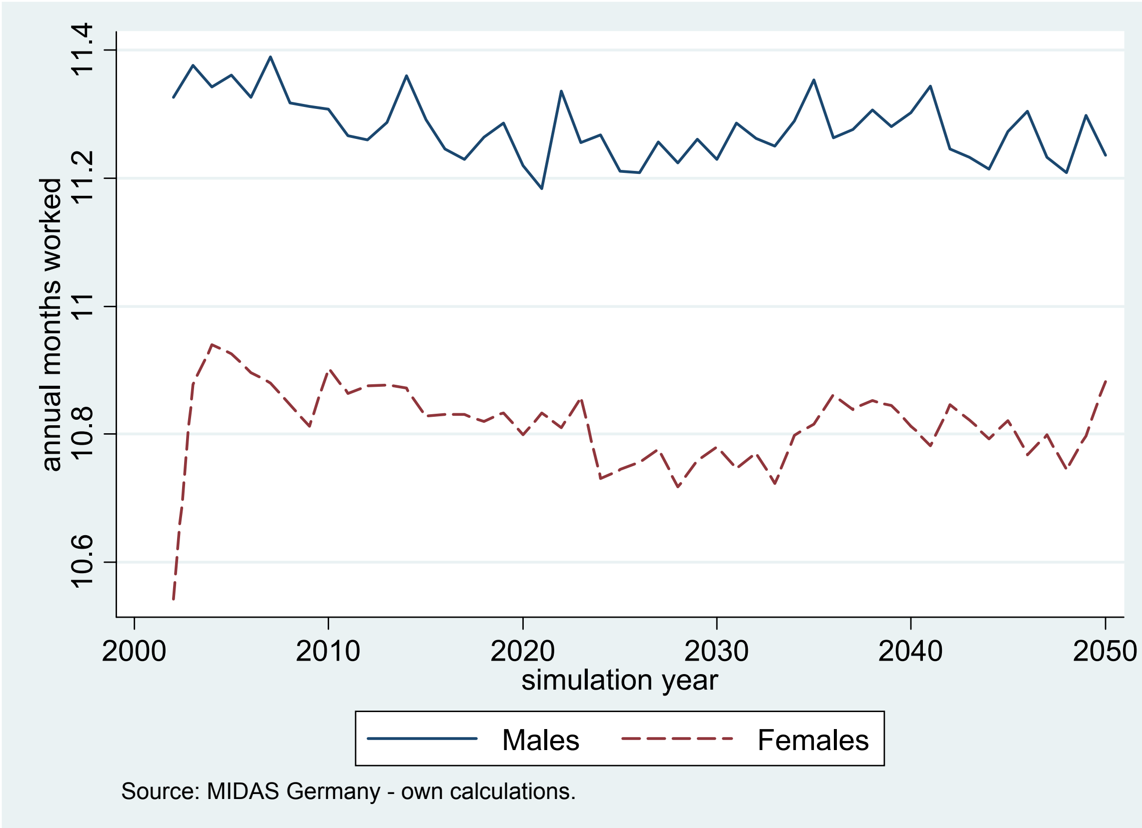
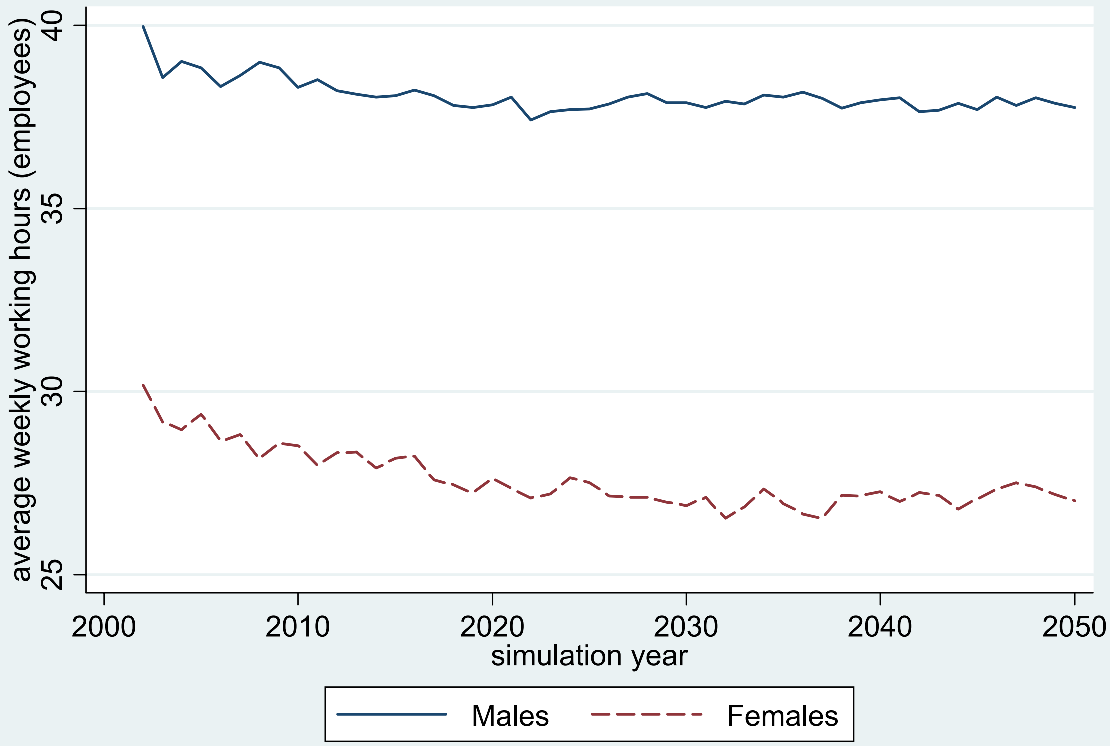


Figure 69 shows the average number of weekly working hours by gender. Here we observe a very small ad hoc adjustment. The number of working hours decreases a bit over time for both, men and women. Men worked around 40 hours in 2002 which declines to about 37.7 in 2050. The average number of weekly working hours for women declines from about 30 in 2002 to 27 in 2050. Thus, the increase in labour market participation for both men and women is associated with a small reduction of weekly working hours.

Figure 69: Average weekly working hours by gender (age 16 – 64, employees)

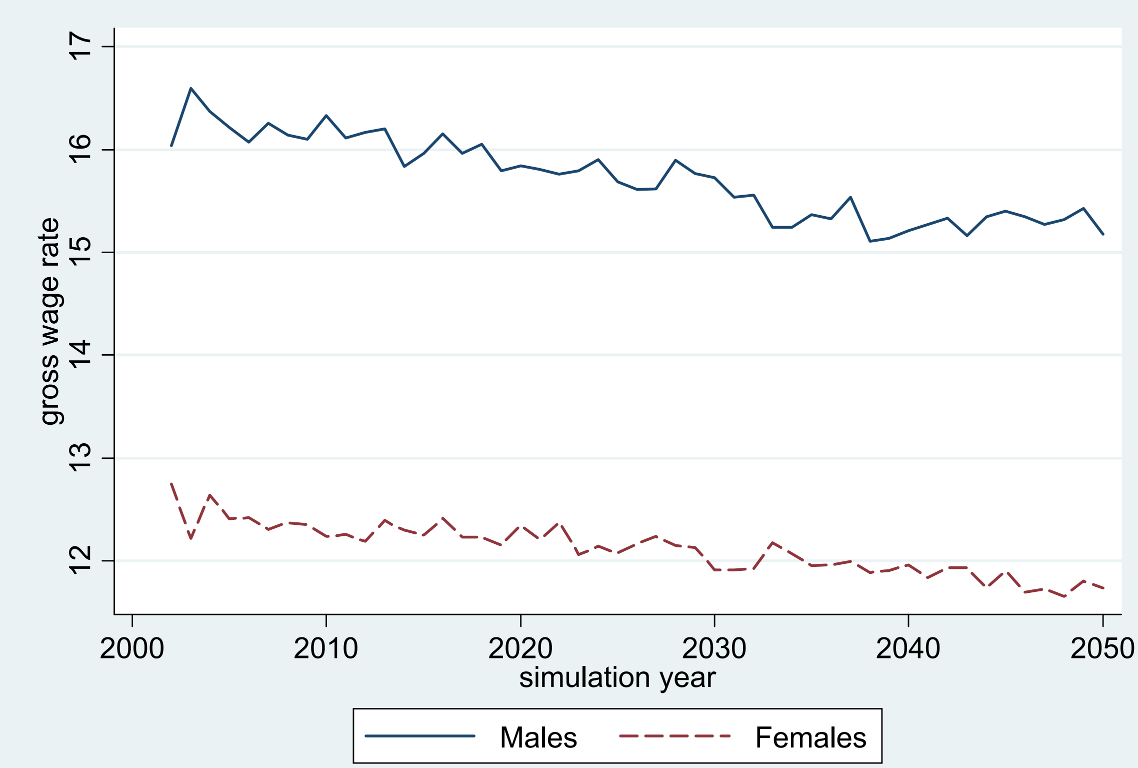


Source: MIDAS Germany - own calculations.

As mentioned above, annual earnings are a product of working hours per year and hourly wages. Wages in MIDAS grow according to AWG projections. However, to give some more insight into the development of these variables during the simulation we present some statistics without growth. At first hourly wages and their distribution are presented and then annual earnings.

Figure 70 depicts the development of wages. In 2003 a small ad hoc adjustment takes place, positive for men, negative for women. During the whole period, the mean wage decreases slightly (roughly one Euro) for men and women.

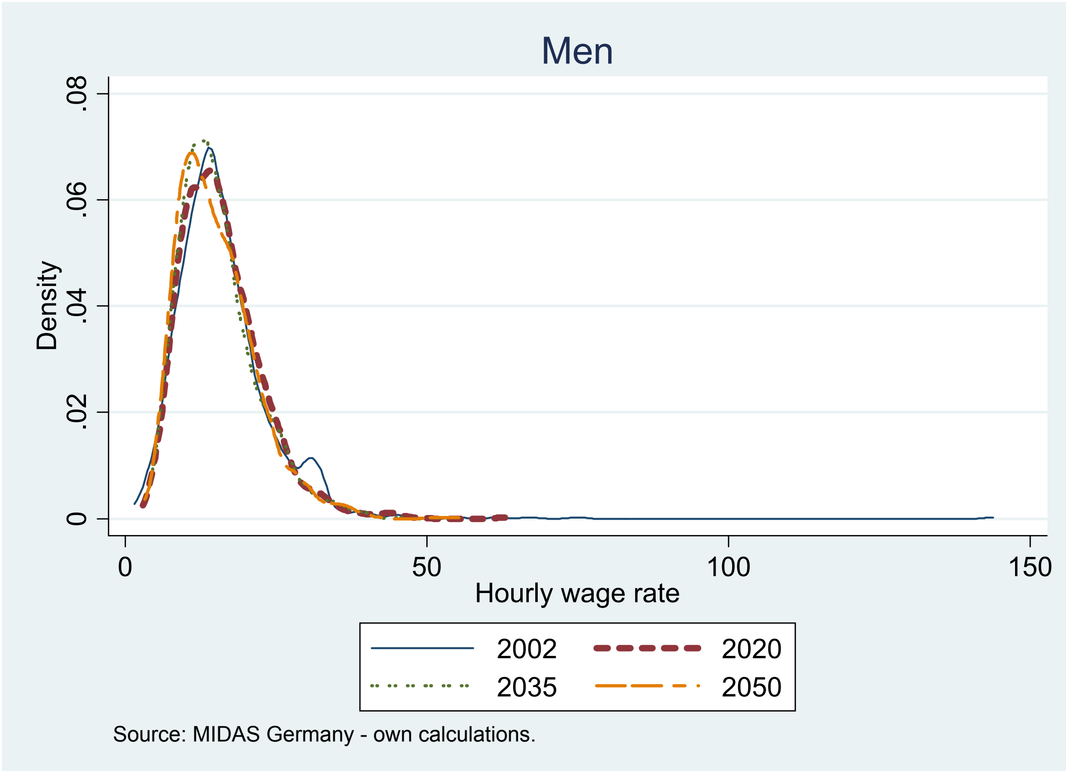
Figure 70: Average hourly wage rate by gender (age 16-64, employees)

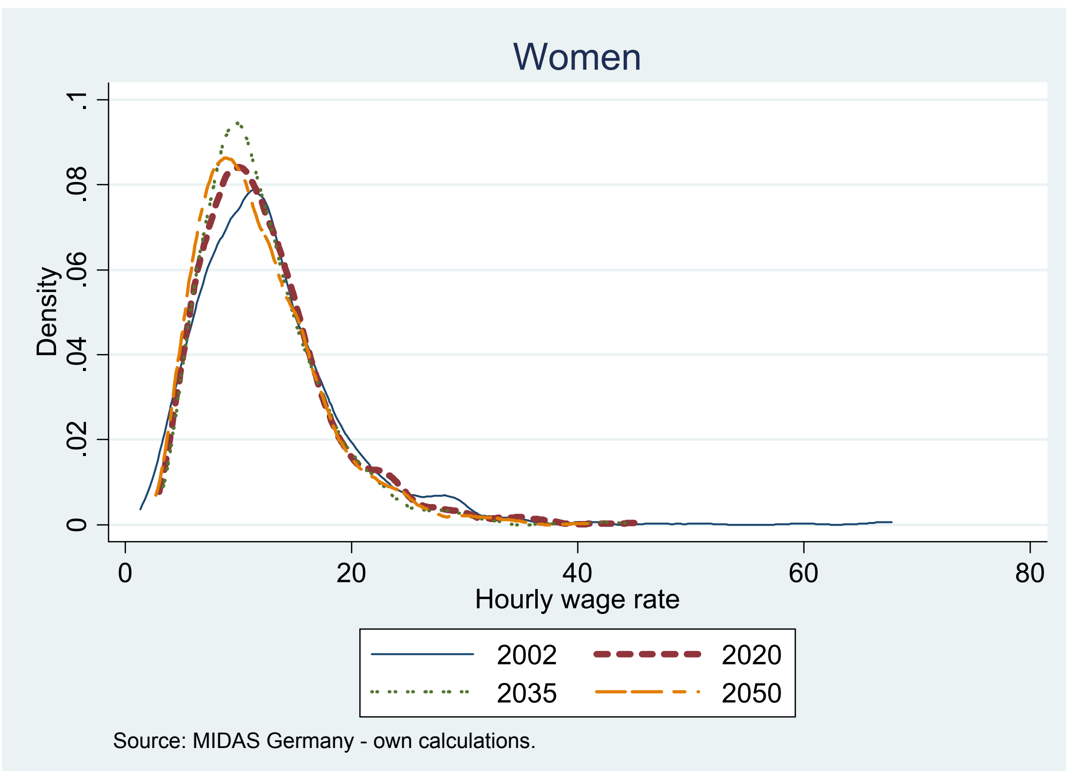


Source: MIDAS Germany - own calculations.

When looking at the kernel densities of hourly wage rates of the whole population (not reported) we find some differences across years. Figure 71 shows that differences exist for men and women: although we add a random component to the simulated hourly wage rates, the observed distribution has a little more "extreme" values than the simulated distribution. This leads for both, men and women, to a longer tail on both sides of the distribution of hourly wages in the base year. Besides this deviation the distribution turns out to be very stable throughout the simulation period.

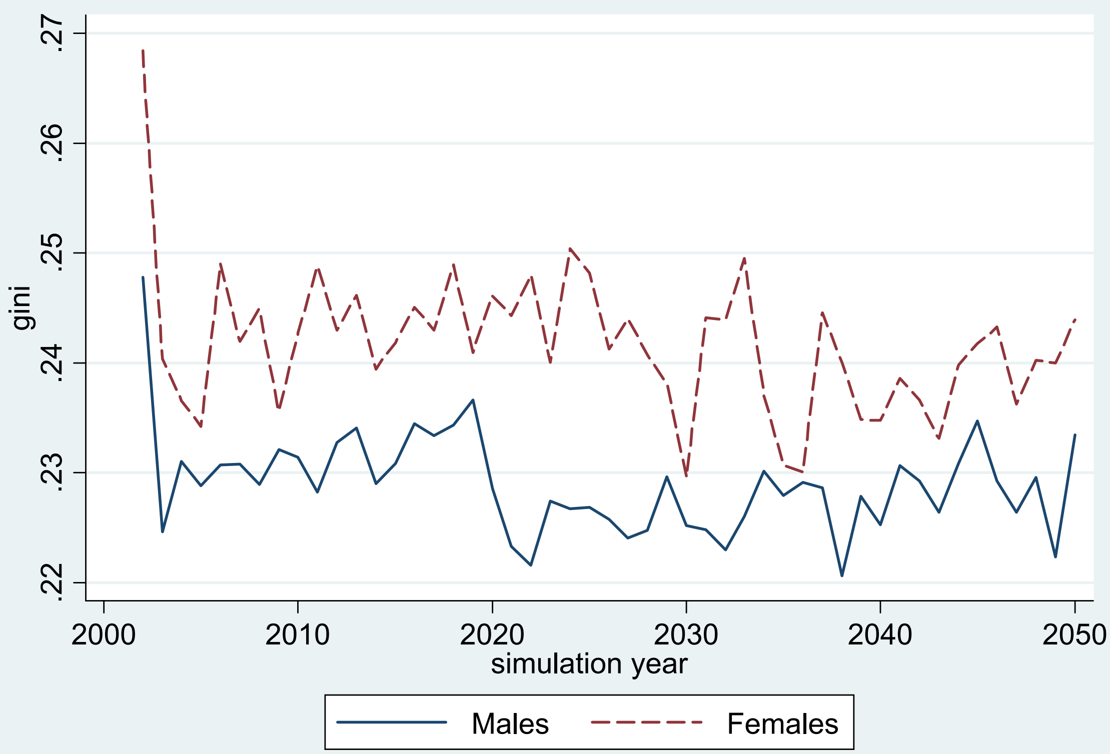
Figure 71: Kernel density estimator of gross wage rates in selected years (age 16-64, employees)





If there is a slightly more narrow distribution in the simulated sample compared to the original sample we would also expect other distributional measures to show this effect. In fact, Figure 72 provides evidence that this is the case. There is a huge adjustment of the Gini in the first simulation period, about two or more points. But after this adjustment the Gini behaves comparably stable. The Gini for women is higher than for men, that difference is smaller during the simulation.

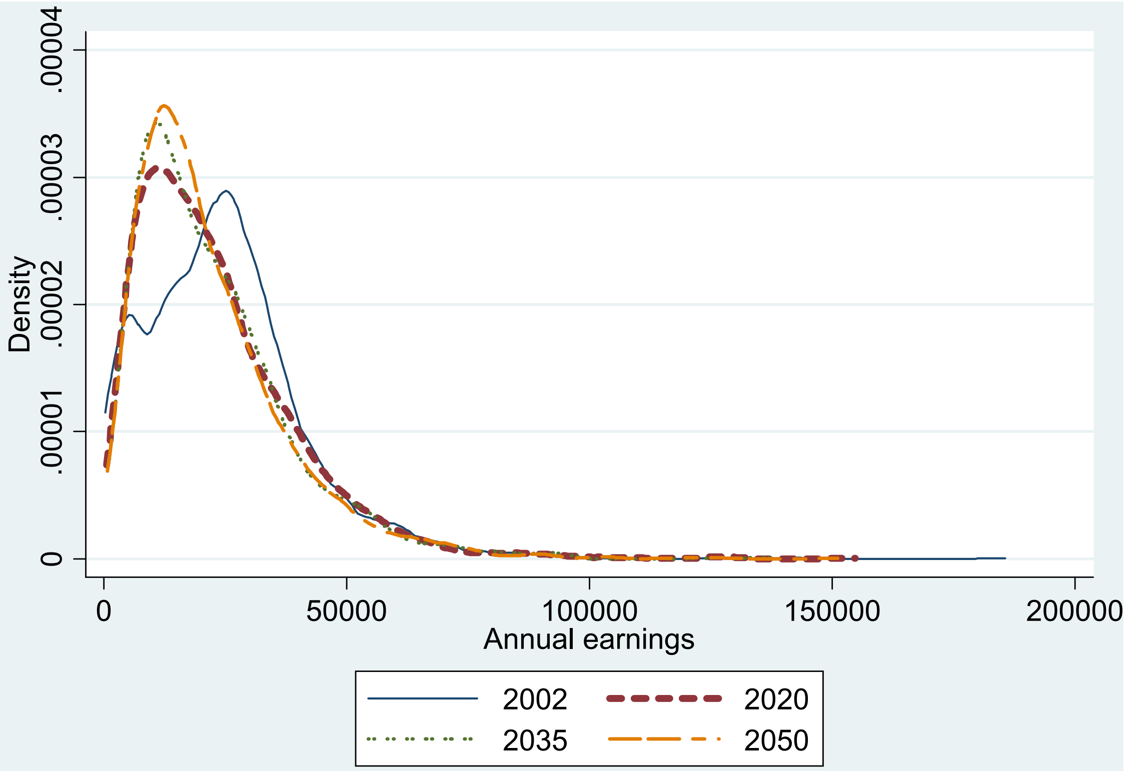
Figure 72: Gini coefficient of hourly wage rates by gender (age 16-64, employees)



Source: MIDAS Germany - own calculations.

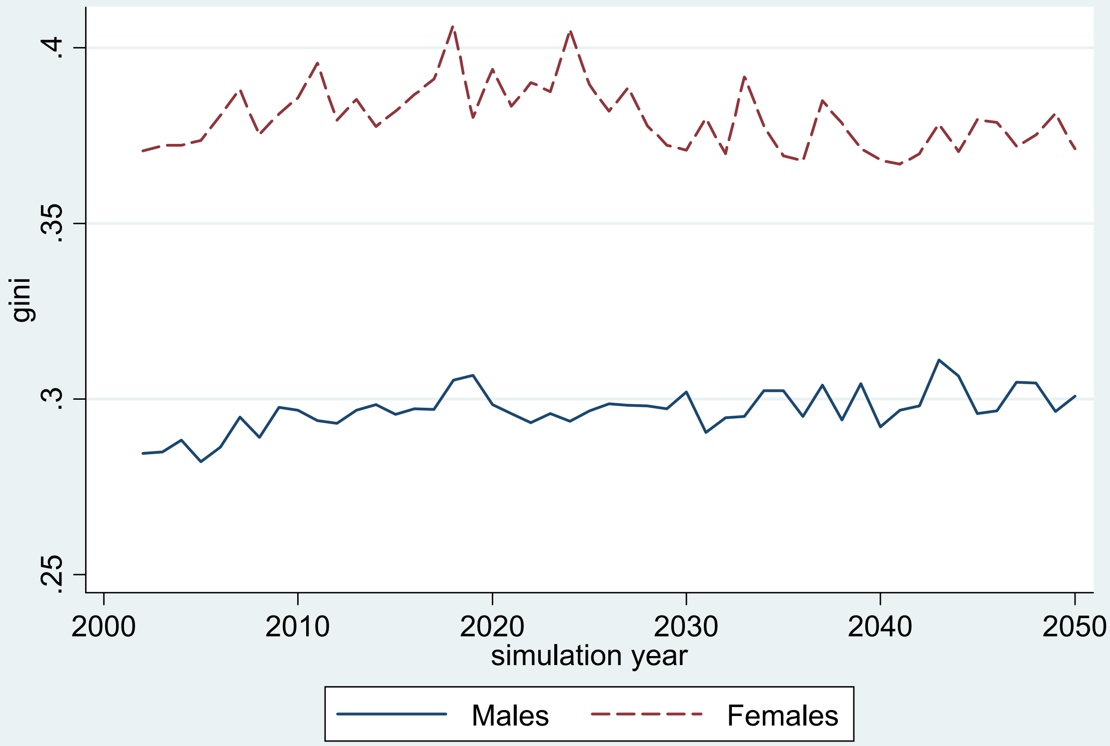
Annual earnings are then calculated as the product of months, hours and wage rate. Each of these variables is subject to some adjustment in the simulation period. The annual labour income combines all these variables which in turn again leads very likely to an ad hoc adjustment. The differences in the distribution are visible in Figure 73 and it applies the same explanation that explained the deviation for wages. However, Figure 74 presents the Gini coefficient by gender for this variable and shows that there is no strong ad hoc adjustment. On the other hand, it can be seen that the Gini is slightly more volatile than that of hourly wages. The graph shows very clearly that the inequality in annual earnings is higher than in hourly wages and this is particularly strong results for women (from about 24 points to roughly 38). Of course this reflects the high inequality in annual labour supply (hours and months) among women.

Figure 73: Kernel density estimator of gross annual labour earnings in selected years (age 16-64, employees, men and women)



Source: MIDAS Germany - own calculations.

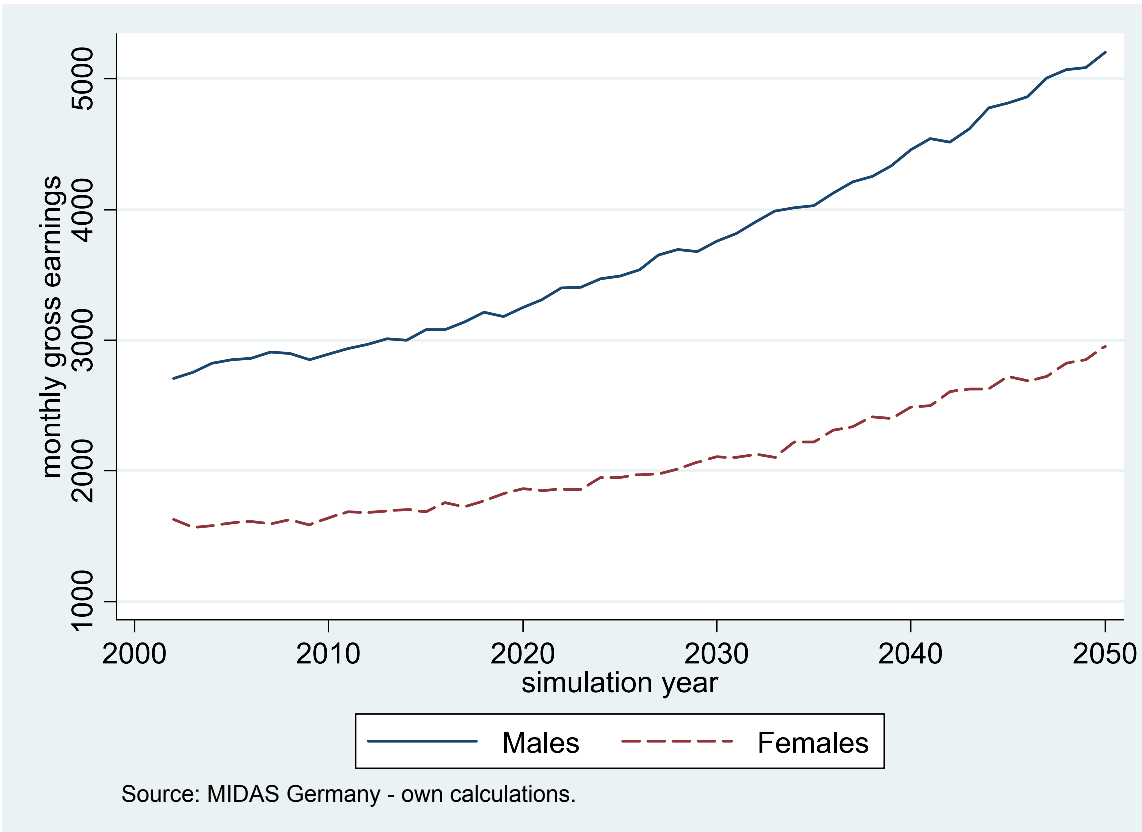
Figure 74: Gini coefficient of gross annual labour earnings by gender (age 16-64, employees)



Source: MIDAS Germany - own calculations.

The annual growth of labour income is assumed to follow AWG projections: until 2010 a growth rate of 0.9% is assumed, between 2010 and 2020 1.5% and 1.7% thereafter. Figure 75 shows how average gross earnings develop under these growth assumptions. As a rule of thumb, real wage income roughly doubles until 2050 on average.

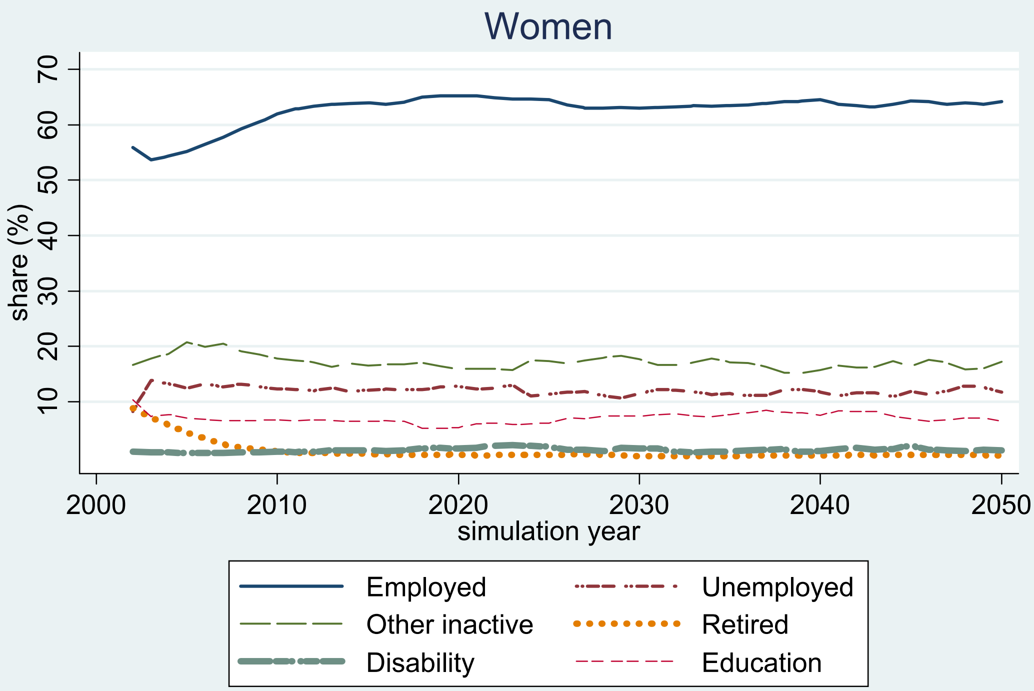
Figure 75: Average monthly gross earnings with AWG growth assumption by gender (age 16-64, employees)



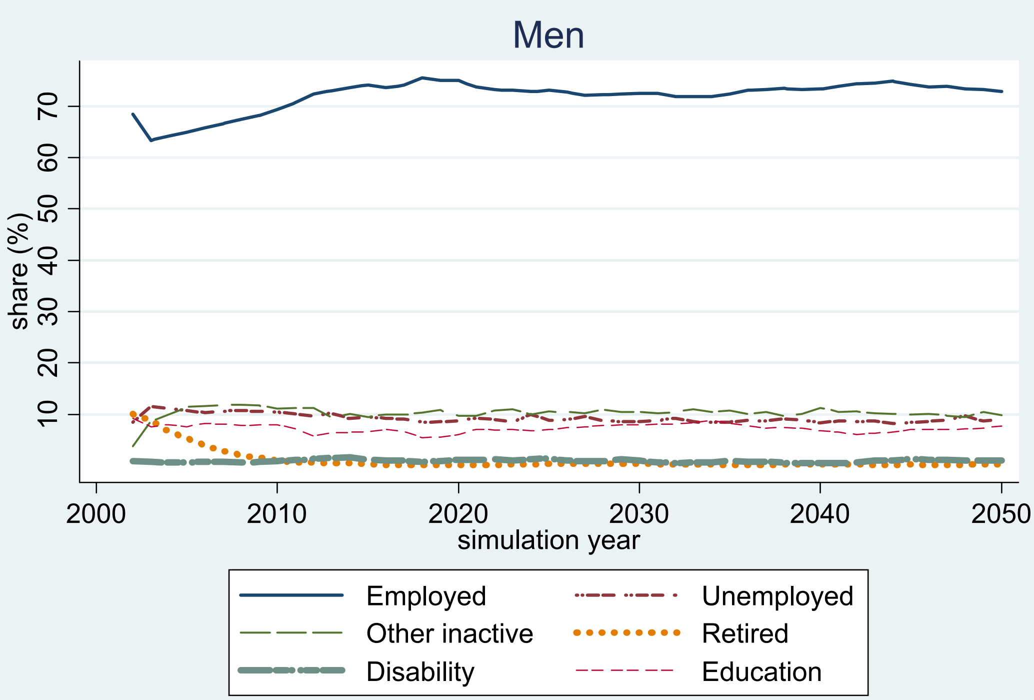
For persons who have been classified as not being in work on the first stage of the decision process, several possible states were considered: being in education, unemployed, retired, inactive due to disability or other inactive. Early retirement used to be very common in Germany but the recent pension reforms significantly lowered such possibilities and the mandatory retirement age will actually increase in the future. In MIDAS we keep the mandatory retirement age constant at 65 and limit rather strictly the possibilities to retire early. This is why the share of retirees in the working population decreases markedly until 2010. There is also a small fraction of individuals who are not working because of disability. They receive a disability pension, but their share is relatively small. In the group of people aged 55 to 64 their share is about 4 or 5%.

Figure 76 shows how the shares evolve over time in comparison to the employed population. Obviously the state "other inactive" comprises periods of childrearing which characterize female careers. The rate of other inactive women is roughly between 15 and 20% throughout the simulation period. The unemployment rate is about 10% for men and for women.

Figure 76: Employment rate, unemployment and other inactive by gender (16-64)



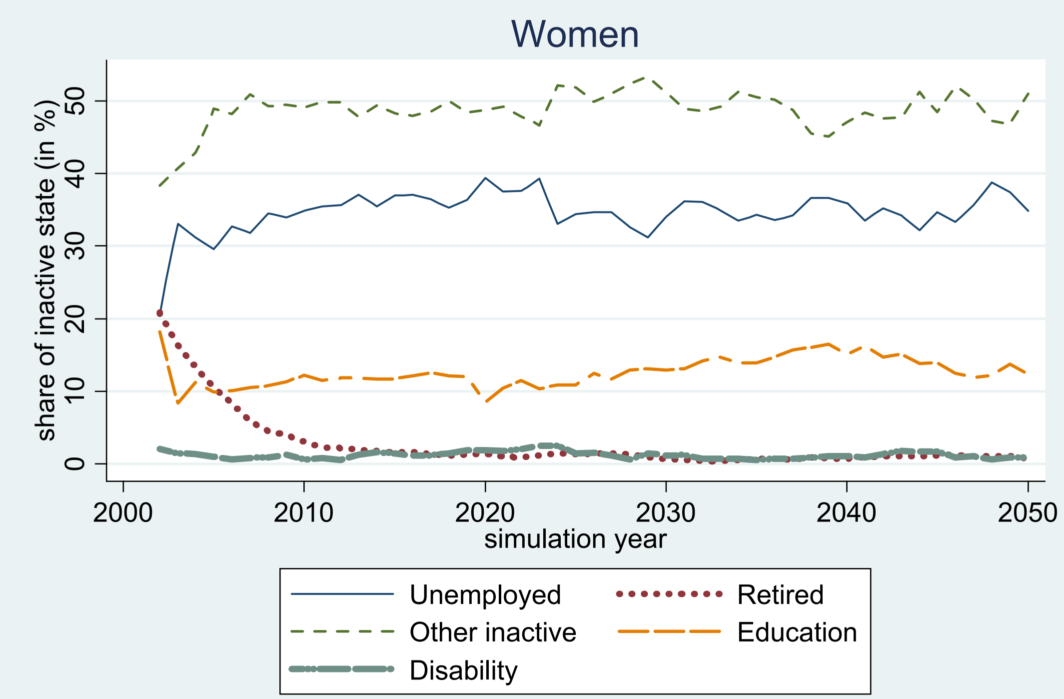
Source: MIDAS Germany - own calculations.



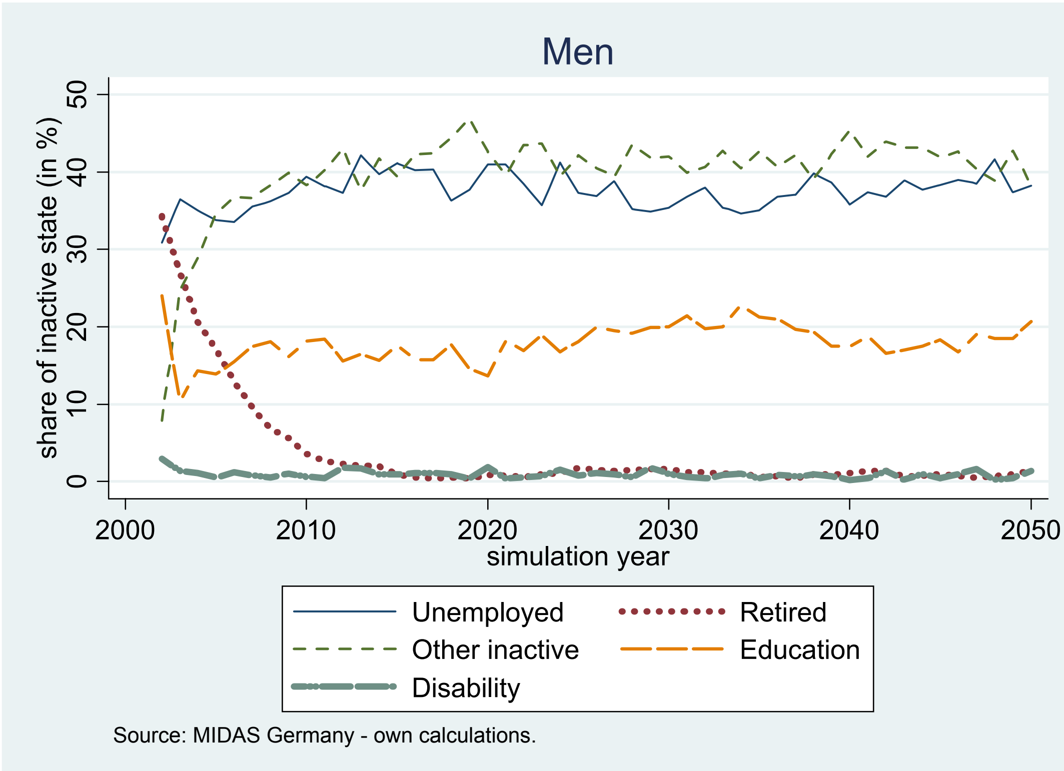
Source: MIDAS Germany - own calculations.

Figure 77 shows the distribution of states within the not employed population. Differences between those states become more visible. In particular we observe a strong ad hoc adjustment in the state of unemployment, education, and of "other inactive". Education of course is adjusted due the assumption that individuals have completed their education by the age of 25. This necessarily decreases the share of people in education and leads to an increase in the remaining shares. Note that the overall share of not employed individuals decreases over time.

Figure 77: Composition of inactive states by gender (age 16 – 64)



Source: MIDAS Germany - own calculations.



5.2.3. Retirement

Public pensions in Germany relate old age income mainly to the individual employment career. In short, the sum of insured periods and the relative wage income in each period determine the number of earnings points due to labour income. Of much less quantitative importance are other sources for earnings points. In the past, the most important sources for additional earnings points have been periods of higher education and periods of (insured) unemployment. The last reforms have not abolished these types of earnings points, but strongly limited the amount granted. On the other hand, earnings points granted per child have been considerably increased in the last reforms.

Earnings points due to labour income can be thought of as an index that relates the individual labour income to the average labour income. Thus, earning the average wage implies an earnings point of one. A bit simplified, the pension amount is then calculated as the product of earnings points, added up over the entire career, and the current pension value that equates an earnings point to an amount of Euros.

The number of earnings points and thus the pension amount certainly depends on the age people withdraw from the labour force or retire and the age of labour market entry. A look at the development of the mean of these variables allows a first glance at the likely development of future public pensions.

Figure 78: Average age of labour market entry by gender (whole population)

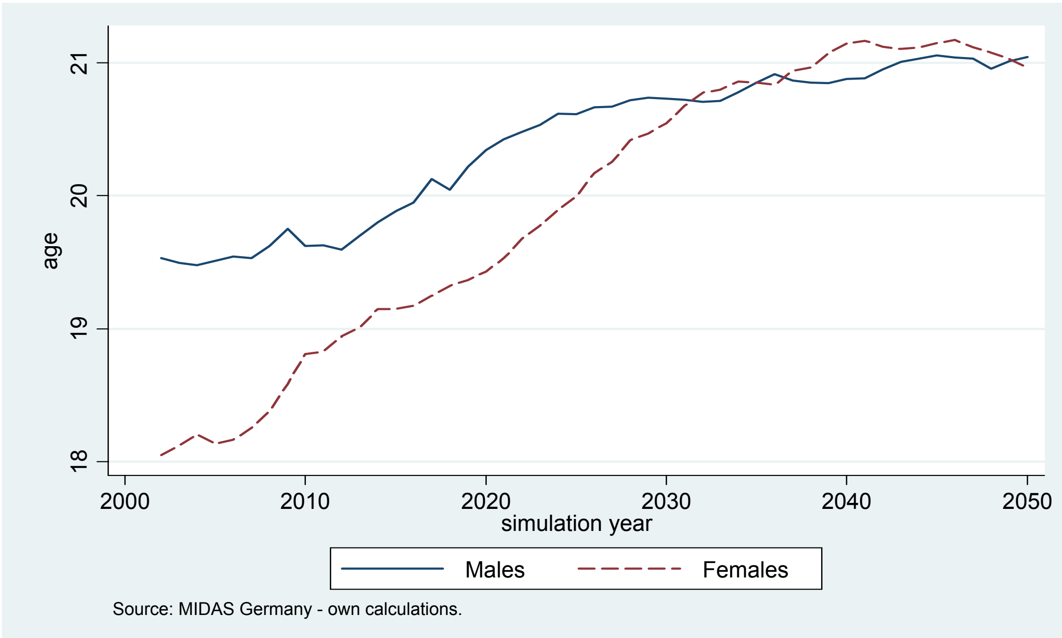
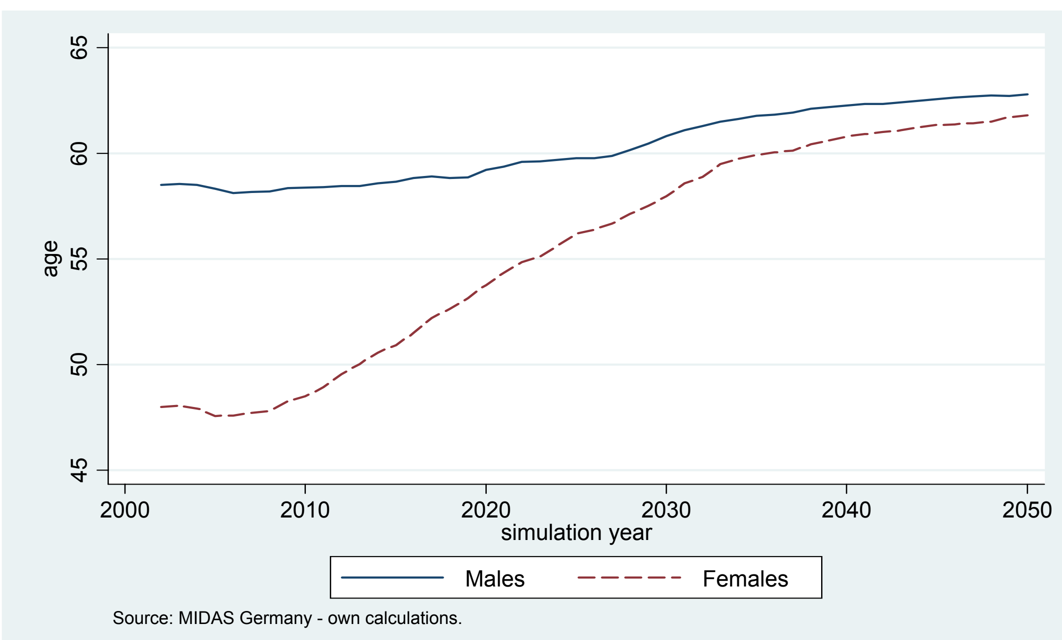


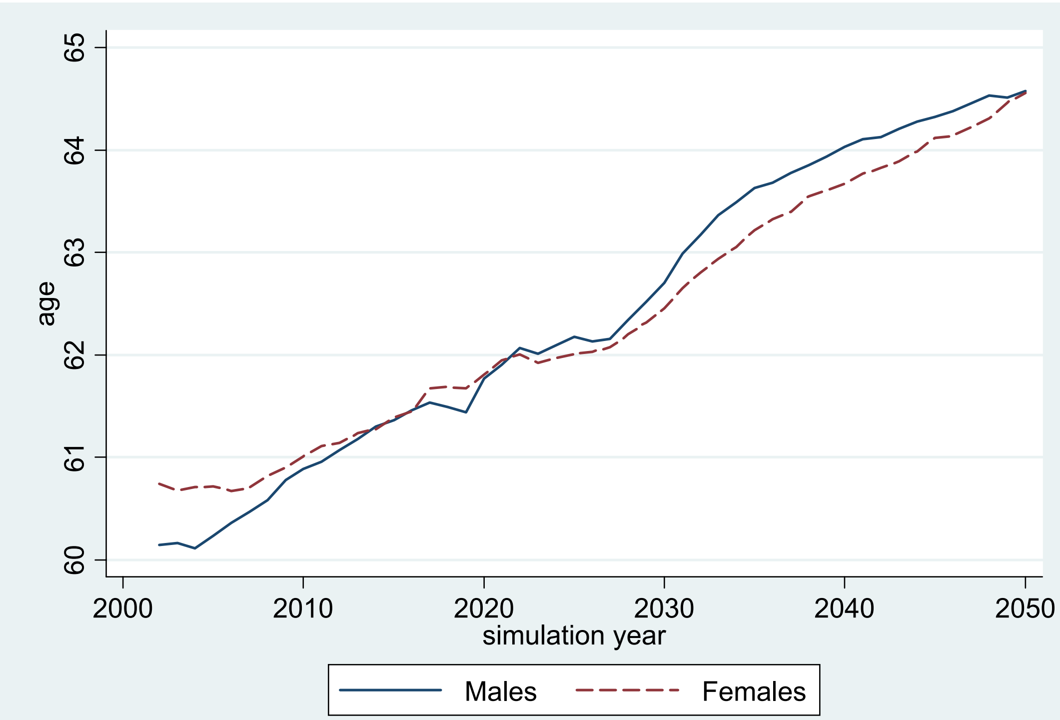
Figure 78 shows that due to the assumptions on the future changes in the share of persons with medium and higher education, the average age of entry to the labour market rises by around one and a half years for men and about three years for women.

Figure 79: Average age of withdrawal from the labour market (current retirees)



On the other hand, due to changes in the pension legislation and behavioural changes, the model predicts an increase of the age of withdrawal from the labour force and an increase of the retirement age (see Figure 79 and Figure 80).

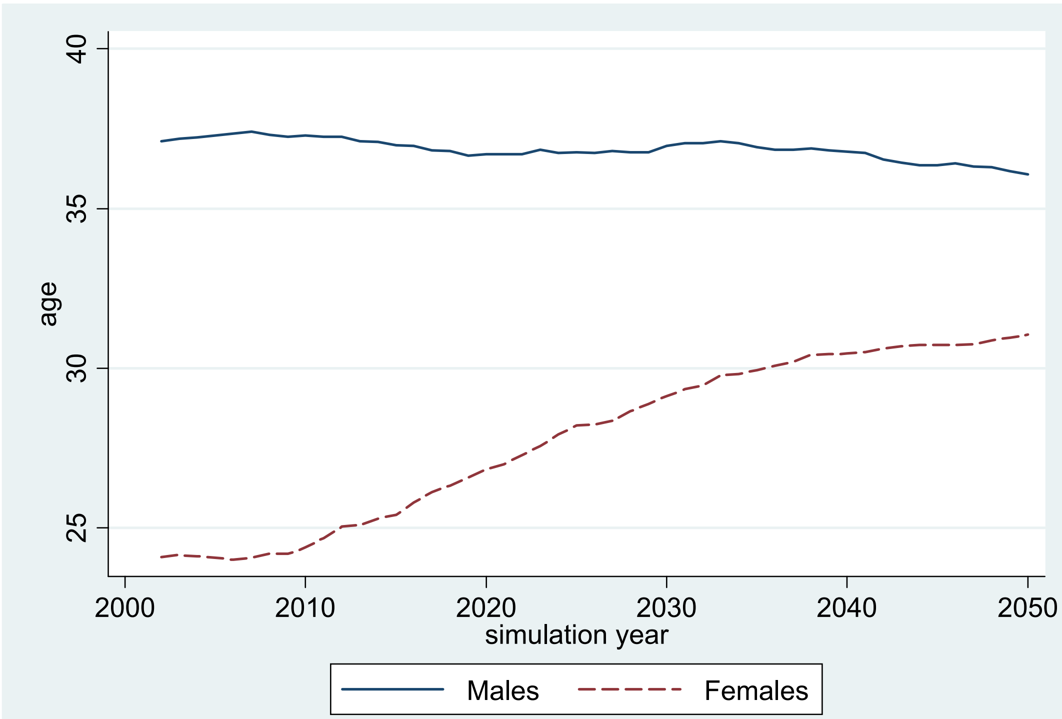
Figure 80: Average age of retirement by gender (current retirees)



Source: MIDAS Germany - own calculations.

The net effect of these changes on the length of the career is shown in Figure 81. The length of the career is defined as working years and thus takes into account the years between labour market entry and age of withdrawal from the labour force. For men, the opposite effects of longer education and later withdrawal from the labour force nearly cancel out. For women, the model predicts a strong increase of the length of the career.

Figure 81: Average length of careers by gender (current retirees, each year employed adds to the length of the career)



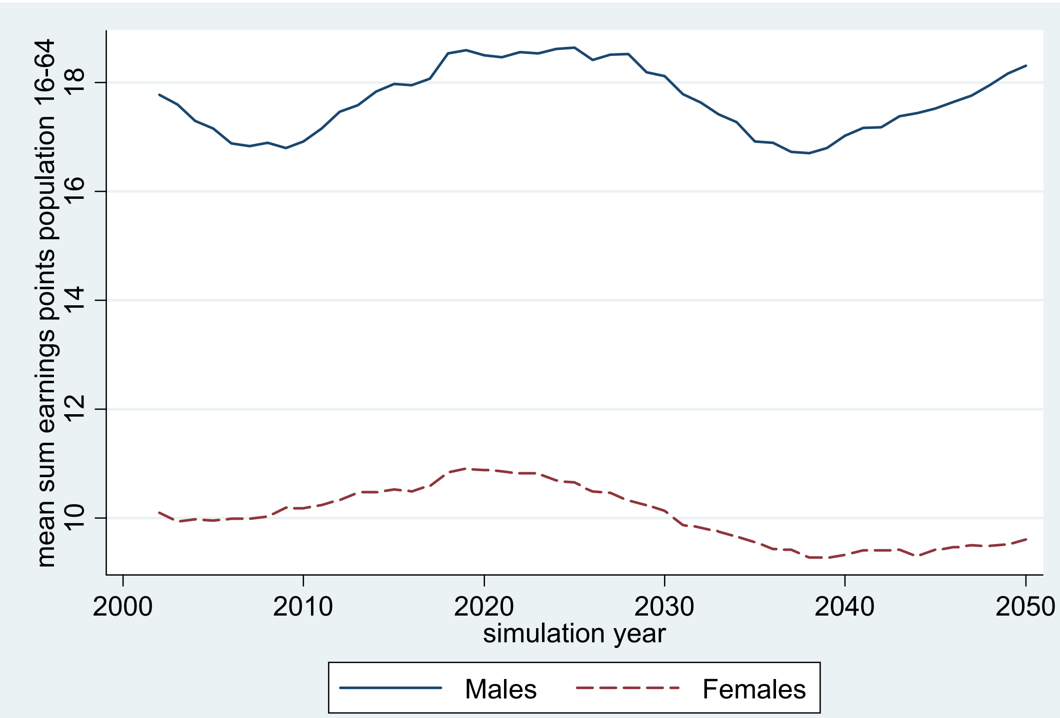
Source: MIDAS Germany - own calculations.

As already mentioned above, the length of the career is only one determinant of individual pension rights. The other factor is the relative wage position of a person in each year of working life. The relative wage position in each year is reflected by the number of earnings points a person is granted in that period. The pension rights are (roughly) proportional to the sum of earnings points a person accumulates over the course of her working life.

Due to the importance of the sum of earnings points, we take a look at the development of the mean of the sum of earnings points (age 16 to 64) over time (see Figure 82). The changes in the sum of earnings points over time are generally rather small. Somewhat surprisingly, for women the average sum of earnings points does not increase over the whole period although the participation rates of women and the length of the career increases for women.

There seem to be several causes for this finding. As shown above, the average number of working hours decreases for women and thus reduces their relative earnings level compared to men. This implies a lower number of earnings points for women. Moreover, a considerable part of women shows very low numbers of working hours and low hourly wage rates. In case their earnings fall below the lower threshold of the public pension scheme of currently 400 Euros per month, they are not compulsorily insured and do not receive earnings points. A further possible explanation is that we have slightly overestimated the sum of earnings points in the backward calculation of the earnings points of those persons already in working life at the start of the simulation. As the data base (SOEP) provides direct information on wage income only in the survey period (starting in 1984), the relative wage position for earlier periods in working life had to be imputed based on the results of an estimated equation for the relative wage position.

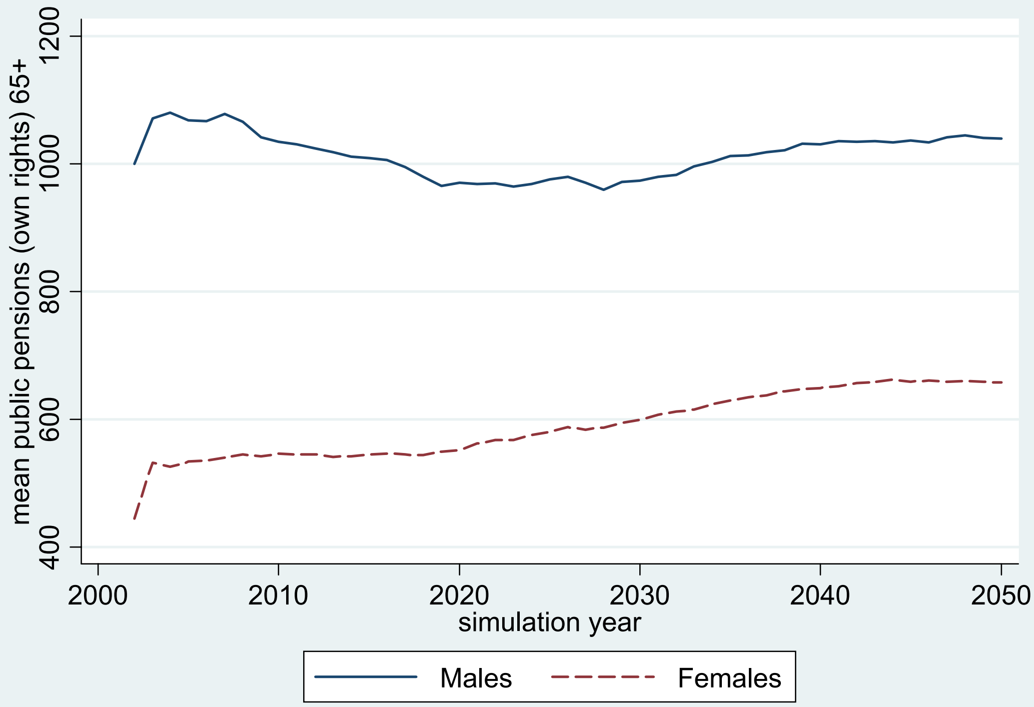
Figure 82: Average sum of earnings points from employment by gender (age 16-64)



Source: MIDAS Germany - own calculations.

If one neglects productivity growth and thus also the impact of the adjustment rule for public pensions, the level of public pensions will stay rather stable in the period under consideration. This is shown in Figure 83. The initial increase from the year 2002 to 2003 seems to be caused by a simplifying assumption in the simulation model: While the differences in the pension regulations in West- and East Germany were considered up to the year 2002, we assume identical rules for the years from 2003 to 2050. Especially, we assume a unique current pension value for West- and East Germany. The value chosen for this unique pension value leads to slightly overestimated results for the level of public pensions in the simulation period. The increase in the pensions for women is mainly due the rise in the number of earnings points granted for the raising young children.

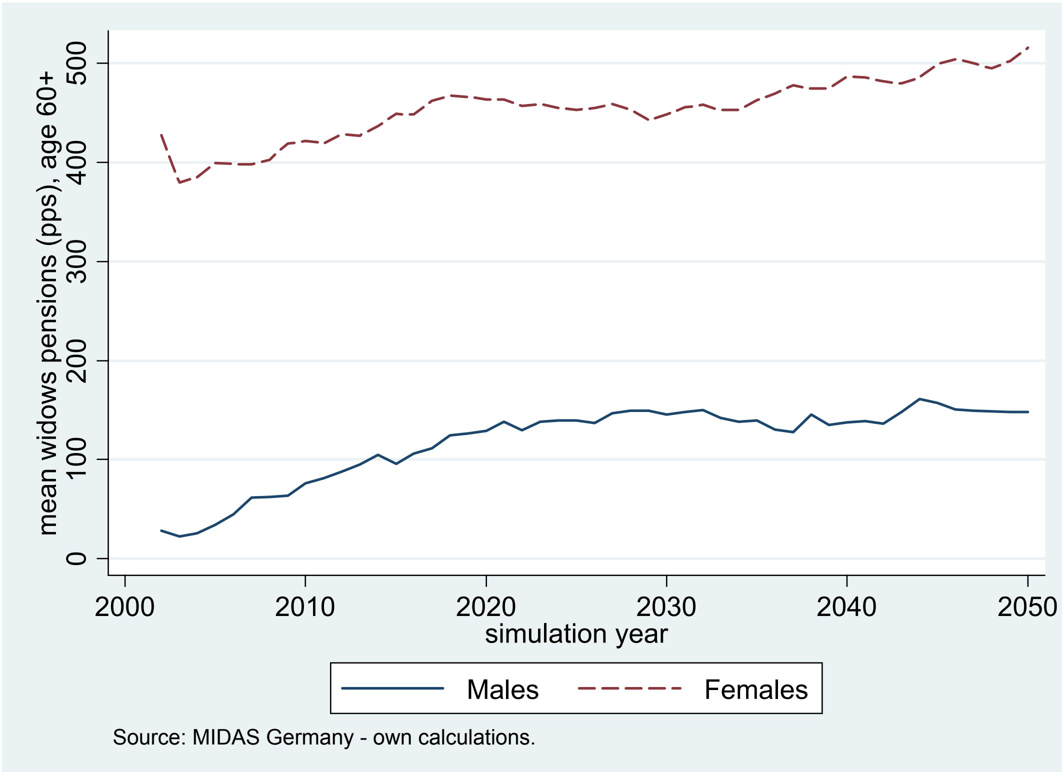
Figure 83: Public pensions by gender, neglecting productivity growth (age 65+)



Source: MIDAS Germany - own calculations.

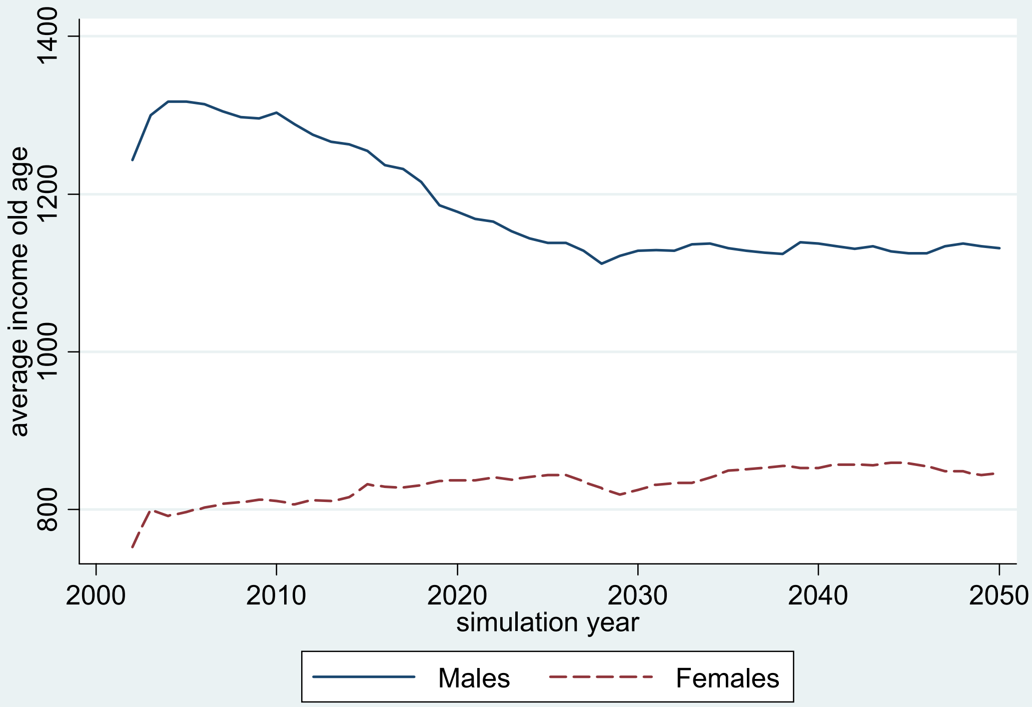
Additional to own pension, the pension scheme provides widow's pensions if the former husband was insured in the public pension scheme. Neglecting wage growth, Figure 84 shows that the average widow's pension for widows of age 60 and over, remains rather stable. The increase of widower's pensions is to some extent due to simplifying assumptions of the model. We consider the withdrawal of widow's pensions if a person receives own income above an exemption level by 40%. However, contrary to the regulations in Germany we take into account only own pension income and not further types of income as they are not represented in the model.

Figure 84: Widow's pensions by gender, neglecting productivity growth (age 65+)



As shown above, the share of civil servants decreases rather strongly in the simulation period. The decrease is certainly overestimated. The model does not capture well the fact that civil servants in Germany usually remain in this status once they have become civil servant. Due to this limitation, we will not explicitly consider the results for pensions of civil servants, but include them in a summarizing variable "old-age income". Due to the falling number of civil servants, pensions for former civil servants also decrease over time.

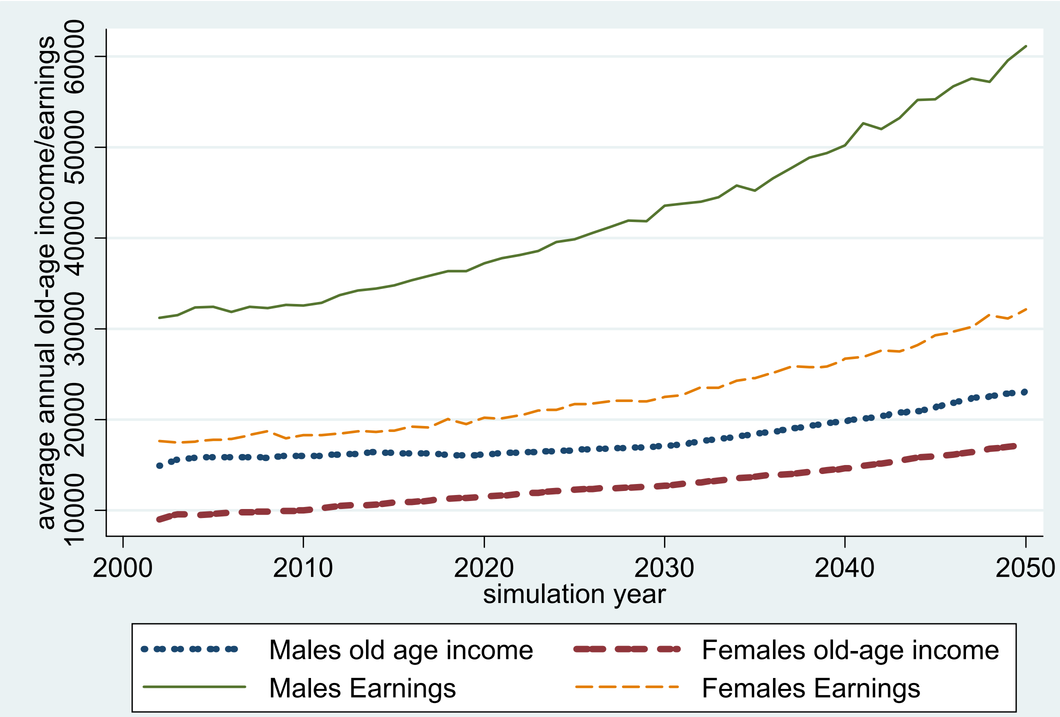
Figure 85: Old-age income by gender, neglecting productivity growth (age 65+)



Source: MIDAS Germany - own calculations.

Old-age income is defined as the sum of public pensions (from own pension rights), widow's pensions in the public pension scheme, pensions for former civil servants and widow's pensions of spouses of former civil servants. The results for the case without productivity growth are shown in Figure 85. While old-age income for females increases, it decreases for men. As already mentioned above, earnings points granted for periods of education and unemployment have been reduced in the last reforms which leads to lower old-age income for both sexes. On the other hand, earnings points granted for raising young children have been increased and these earnings points regularly are granted to women.

Figure 86: Gross earnings and simulated old-age income (with productivity growth)



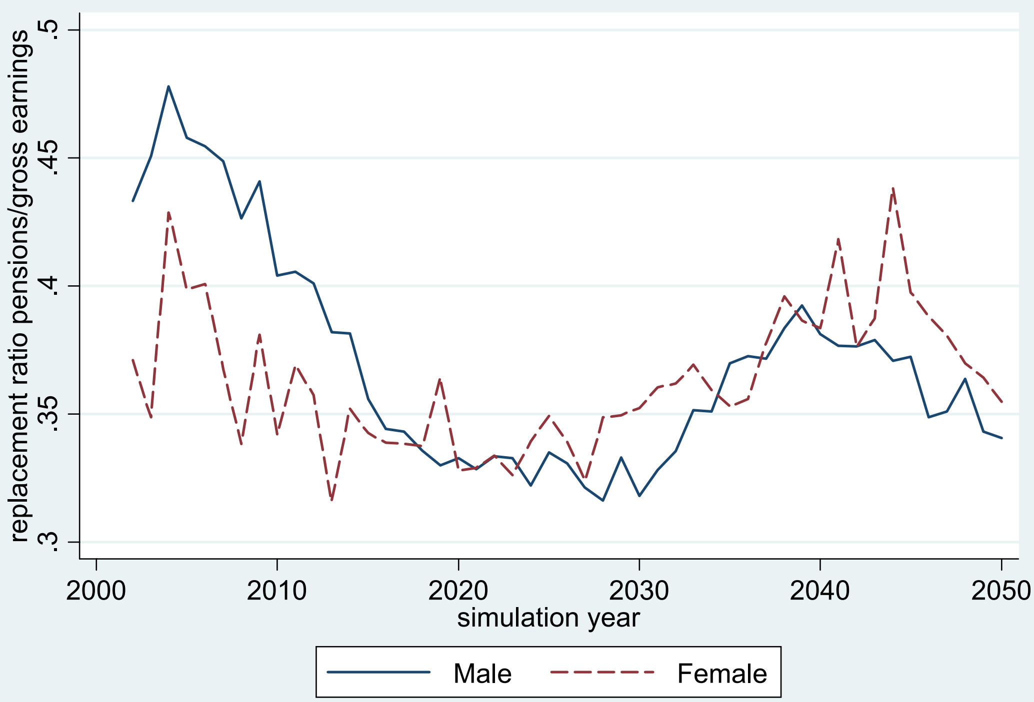
Source: MIDAS Germany - own calculations.

Taking productivity growth into account certainly changes the picture substantially for both sexes. As Figure 86 shows, old age income increases over time for both sexes. Due to the assumptions on the adjustment of pensions to wage growth according to the German pension legislation (see above), the growth rates of old-age income are considerably smaller than the growth rates of earnings.

Please note that in order to facilitate the analysis of the income distribution in the following section, we will consider as old-age income only public pensions (including widow's pension) and neglect pensions of civil servants.

As a bridge to the next section about inequality and poverty the last graph (Figure 87) shows the replacement ratios of monthly pensions and gross earnings. The replacement rate takes into account our growth scenarios in which pensions are assumed to grow slower than earnings (see next section). The erratic movement is caused by low sample size although we used a broader average than the mean of individual replacement rates in a given year. Instead we averaged earnings per year for employees aged 56-64 (separately for men and women) and related that to pension benefits of retirees between 65 and 74. The graph gets more erratic if we narrow that window but its shape is preserved: Replacement ratios decrease significantly for both men and women until 2030 and increase afterwards. This resembles well the ageing process of the population because – somewhat simplified – pension growth is slower the higher the old age dependency ratio is. Around 2030 demographic ageing reaches its peak and the difference in growth rates of pension and earnings shrinks. For women we also find that a higher employment rate leads to higher pensions in the future. This mitigates the downturn in the replacement rate for women.

Figure 87: Replacement rates of own pensions and earnings by gender (with growth)



Source: MIDAS Germany - own calculations.

5.2.4. Inequality, poverty and the adequacy of pensions

The previous sections illustrated the main results from the simulation of the demographic, the labour market (with a focus on dependent employment) and the retirement module. This section combines the trends described and major developments of modelled variables to create a more comprehensive picture of public pensions in terms of inequality and poverty. Here we explicitly include growth of pensions and earnings according to the current German pension legislation. At the end we present a brief sketch of a scenario with a higher growth rate for public pensions.

The base scenario is characterised by the recently introduced new pension adjustment rules. The German pension formula links the growth of pensions to gross wages and demographic ageing.

In 2005 a so called sustainability factor has been introduced. That factor relates the number of pension recipients to the number of contributors to guarantee a slower growth rate of pensions if the share of recipients increases faster relative to the contributors. We calculated the sustainability factor according to the demographic and employment projections of the AWG that we used. In this scenario the sustainability factor leads to a lower growth rate throughout the simulation period while the difference narrows over time – of course, because demographic ageing reaches its peak around 2040. In 2050, wages have roughly doubled on average while pension increase by about 70 percent. At the end, we briefly present some results for a scenario with full wage indexation – used to be the case before 2005.

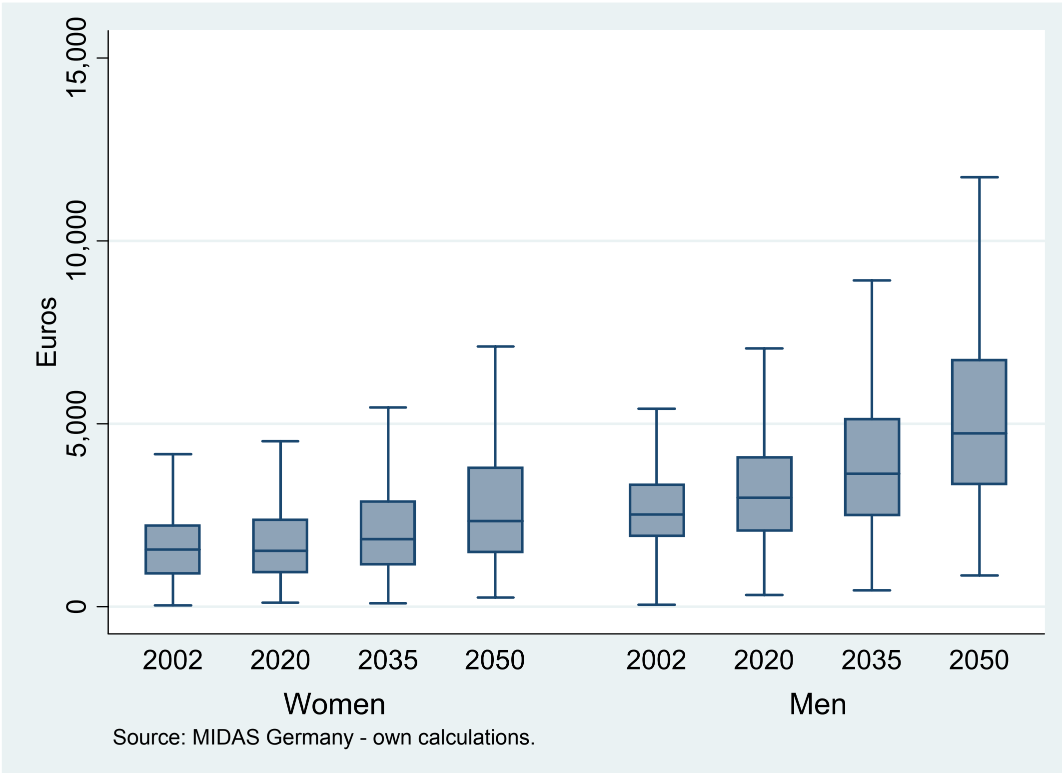
First we analyse the distribution of individual income sources, in particular labour earnings, own pensions, widows and widower pensions. We often refer to the term "total income". Total income throughout this section means the sum of earnings and pension benefits including surviving spouse benefits. The illustration of inequality and poverty measures is restricted to these sources of income. Please note that we simulate "pure" gross income variables and therefore do not consider welfare measures such as social assistance.

Inequality

We first take a look at earnings and pensions on the individual level then we turn to the household perspective. Individual earnings grow according to the AWG assumptions, pension grow according to the pension benefit formula. For the retired whose employment status does not change anymore it does not matter whether we look at monthly or annual benefits since both grow at the same rate. When we look at employment outcomes it is a bit different: growth is attributed to hourly wages and does not have to equal the growth of monthly or annual earnings, i.e. if individuals, for example, work more hours than before, we observe a higher growth rate of monthly earnings. Furthermore, the wage rate is result of a wage regression and depends on observable individual characteristics. The difference of wage rates of an individual between two years is thus also influenced by the developments of these covariates. Despite all these possible sources of deviances we observe that the average hourly, monthly, and annually wage payments grow roughly at the assumed growth rate of the AWG.

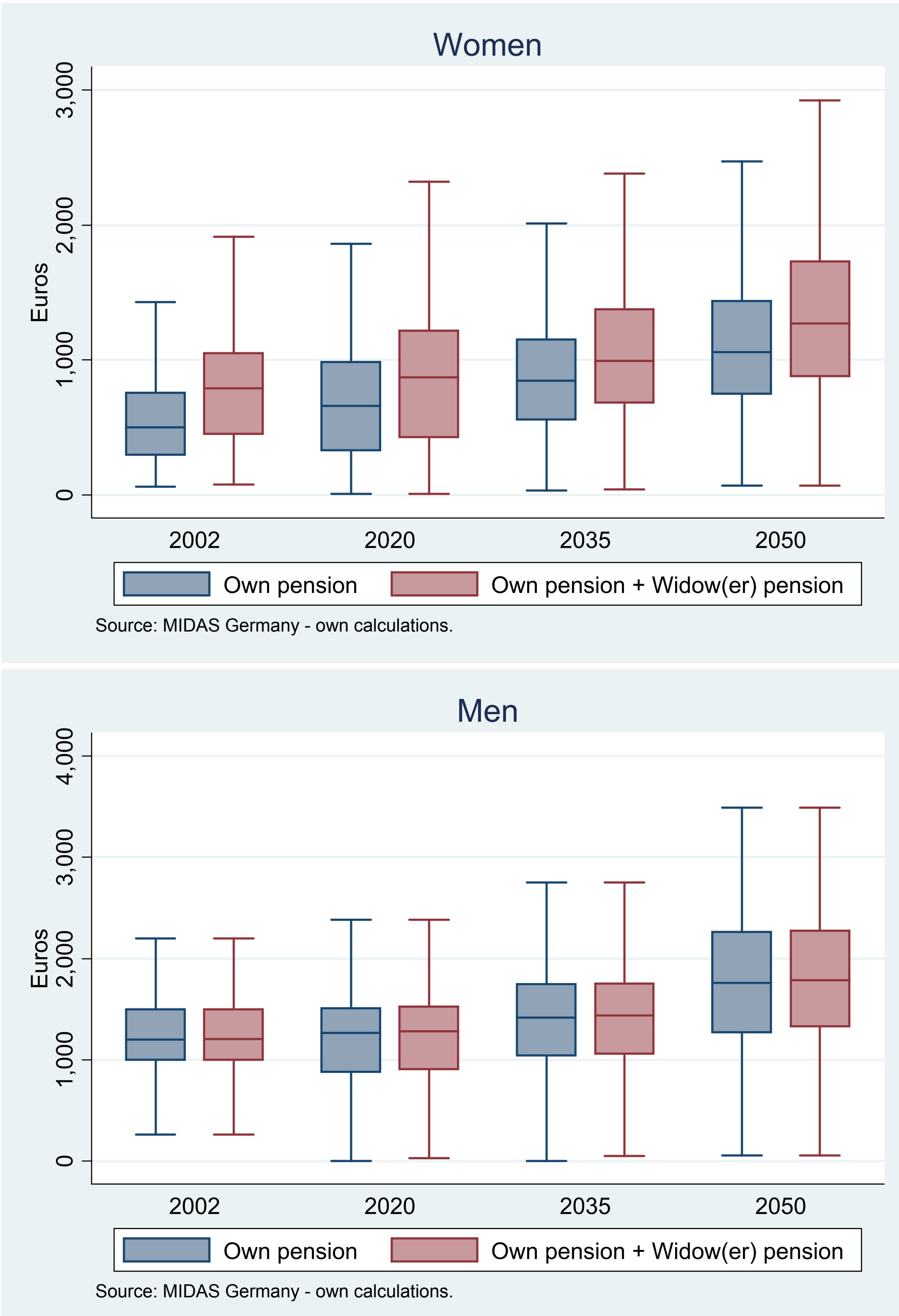
Figure 88 gives a first impression of how the distribution of earnings evolves over time. While we saw that the mean monthly wage increased strongly for both men and women, Figure 88 indicates that the growth of the median is much slower. This results holds for both genders but is more pronounced for women. In 2002 the mean monthly income for wage earners was 1627 (2708) Euros and the median was 1560 (2514) Euros for women (men). In 2050 the difference between both measures increases markedly, with a mean equal to 2336 (4663) and a median of 2889 (5341). In other words, for both men and women the distribution of earnings is getting more unequal.

Figure 88: Box plots of monthly earnings (with growth) in selected years by gender (age 16-64, employees)



The next Figure 89 contains a similar box plot diagram for pension benefits. The diagram includes own pensions and total pension, which consist also of surviving spouse benefits (means tested). The mean pension benefit in 2002 was about 500 Euros for women and 1200 for men. Including surviving spouse benefits increases the pension benefit of women considerably to about 750 Euros on average. Thus the graph clearly shows that retirement benefits derived from employment are very much lower for women compared to men and this does only slightly change over time. This is somewhat surprising because of the increase in female labour market participation. In terms of inequality, when we compare means and medians, the distribution remains rather constant. Both measures remain similar in size over the simulation period. This is interesting because we did not introduce welfare when pensions are below a certain threshold.

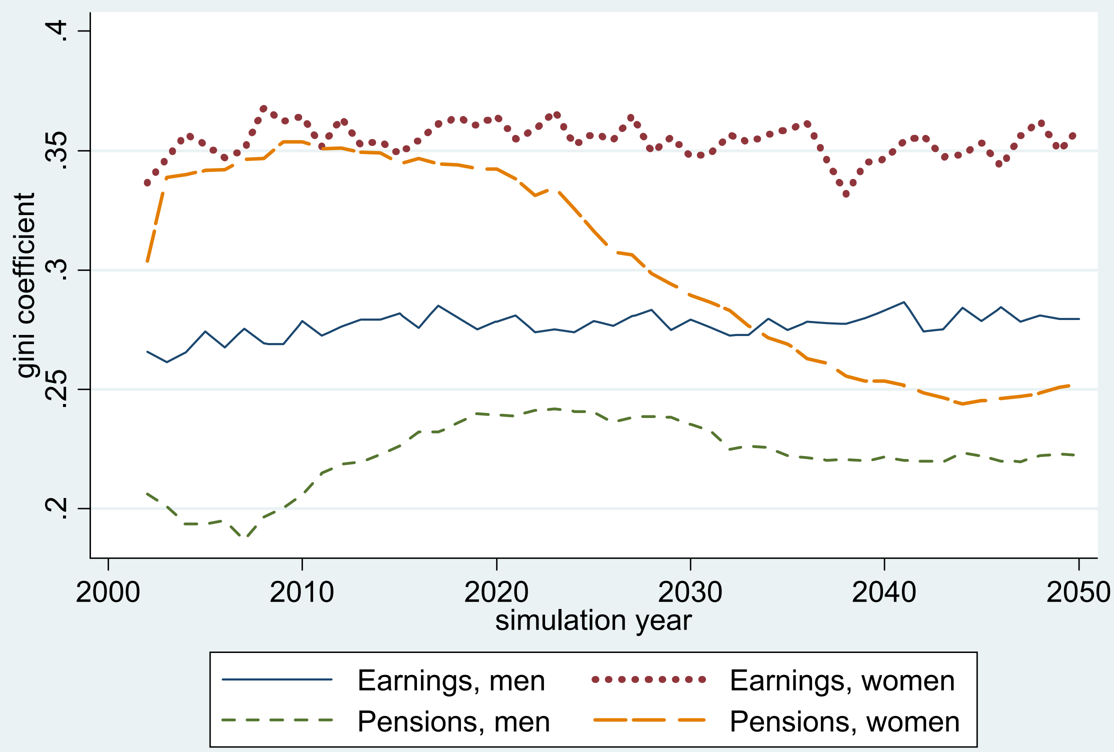
Figure 89: Box plots of monthly pension benefits (with growth) in selected years by gender (age 16-64, employees)



The next step is to look at the Gini of individual income sources. Figure 90 shows the Gini with respect to individual monthly earnings and pension benefits for men and women. Looking at the Gini for labour earnings the graph shows that the Gini behaves relatively stable with a slight positive trend for both men and women. The level of the Gini is higher for women. That reflects the heterogeneous female labour supply in comparison to male labour supply. In contrast to the figures before, we observe that inequality changes a lot within the group of pension benefit recipients. First of all, there is a strong ad hoc adjustment of the Gini for female retirees: the Gini increases between 2002 and 2003 by about 3.5 points. This happens because we do not distinguish between West and East Germany. East and West German women differ markedly in their labour market characteristics and pensioners differ as well. Careers in East Germany used to be significantly higher than in West Germany but the current pension value is lower for East Germans. In our model this difference does not exist anymore from 2003 on. This leads to a one shot increase in pension for East German women and although their share is relatively small, the increase is strong enough to influence the overall average strongly.

The Gini remains stable until about 2025 when it starts to markedly decrease. For men, we observe the opposite on a smaller scale: there is no ad hoc adjustment but a little negative trend until 2007 when the Gini starts to increase from 18 points to about 24 in 2022 from which it declines again to roughly 22, one point higher than at the outset of the simulation.

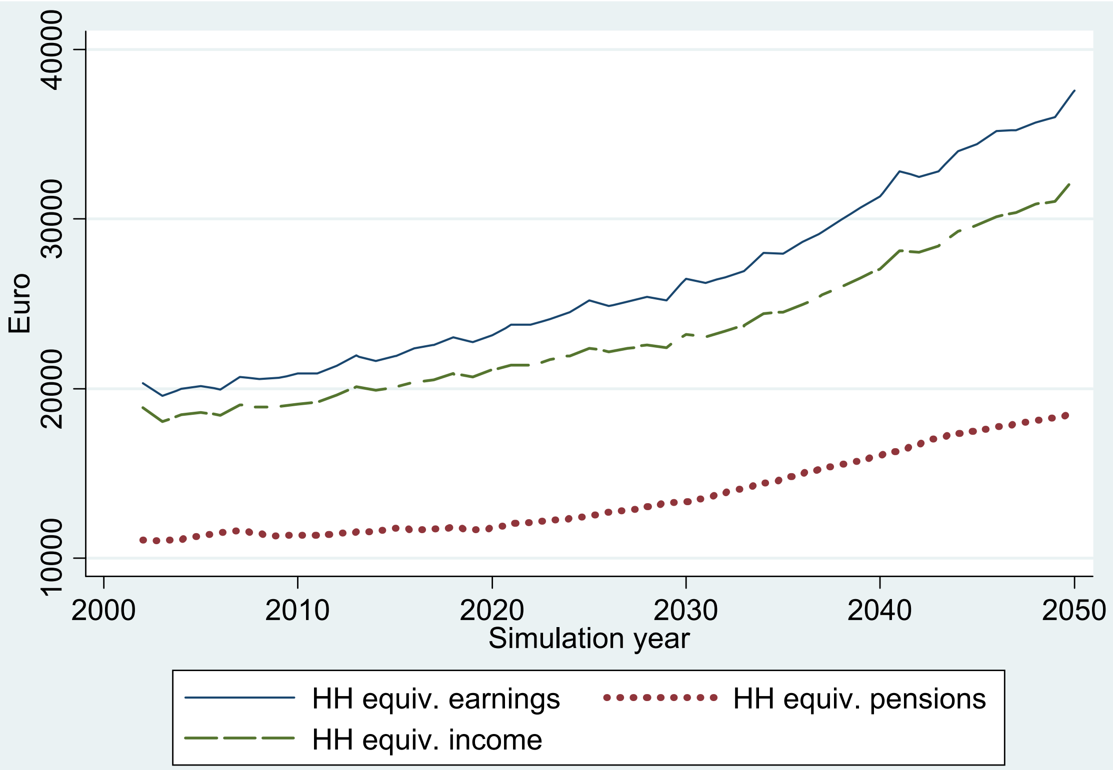
Figure 90: Gini of individual monthly earnings and pensions by gender (age 16-64, employees and retirees)



Source: MIDAS Germany - own calculations.

Having established some facts about inequality at the individual level, we now present more details on the income distribution by moving the analysis to the household level. Household income components are weighted according to the new OECD equivalent scale. Figure 91 shows how the income components develop over time. The dotted line represents annual pension benefits; the dashed line gross earnings and the solid line their combination. The increase in equivalized household earnings between 2002 and 2050 is about 80% and lower than the growth of individual earnings. Equivalized pensions increase from 11040 Euros to 18480 Euros or by roughly 70 percent. That is interesting because it implies that the structural effects, i.e. demographics, household composition, and changes in labour market behaviour, dominate at the household level the process of income growth. Thus, it is no surprise that the income of households which received income from two sources, pensions and labour earnings, experienced an even higher growth with about 85% until 2050.

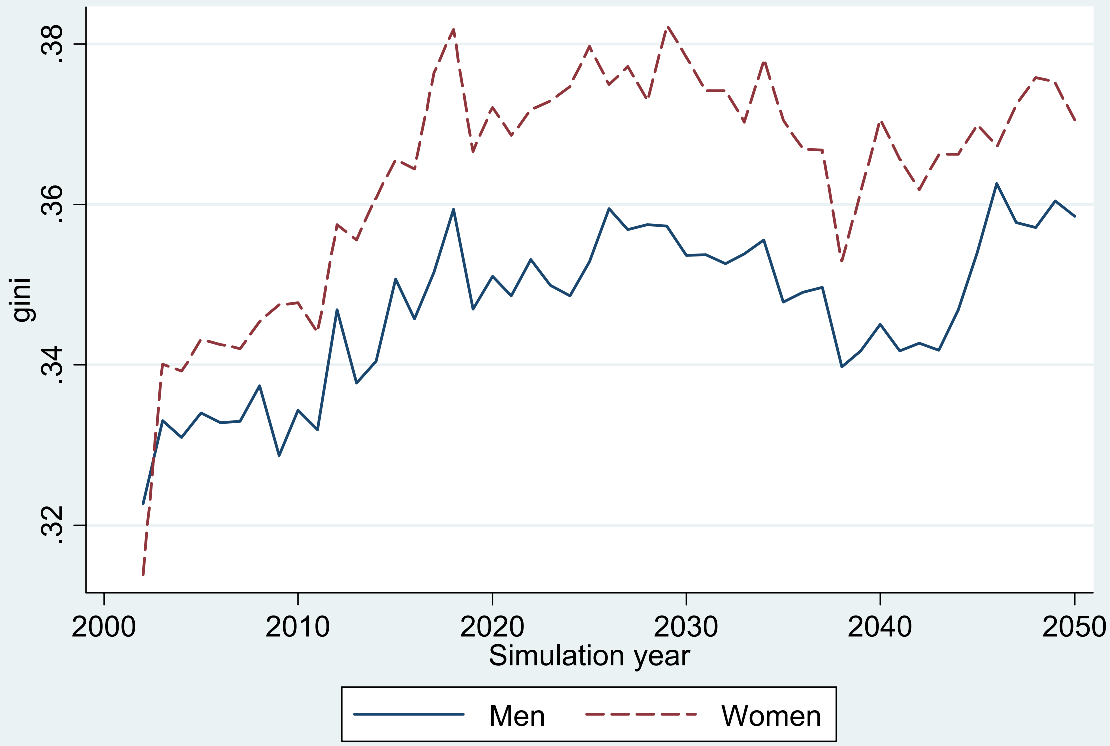
Figure 91: Household equivalent annual earnings, pensions and income (earnings+pensions)



Source: MIDAS Germany - own calculations.

Figure 92 shows the development of the Gini for equivalized household earnings. Interestingly, and in stark contrast to what was found for individual earnings, the Gini is not stable over time. The inequality increases up until 2020 for both men and women. For both, the Gini starts off from about 32 points and increases for men to a value between 34 and 36 and for women between 36 and 38. The household dimension leads to this instability in particular for one reason: other income components than pensions and labour earnings are not modelled. This means that we included a many household members who are not wage earners or pension recipients but who may have other income sources. In other words, the graph shows a very specific inequality which refers only to labour earnings.

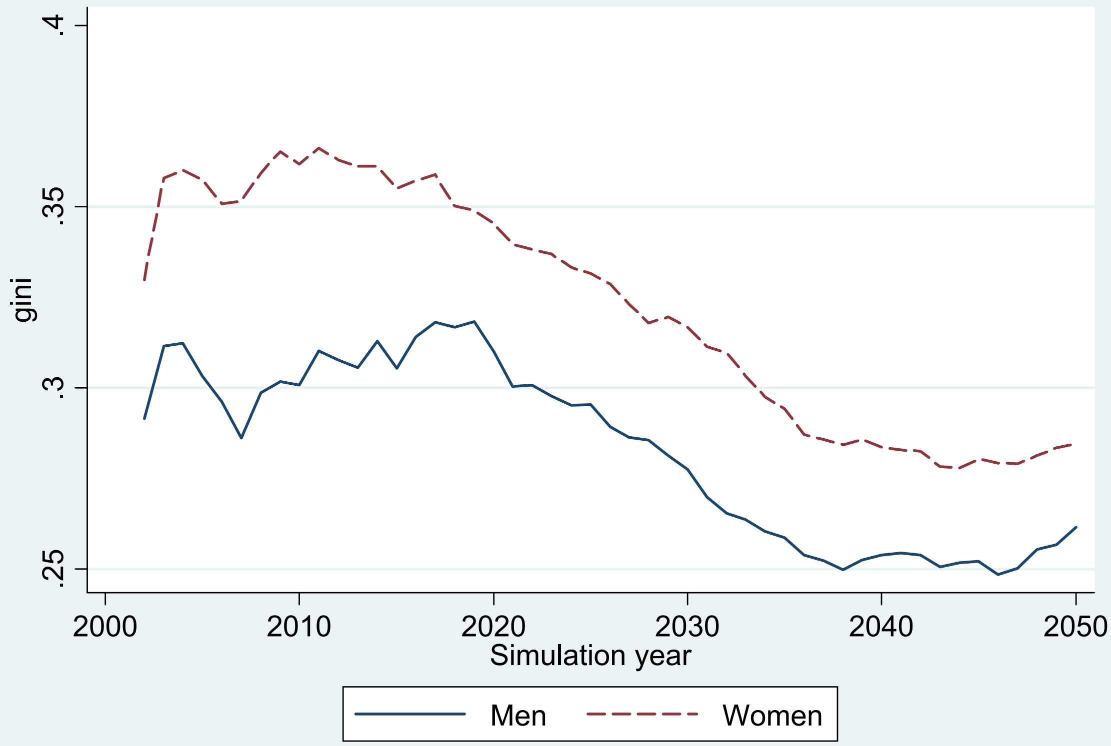
Figure 92: Gini coefficient of equivalized household gross monthly earnings by gender



Source: MIDAS Germany - own calculations.

It is a bit different for households with pension benefit recipients because here are less household members found who do not receive any benefit. Therefore, the Gini is less volatile and apart from the initial ad hoc adjustment, there are no large kinks. The Gini starts off higher for women (about 35 points) than for men (about 30 points). Besides the difference in levels both measures develop quite parallel. This is not too surprising because these households have a large and even growing share of two person households. When we then calculate household equivalent income and analyse both genders separately results should not differ too much between them – of course a difference in levels was found and does not contradict the argument.

Figure 93: Gini coefficient of equivalized household gross monthly pensions by gender



Source: MIDAS Germany - own calculations.

Poverty

In a next step we analyse the different income components in terms of poverty. We use the headcount ratio and the poverty gap ratio to analyse the equivalized household income components. The poverty line used in this section is 60 percent of median total equivalent income (earnings plus pension benefits).

The focus of the following comparison is on earnings and total income.[43] The poverty line takes into account both, pensions and earnings and serves as the basis of this comparison. To what extent is poverty reduced when we take into account pensions in contrast to a scenario where income results only from labour earnings? Figure 94 shows two graphs: the first graph depicts the headcount ratio for equivalized household income from labour earnings and for income from labour earnings plus pension benefits. Of course, we expect pensions to reduce poverty among households because they replace labour income rather than add to it on an individual level. Thus, taking into account total income will increase household income for pensioners strongly: it adds to earnings where generations of workers and retirees live together and it adds to zero income

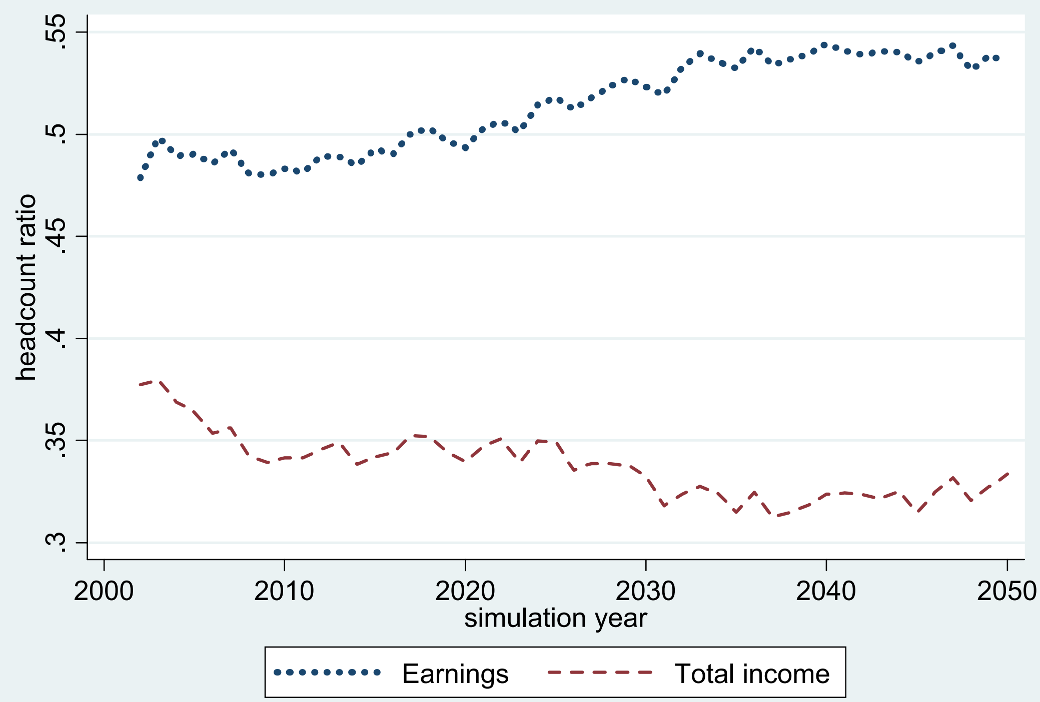
[43] Given the scope of MIDAS, various other income components cannot be simulated.

where the household consists only of retirees. That is also shown in Figure 94; the headcount ratio is markedly lower: the difference is about 10 percentage points for total income compared to earnings.

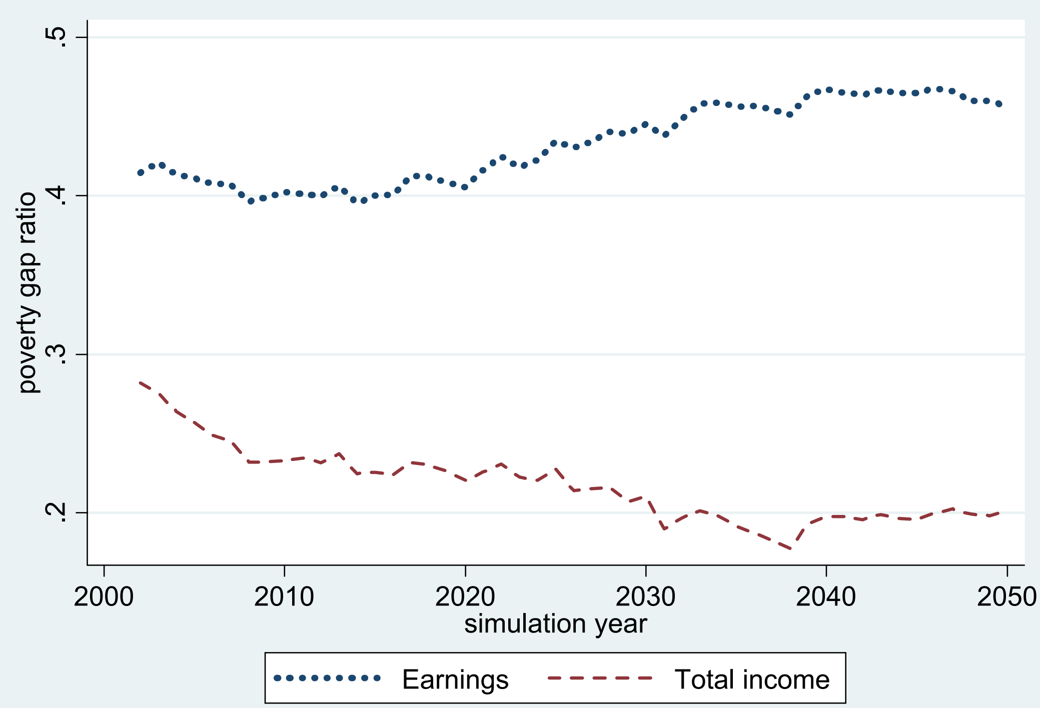
Over time, the headcount ratio of earnings increases and that of pension decreases. This corresponds quite well to the Gini that decreases for household equivalized pensions (Figure 93) while the Gini of equivalized earnings increases. Furthermore, the number of pension recipients increases in total as well as their relative share in comparison to wage earners. When we look at the second graph of Figure 94 we find a similar development of the poverty gap ratio. That is, the intensity of poverty develops parallel to the incidence of poverty.

Figure 95 shows the same statistics as Figure 94 stratified by gender. The gender income gap that was observed for all income components (with the exception of widow's pensions) has its equivalent in a higher poverty rate and a higher intensity of poverty for women. However, the graphs show an interesting effect related to that gap: the reduction of the poverty rate and gap ratio when taking total income into account is higher for women than for men. Thus, looking at total income we find a reduced gender income gap. Pensions are more equally distributed and women receive on average higher widows pensions than men, both effects lead to the lower poverty indicators.

Figure 94: Incidence (headcount ratio) and intensity (poverty gap ratio) of poverty pertaining to total income and earnings: the effect of retirement benefits

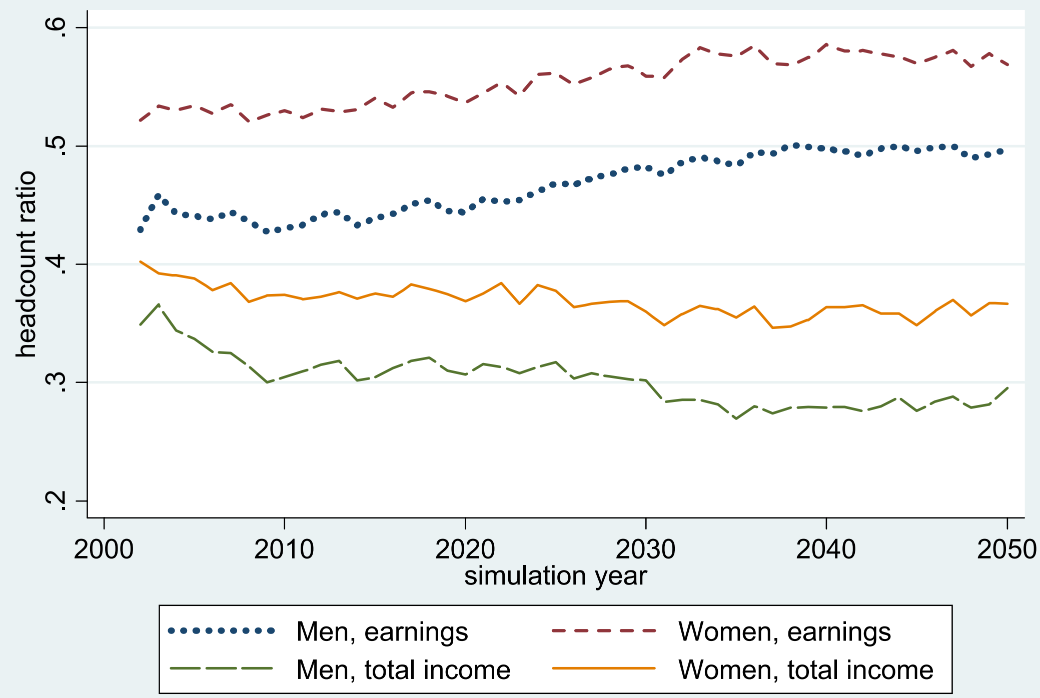


Source: MIDAS Germany - own calculations.



Source: MIDAS Germany - own calculations.

Figure 95: Incidence (headcount ratio) and intensity (poverty gap ratio) of poverty pertaining to total income and earnings: the effect of retirement benefits by gender



Source: MIDAS Germany - own calculations.

Source: MIDAS Germany - own calculations.

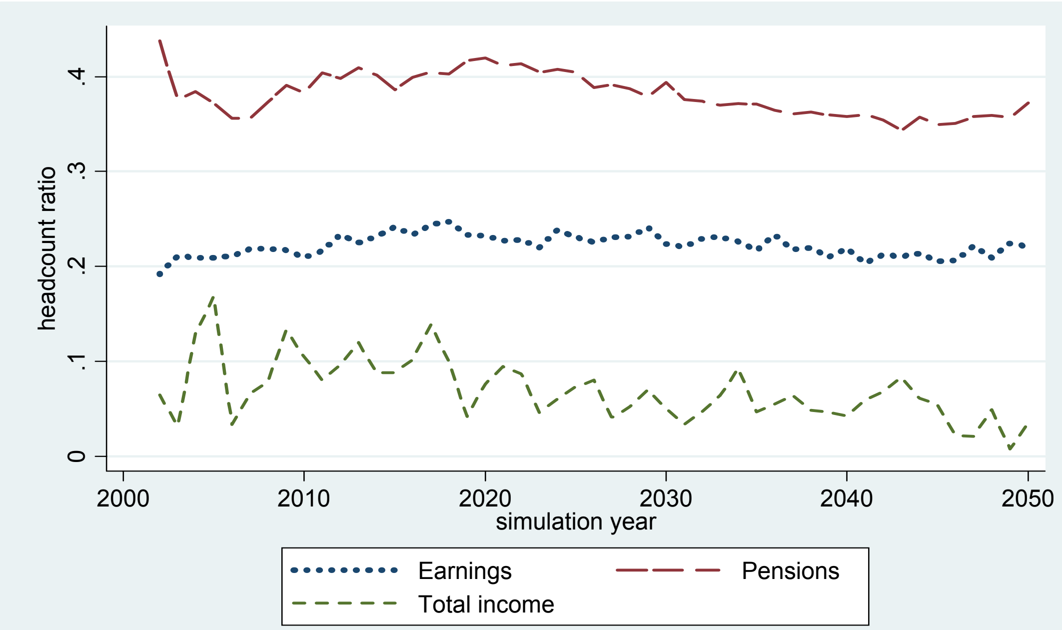
The poverty-situation of workers and pensioners

The former graphs showed that poverty is reduced when taking pensions into account. And the effect was relatively large and all graphs showed a negative trend in poverty indicators for total income. One reason for finding an effect on poverty indicators was that we compared the poverty rate and intensity with and without taking into account pension benefits. The interesting outcome was the degree to which poverty is reduced and how it develops over time in these households when taking into account pensions. In a next step we compare individuals from households with earnings, pensions or with both sources of income. Figure 96 shows the incidence and intensity of poverty among individuals with households that have only earnings, only retirement benefits, or both.

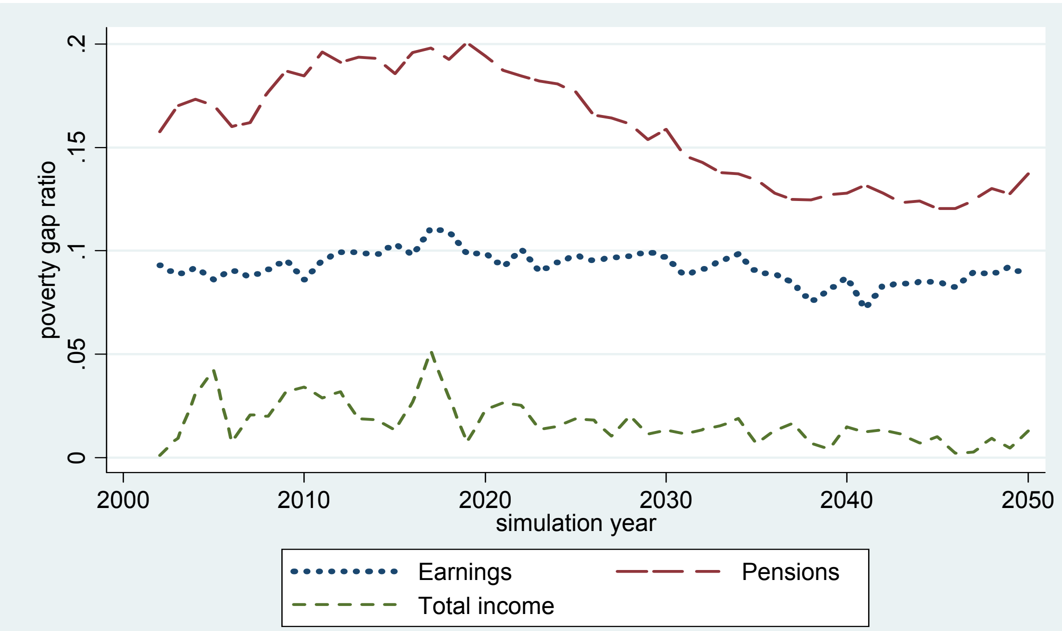
In contrast to previous figures, the differences between poverty indicators results from the difference in income sources because we only consider those households with positive income.

Receiving income from both sources, earnings and pensions, leads to a lower risk and intensity of poverty as compared to having only one source of income. The average age of wage earners in households with retired members is higher than of households in which only wage earners live. This leads in turn to higher earnings on average because of the higher human capital. On the other hand, the outcome is not necessary as such because gross pensions are lower than gross earnings on average. But we also find that older households are smaller leading to less redistribution of income to members who do not earn themselves income (children). Adding to the difference in levels, pensions show a negative trend in poverty risks and intensity over time. This trend is dominated by higher pension benefits for women and a stable or slightly negative growth for men. All households experience the aforementioned trends regardless of their sources of income. That explains the decrease in poverty risks and intensity over time for pensions and total income.

Figure 96: Incidence and intensity of poverty pertaining to individuals from working and retired households



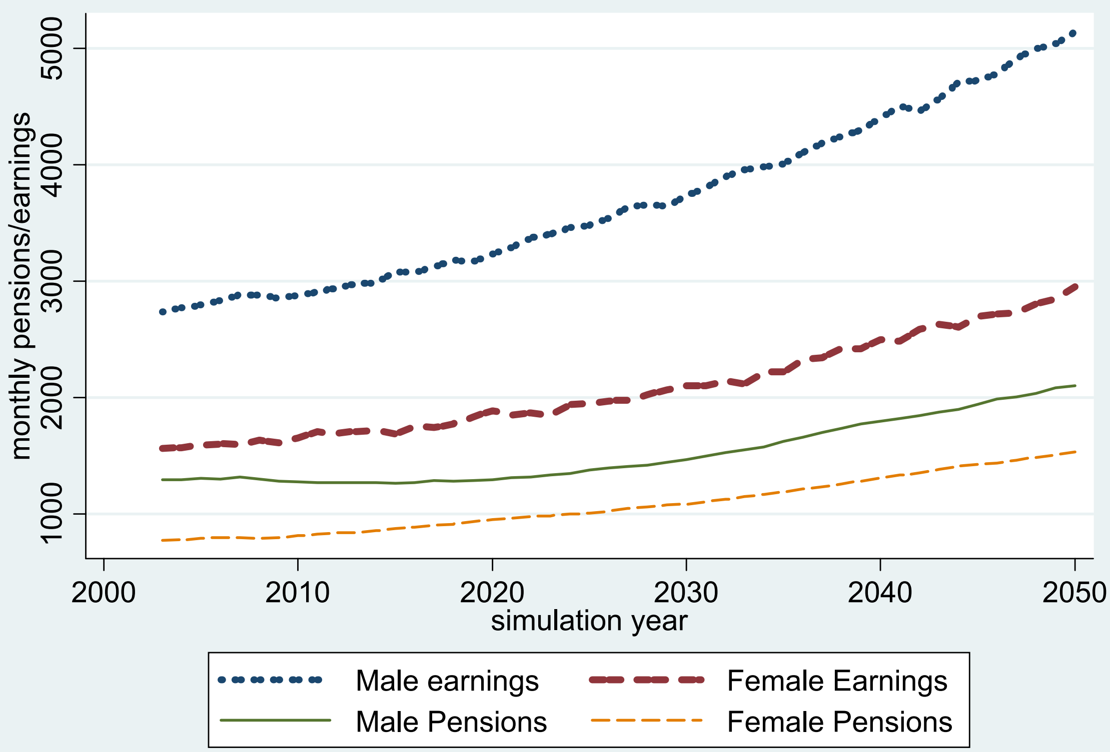
Source: MIDAS Germany - own calculations.



Source: MIDAS Germany - own calculations.

5.2.5. Alternative scenarios

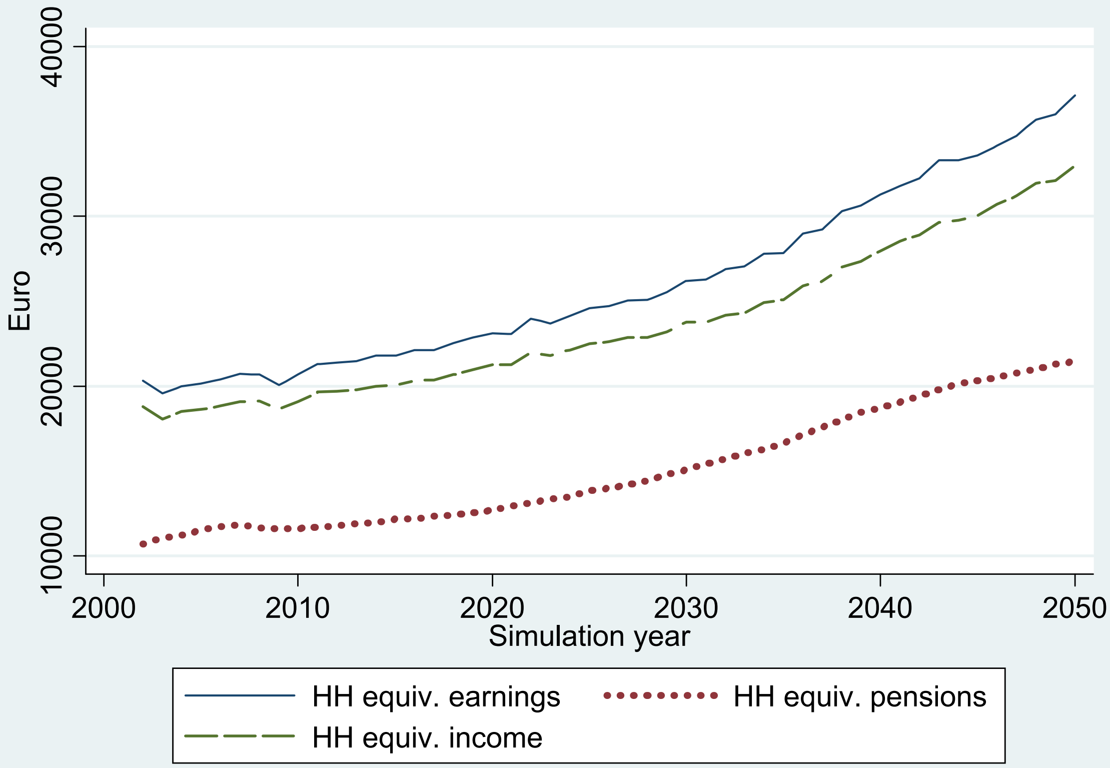
For Germany we simulated an alternative scenario that follows the pension adjustment that uses pure gross wage growth. The prior section explained that the new German legislation introduced an element in the pension formula that reduces pension adjustment to a factor lower than gross wage growth in the future. Here pensions grow with the same rate. The average female (male) retiree received total pension benefits of about 745 (1244) Euros in 2002. In 2050 this amount has more than doubled for women with about 1534 Euros. Men experienced a slightly slower pension growth with an amount of 2103 Euros in 2050. In both cases pension grow faster or stronger than in the basis simulation.



Source: MIDAS Germany - own calculations.

In the former scenario we already observed that the household context modifies these growth rates such that the relative increase in household equivalent pension income increases more strongly than household earnings (compare Figure 91). This explains why the household equivalent pension income in Figure 97 more than doubles while earnings increase by about 80 percent.

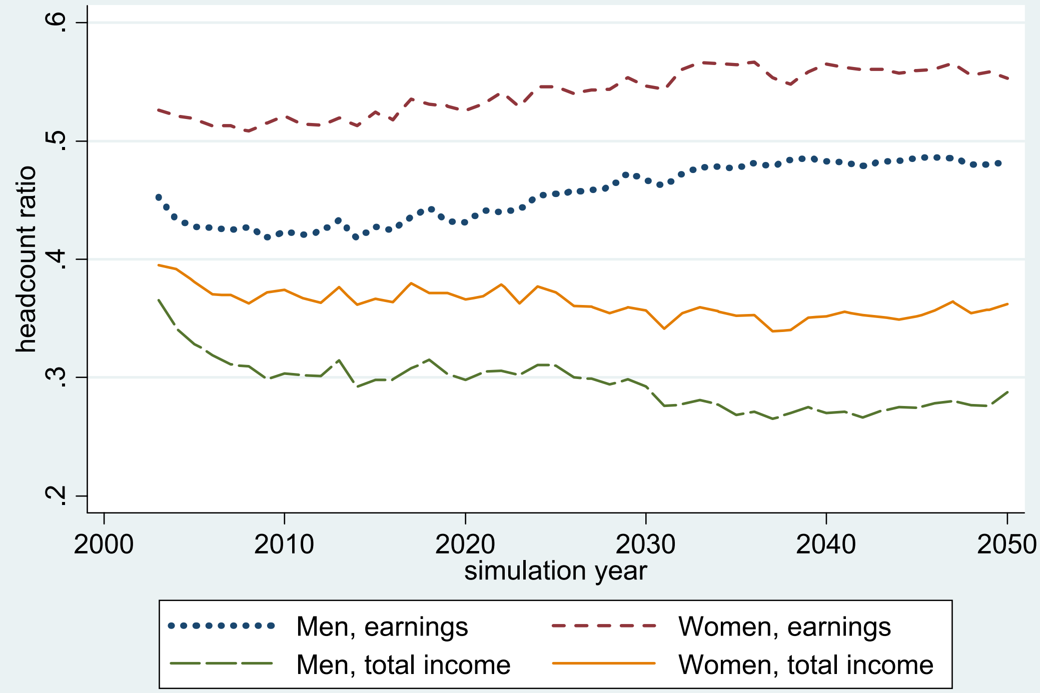
Figure 97: Household equivalent annual earnings, pensions and income (earnings+pensions)



Source: MIDAS Germany - own calculations.

How does this effect in household income levels translate to poverty? The next graph (Figure 98) shows the poverty indicators stratified by gender. The effect of higher pension adjustment turns out to affect the level of both poverty measures but not the shape of their development. The same conclusions hold true that were drawn from Figure 95: pension reduce the risk of poverty significantly and narrow the gender income gap. This variant of a higher growth adjustment of pensions lead to lower poverty indicators.

Figure 98: Incidence (headcount ratio) and intensity (poverty gap ratio) of poverty pertaining to total income and earnings: the effect of retirement benefits by gender



Source: MIDAS Germany - own calculations.

Source: MIDAS Germany - own calculations.

5.2.6. Conclusions

This section presented the results of MIDAS for Germany with a special focus on adequacy. The first section presented the results of the demographic simulations. The most important result was that demographic ageing in Germany will be steep and fast in the coming years resulting in considerable pressure on the public pension pay-as-you-go system. The model does not include immigration which could mitigate the ageing process but is not likely to reverse it.

Borrowing form AWG projections we aligned our simulated employment rates. AWG projections imply a remarkable increase in labour force participation for both men and women. Albeit we observe an increase in female labour market participation the model does not show that the gender wage gap narrows or that inequality among women in terms of income determinants narrows. This might be a possibility for further improvements of the model and it is likely related to the modelling of educational attainment, which is assigned in a static manner with statistics from 2002. However, the main outcomes of this section are relatively stable individual income variables and the increase in the employment rates.

The next section sheds light on the implications for pensions: First, we consider the development of the level of public pensions. As individual pensions in Germany depend on the earnings history over the whole working life, the reported results are based on backward estimations of pension rights accumulated up to starting year of the simulation and the simulation itself. The results indicate that the average level of pension rights based on the earnings of employees will remain rather stable if one neglects productivity growth. The last reforms have strongly limited the amounts of additional pension rights granted for example for periods of schooling and unemployment which tends to reduce the pension level in the future. On the other hand, pension rights for the raising of young children, which are usually granted to the mother, raise the pension level of women. These effects will however be dominated by growth effects if productivity increases by the rates expected by AWG. An important caveat refers to the pensions of civil servants. The model does not well capture the transition to and from the state "civil servant" which leads to an underestimation of the share of civil servants and an underestimation of the respective pensions for former civil servants.

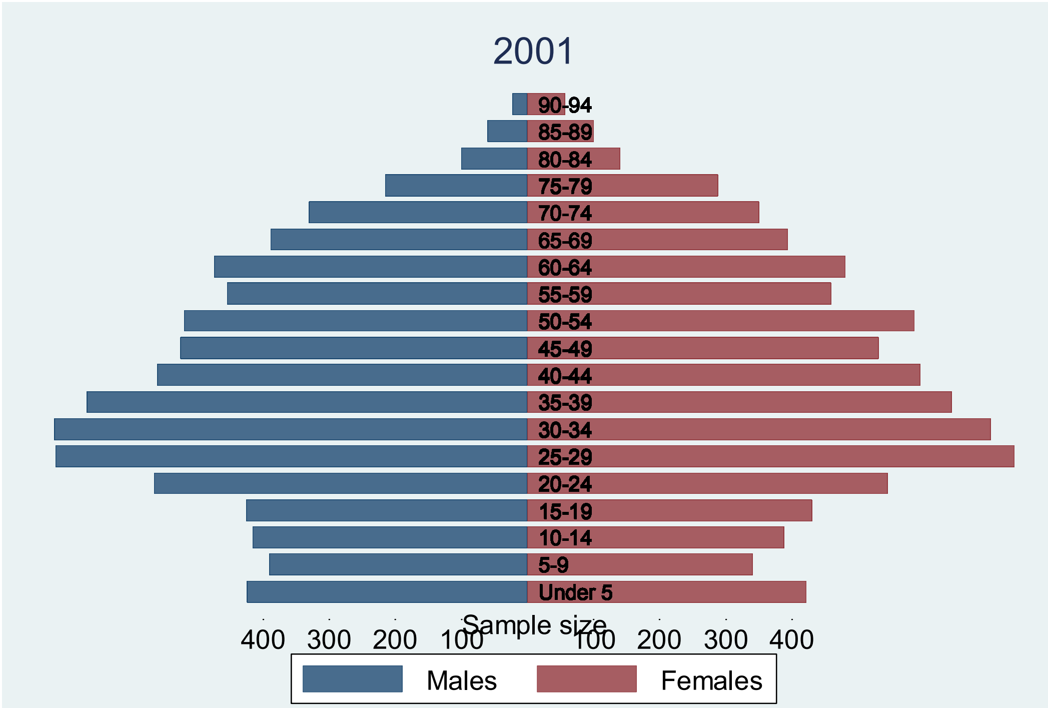
When drawing conclusions from the model, the current scope of MIDAS has to be taken into account. In particular the reduced modelling of income sources does not allow for general statements about poverty or inequality with respect to the whole population. However, we can make comparisons of the modelled income components, between them and over time which both showed to be valuable given the technical framework of MIDAS. It was shown that pensions have a considerable effect on the reduction of inequality of household income. In particular the model emphasizes the role of surviving spouse benefits for women. Furthermore, pensions in total household income result in a narrower gender income gap and help to reduce gender inequality in terms of material resources. Of course this section also showed that the household context is of great importance for poverty and inequality measures which leaves room for further improvements of MIDAS and the extension to other income sources and net figures.

5.3. Italy

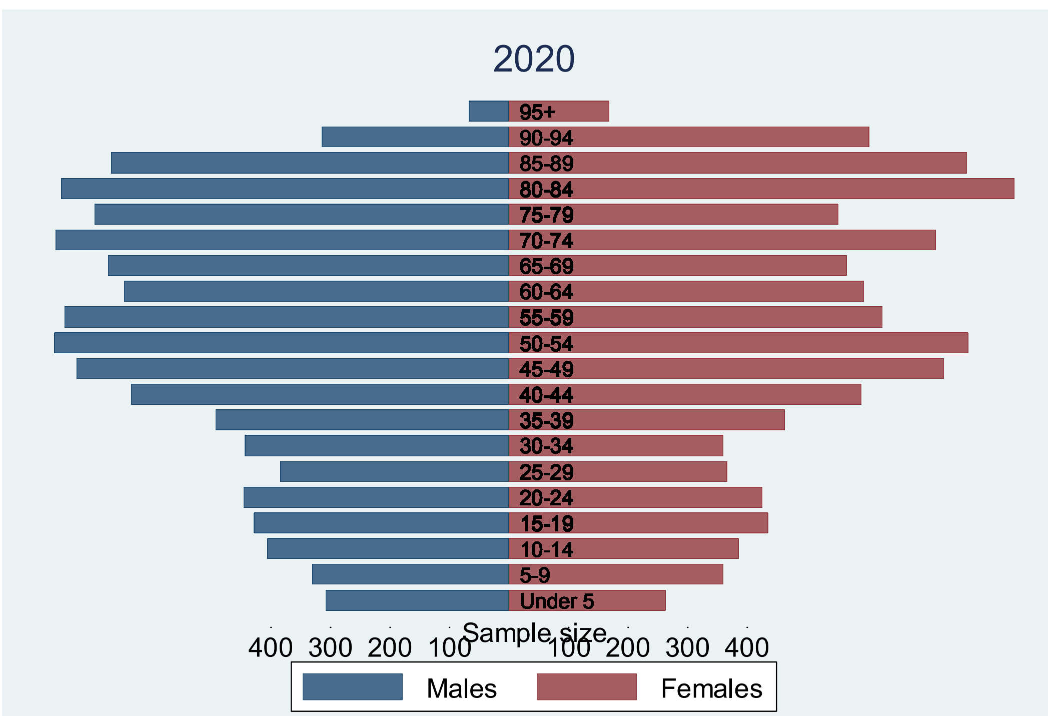
5.3.1. Demographics

Analogous to the Belgian and German versions of the model, population growth in the Italian version of MIDAS is driven by the demographic projections of the AWG. The distribution of the population by age and gender along the simulation years is shown in Figure 99. The age-composition of the population is reported for years 2001 - the base year for Italy – and for the simulation years 2020, 2035 and 2050. In the base year, most of the population is concentrated in the young cohorts, aged between 25 and 39. In year 2020, the younger cohorts are already less populated than the older ones. This process of ageing population continues during the simulation years. The dependency ratio (the ratio of the elderly population aged 64 and over) to the active population (aged between 14 and 64) more than triples - from 0.22 in 2001 to 0.70 in 2050. This result it is not surprising since Italy is one of the countries with a very high rate of population ageing and a very low fertility rate. A secondary reason is that the model does not directly take into account immigration. The distribution by gender remains fairly stable over the simulation period with only a slight increase in the proportional size of the male population. This is not shown in a separate figure.

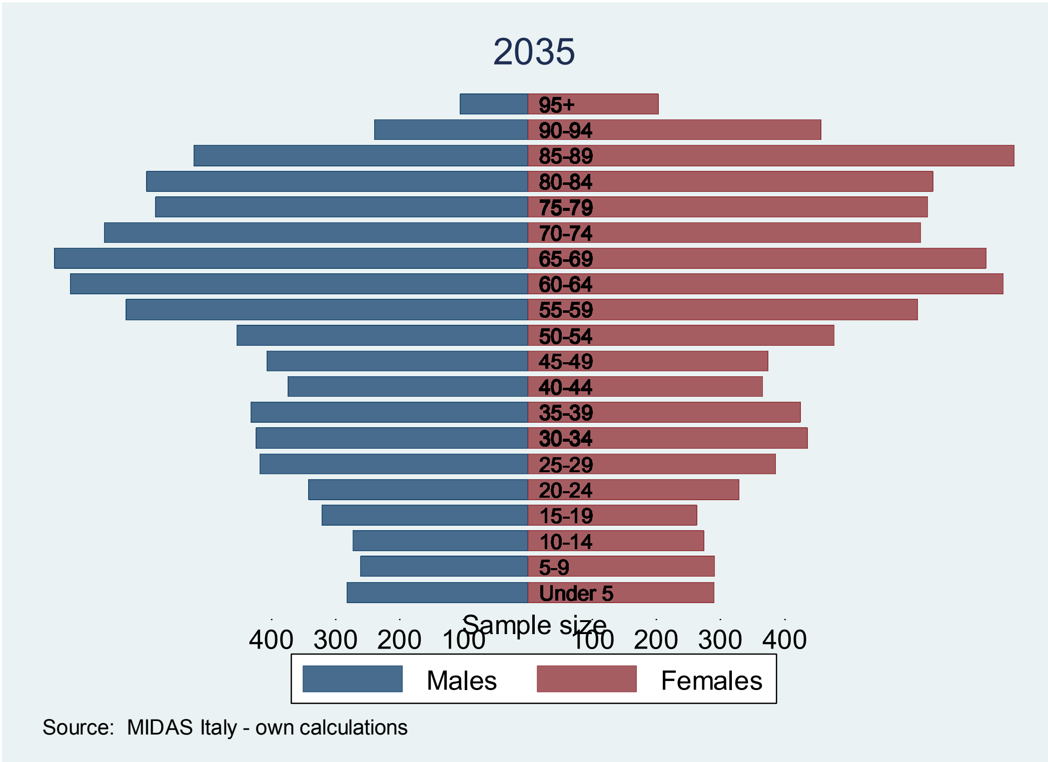
Figure 99: Males and females in age groups in selected years

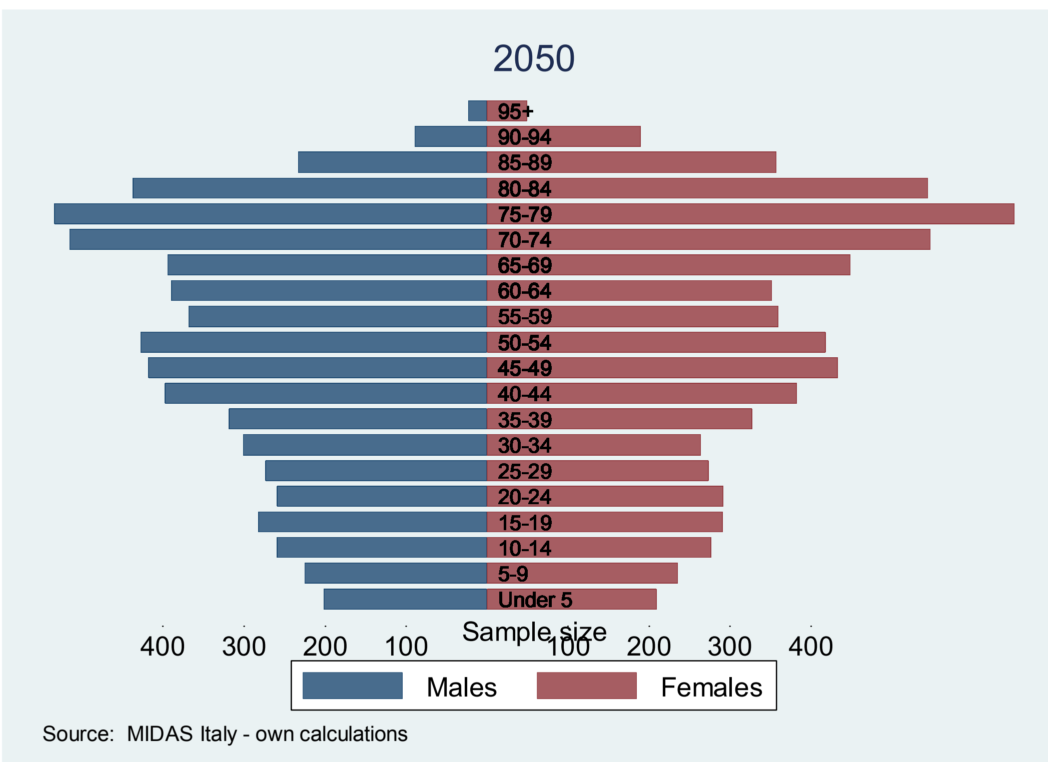


Source: MIDAS Italy - own calculations



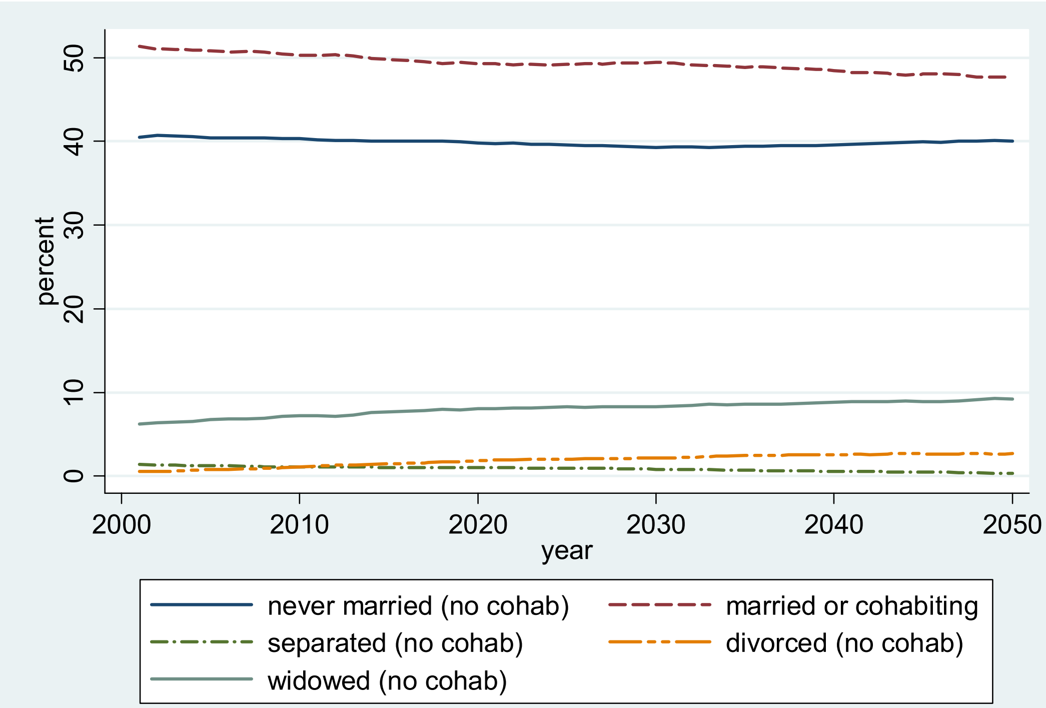
Source: MIDAS Italy - own calculations


2035
95+
90-94
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
Under 5
400 300 200 100 100 200 300 400
Sample size
Males
Females
Source: MIDAS Italy - own calculations


2050
95+
90-94
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
Under 5
400 300 200 100 100 200 300 400
Sample size
Males
Females
Source: MIDAS Italy - own calculations

The simulation results of the marriage market where the family formation and dissolution is simulated are presented below. Starting with Figure 100 that shows how the population is distributed by marital status, taking married and cohabiting individuals together.

Figure 100: Proportional size of marital status



Source: MIDAS Italy - own calculations

The majority of individuals live in a partnership (legally married or cohabiting), followed by singles (those never married divorced or separated) which account for about 40% of the total. The high proportion of singles is largely due to children still living with their parents and having no spouse or partner. The other categories (widowed, separated, divorced) are therefore proportionally much smaller. While the proportion of singles in Figure 100 remains fairly stable, that of married individuals declines steadily, a decrease that is counterbalanced by the increase of those never married, widowed and divorced. These trends are consistent with an ageing population over the simulation years. Moreover, within the group of those being in partnership, the proportion of cohabiting individuals' increases compared to the proportion of married individuals as shown in Figure 101.

Figure 101: Proportional size of cohabiting individuals within the group of those living together

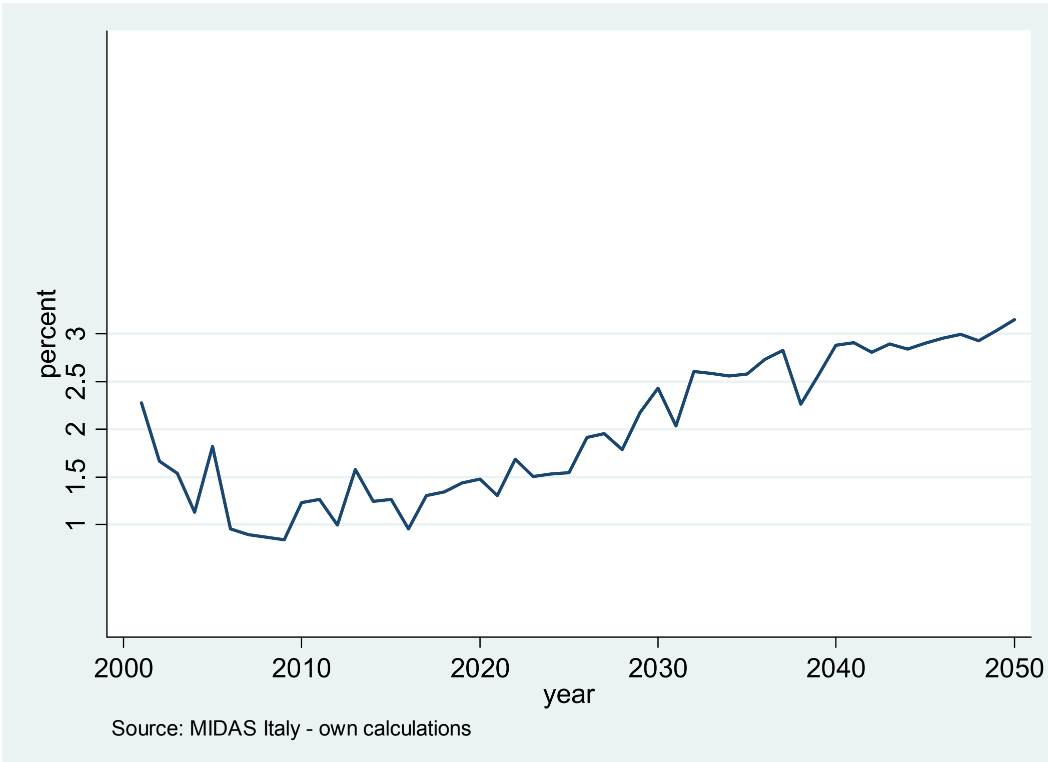
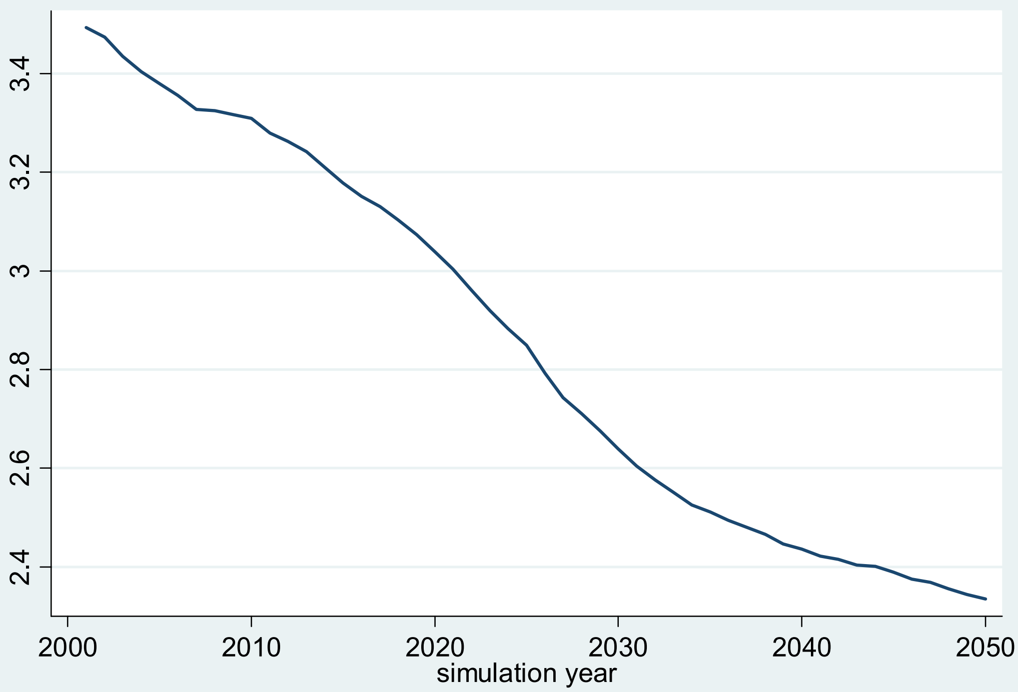


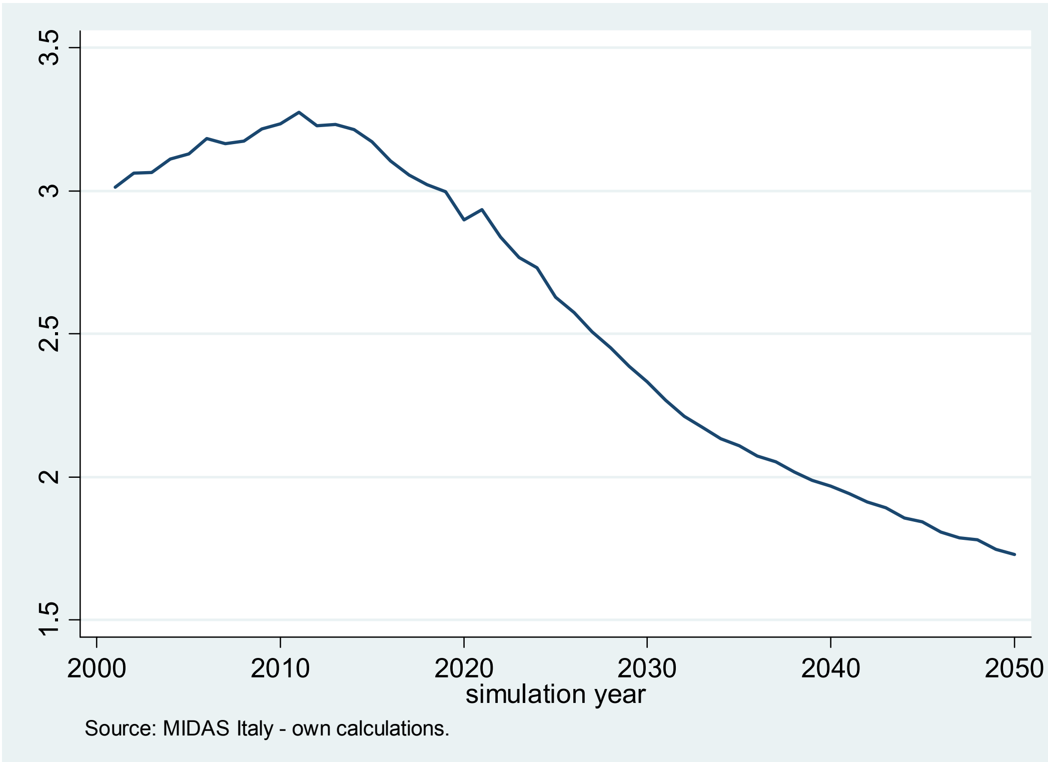
Figure 102 shows a declining number of individuals in the households during the simulation years and this is related to the decreasing marriages and increasing divorces and separations. As already signaled in the Belgian case the decreasing trend in household size is also attributable to the way households' creation is modelled in Midas, essentially forcing single individuals to form a new household after a certain age.

Figure 102: Average number of individuals in households



Source: MIDAS Italy - own calculations.

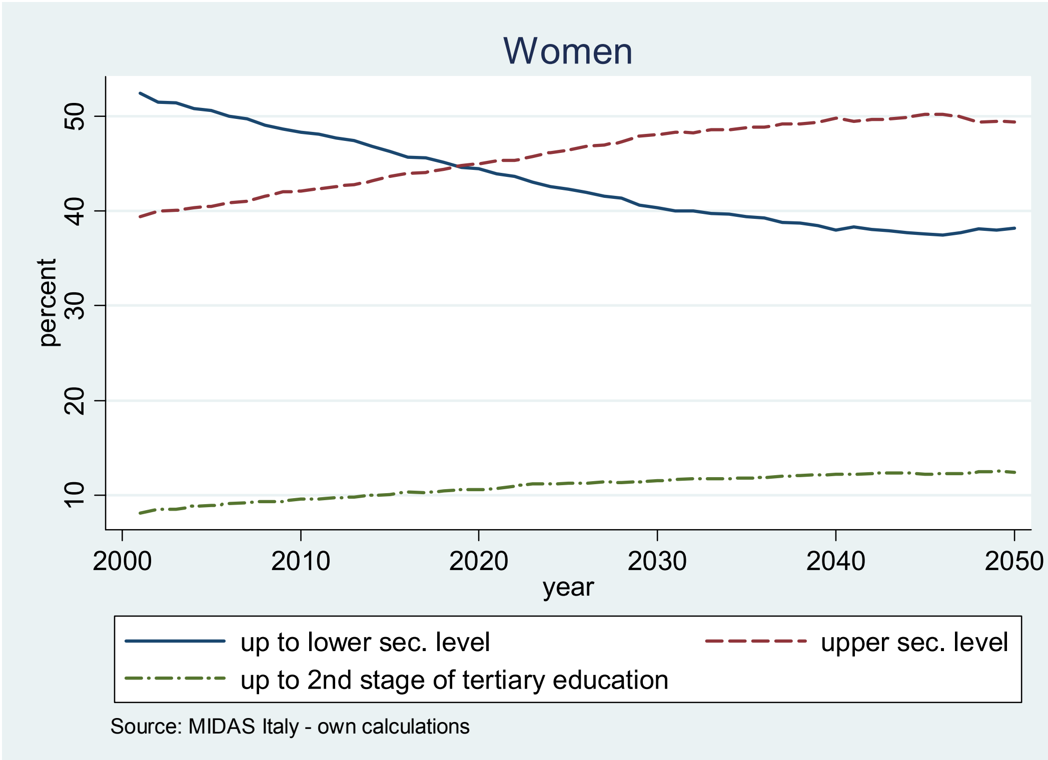
Figure 103: Average number of individuals in households where at least one individual is retired

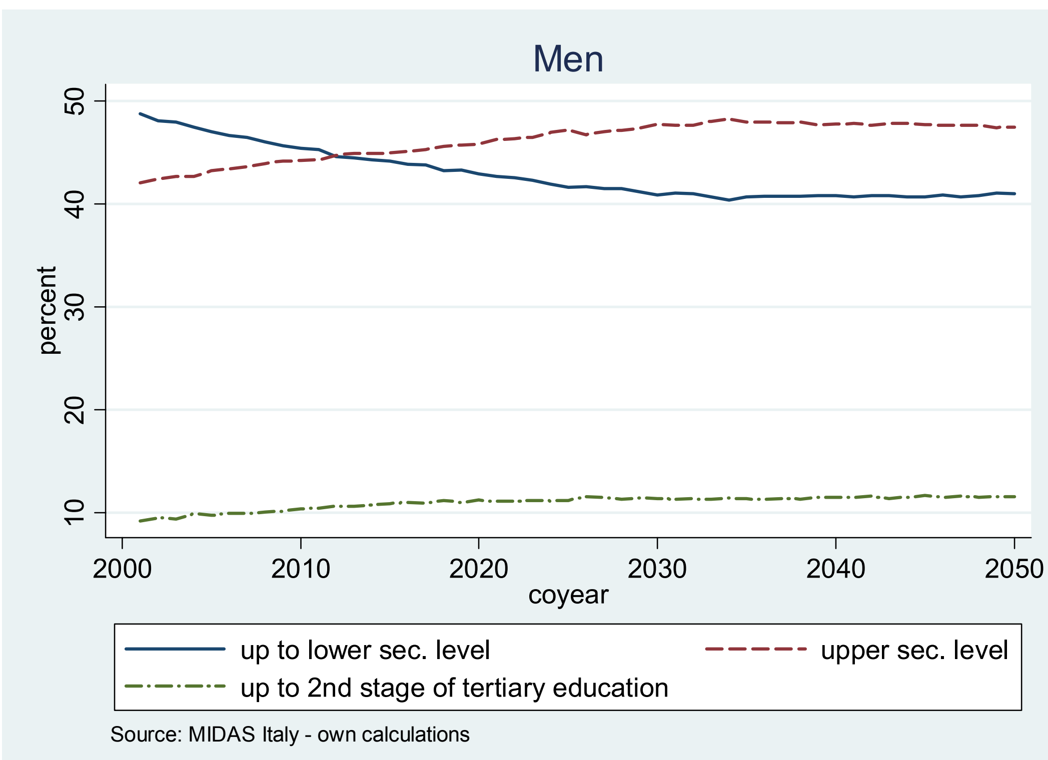


On the other side even the elderly form households on their own; as is shown in Figure 103 where the number of individuals of the households in which at least one is retired declines along the simulated years but the decrease started later on after 20 years of simulations. These households with retired, that are mainly elderly, have a lower probability of marriage dissolution compared to the younger ones; moreover with higher probability the sons have already left these household. When the multigenerational households are replaced by the simulated one, the models assumption on household creation and dissolution cause a decreasing a decline in the households size even in where there is at least a retired individual.

The distribution of population over time by educational level and gender is shown in Figure 104.

Figure 104: Proportional educational attainment of women and men



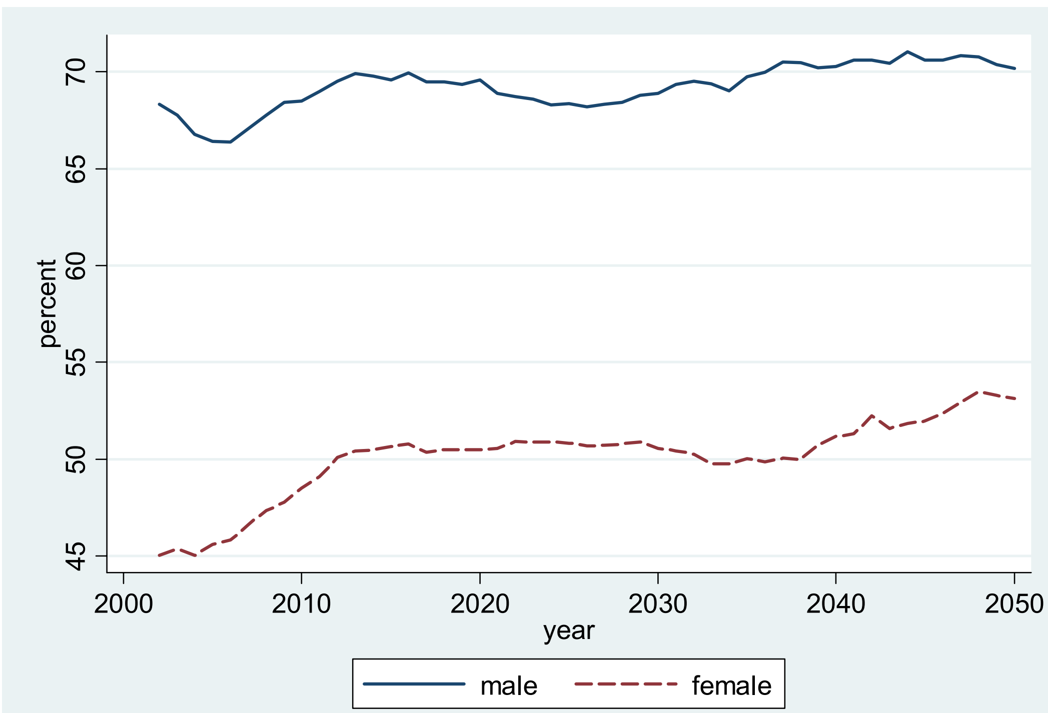


For both men and women, the simulated average level of educational attainment rises over time. However the increase is mostly due to women large increase in the share of secondary and tertiary education, while, on the other side, the proportion of individuals with lower level of education (ISCED equal to 2 or lower) decreases. Compared to countries such as Belgium and Germany, the proportion of individuals with high education level is low in Italy, and is consistent with the alignment based on the observed proportional attainment levels of individuals between 30 and 34 years of age[44].

5.3.2. Labour market states and earnings

As already said for Belgium and Germany the working population is aligned to the country-specific activity rates of the AWG by age and gender. Figure 105 shows the percentage of males and females who are in work.

Figure 105: Proportional size of working population between 16 and 64 year old



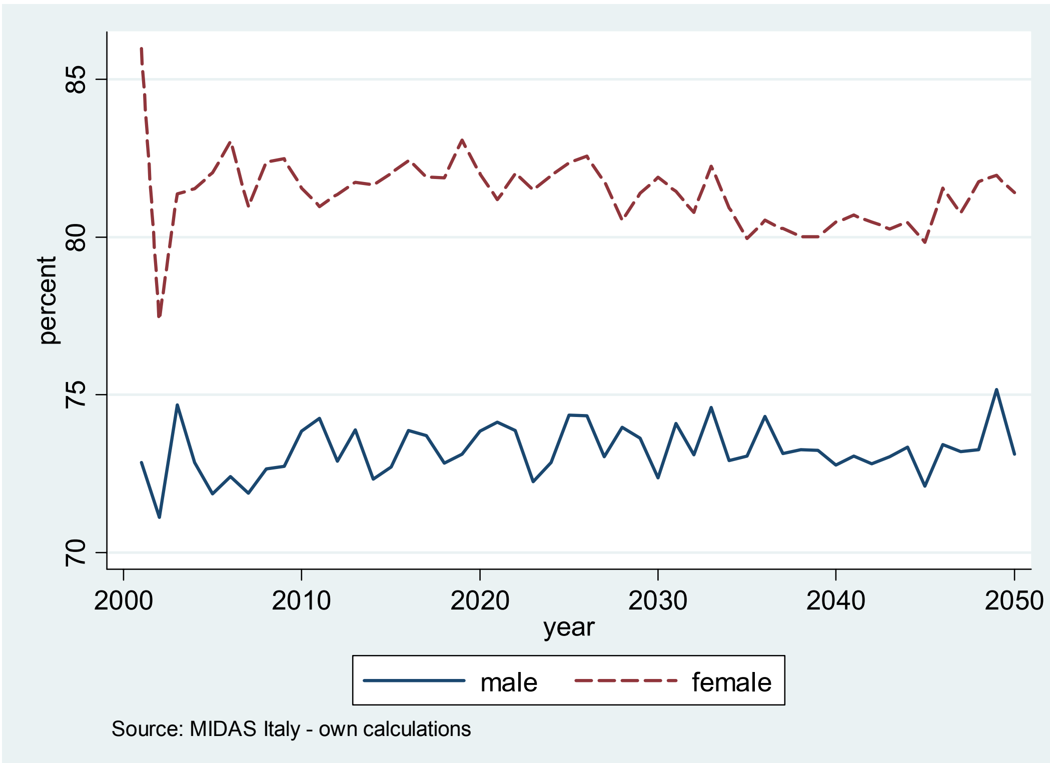
Source: MIDAS Italy - own calculations

[44] The assumption set that in the simulation years the majority of individuals have completed their education by the age of 30 and - at the same time - they are representative of the youngest generation.

The males activity rate is quite stable during the simulation times while the females activity rate increases up to about 2015, then it continues to have a slight increasing trend consistently with the AWG projection that indicate an increasing activity rate for women.

Next, Figure 106 shows the number of employees as a proportion of working population by gender.

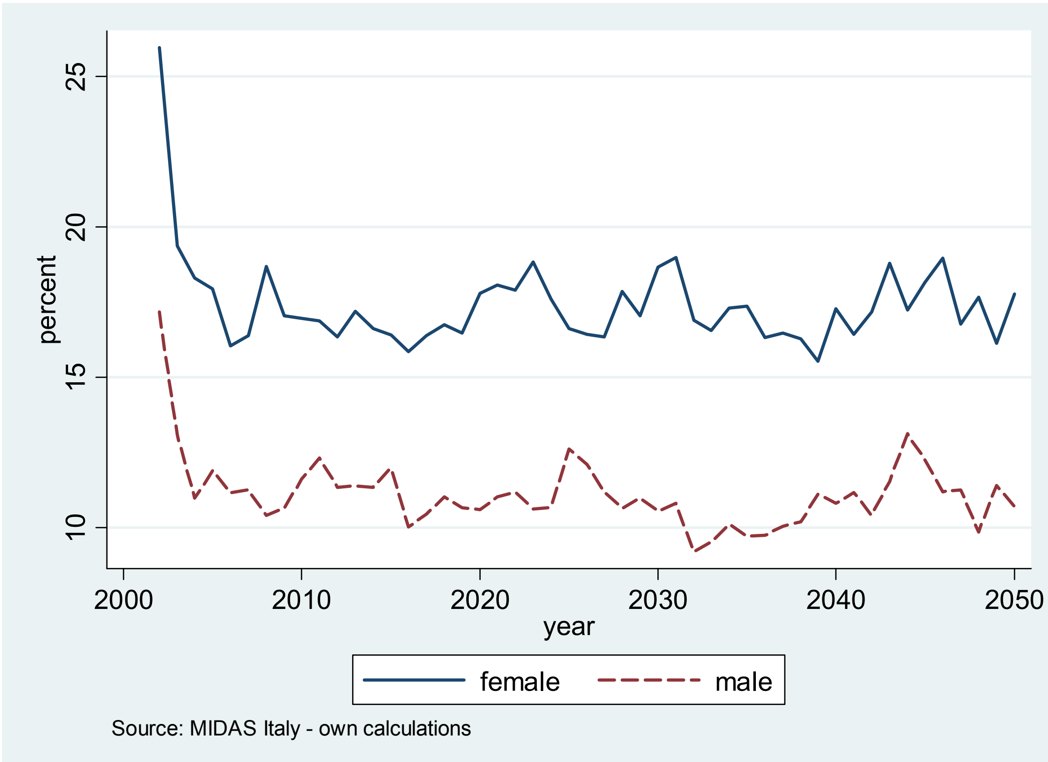
Figure 106: Employees as a fraction of working population



This figure highlights that men have a lower probability to be employee than women but that this difference is smaller in the simulation years than in the starting year 2001. For males, the employee's percentage range between 72-75%, and for women, it lies around 80%; these values are both in line with the values of the current national statistics.

Employees can work either in private or in public sector. Figure 107 shows the proportion of workers in the public sector, as a fraction of respective employees by gender.

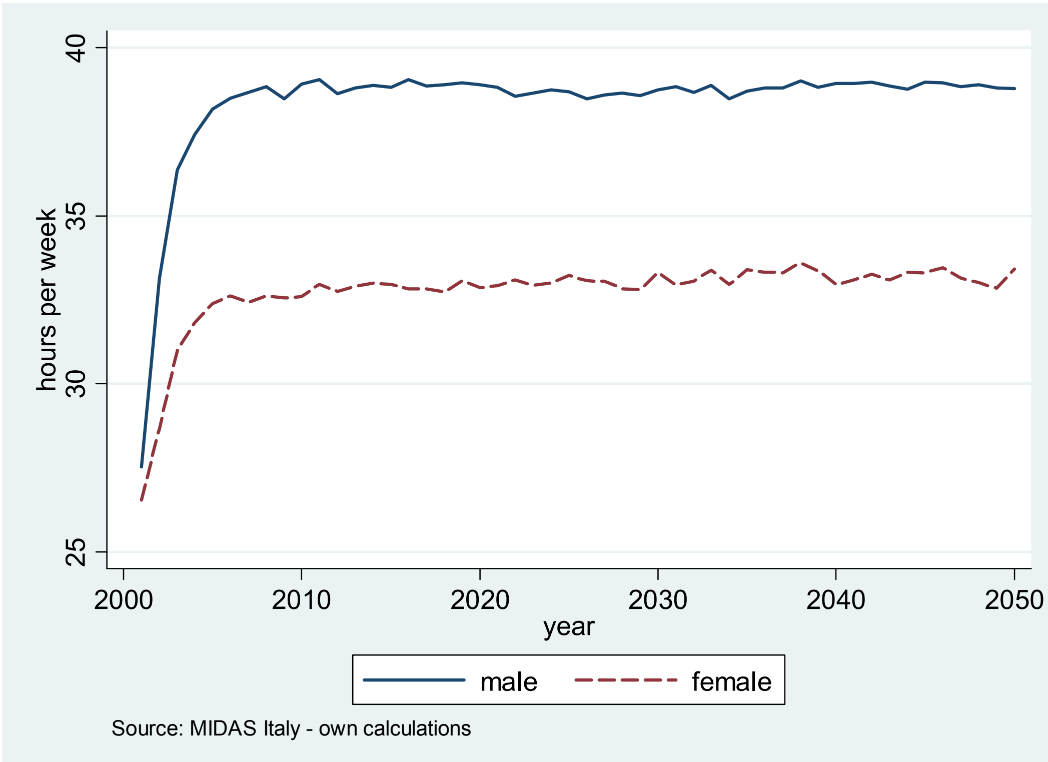
Figure 107: Workers in the public sector as a fraction of employees



This figure shows that women have a higher probability of working in the public sector than men. The proportion of workers in the public sector - both men and women – considerably decreases between the base year (2001) and the starting years of simulation and then become quite stable during the next simulated years. In this case the starting year from the ECHP data set overestimate the number of public employees, while during the simulation years the percentage of public employees is slightly lower than the current ratio.

The other important part of the labour market module determines the annual wage. Gross earnings and their components - hourly wage-rate, the number of hours worked per week and the number of months worked per year - are examined in the following figures. These wages components are estimated using a GLS estimator for panel data with random effects. The individual effects, once estimated, pertain to the individual for all his or her working life. Figure 108 represents the average reported number of hours worked per week, distinguishing between men and women in work.

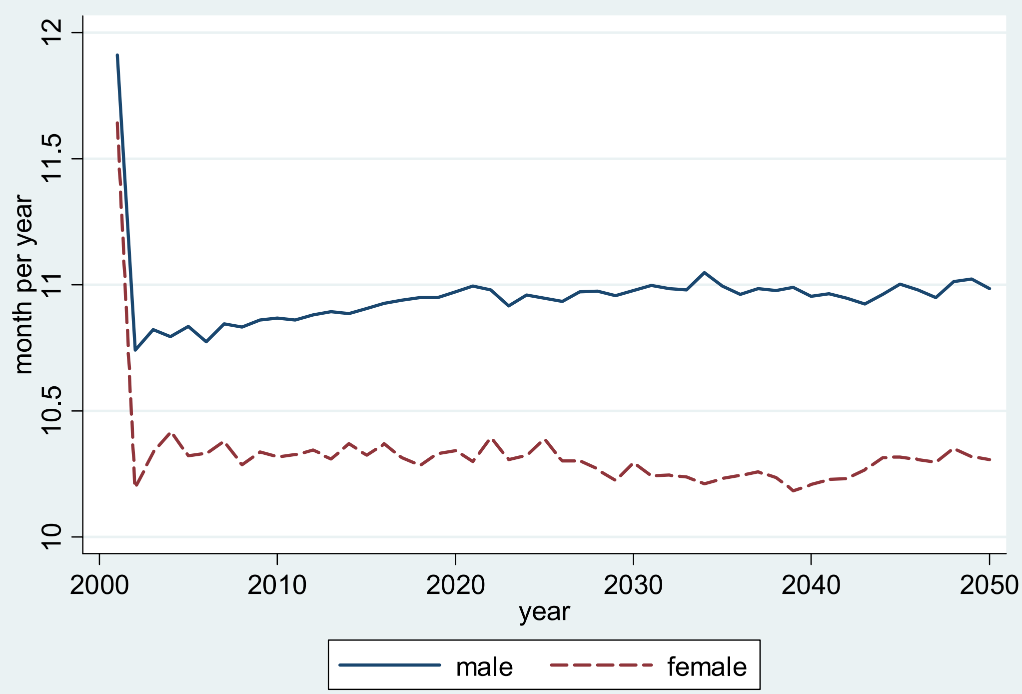
Figure 108: Average actual number of hours worked per week of employees



A difference of about 5-6 working hours per week exists between women - reporting between 32 and 33 hours -and men (around 38 hours) starting from the first years of simulations and remain more or less the same until 2050.

Figure 109 presents the number of months worked per year by gender.

Figure 109: Average number of months worked per year of employees

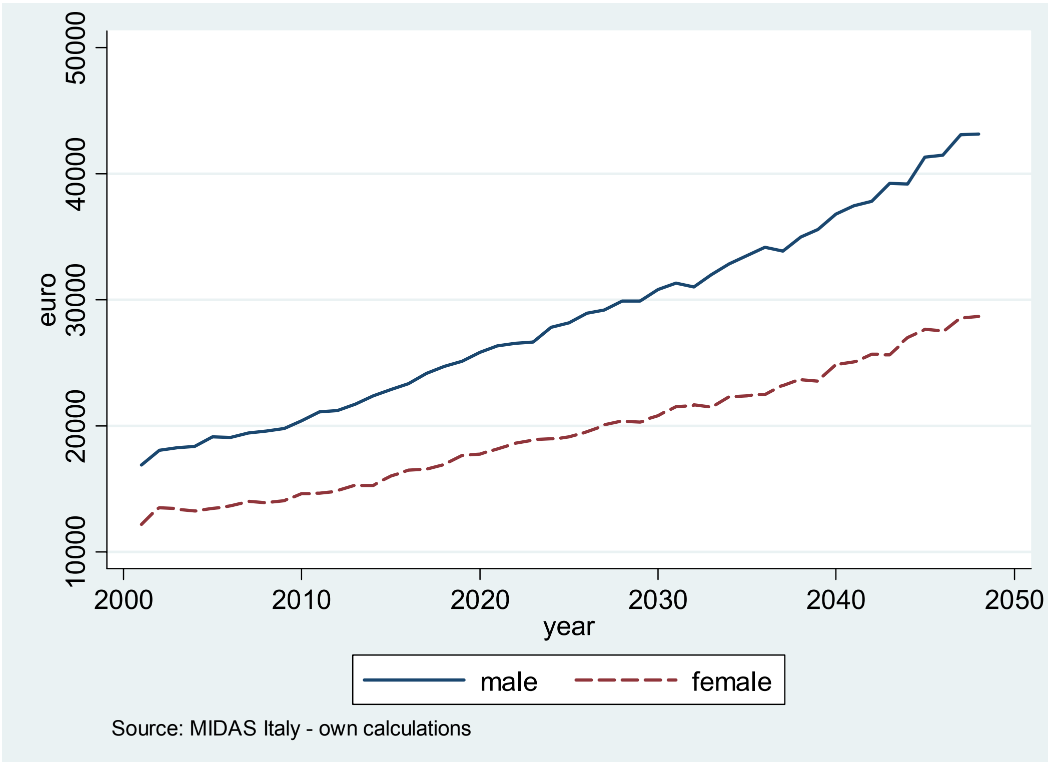


Source: MIDAS Italy - own calculations

For men, the average number of months worked decreases slightly from the base year to the first year of simulation and then grows slowly in the next simulated twenty years up to stabilizing at around 11 months. For women, there is again a considerable decrease between the base year and the first year simulated and then it fluctuates between 10.2 and 10.4 decreasing somewhat after 2025.

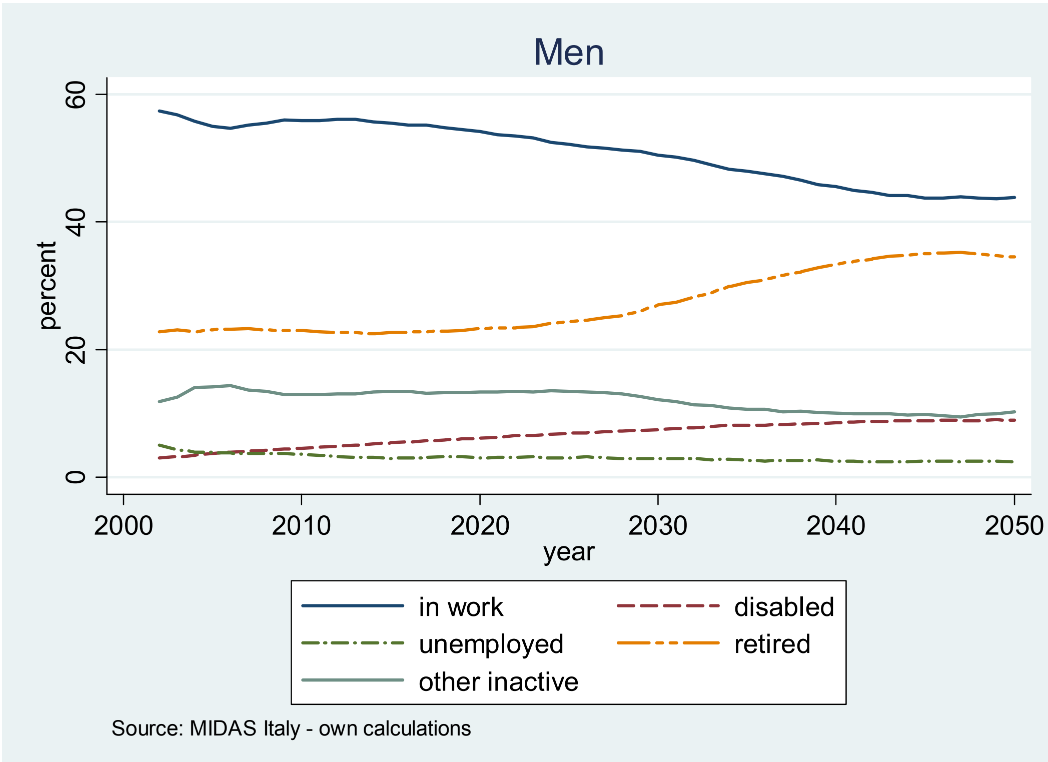
The annual wage is calculated as the hourly wage (increased with the productivity growth rate assumed by the AWG projections) times the number of hours per month, times the number of months per year. Figure 110 also shows that the gender wage gap increases somewhat during the simulation years.

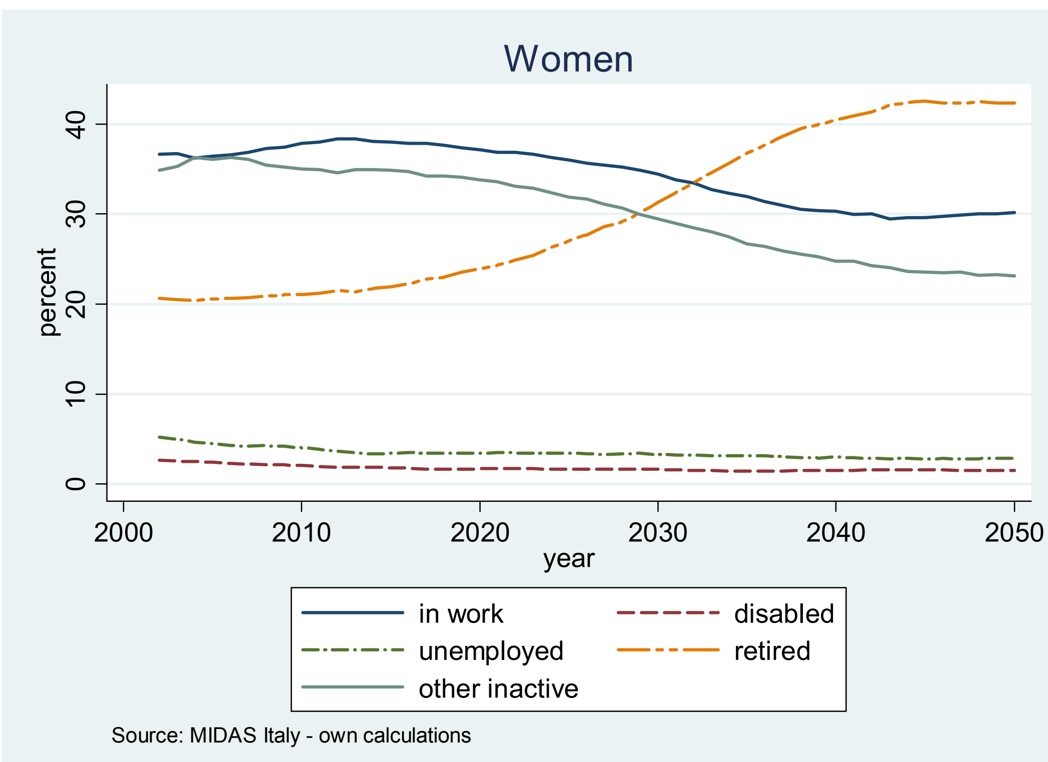
Figure 110: Average gross annual wage



Finally, if an individual is not in work, he or she can be unemployed, disabled (for Italy this coincide with being an invalidity pension recipient), retired or -as a residual component- being 'other inactive'. This last state includes students and housewives. Figure 111 presents the separate development of labour market states for males and females of 16 and older. In the simulation time the trends of the in work, retired and other inactive reflect the demographic ageing, and this effect is more evident after 2030. The percentage of retired women increases over time and after 2030 they are more than working women and than other inactive. With respect to the other inactive, this result is mainly due to the impact of the NDC system reform - fully working after 2030. This reform will allow women to receive a pension benefit even accruing a short years of working life increasing the probability of having a pension. Relevant effects are related to the increasing activity rate during the next period: the rate is expected to rise in the first periods and then to tend to stabilization. The increase in the first period produces a shift from the other inactive towards the retired in the following periods: the stabilization of the activity rate in the last simulation years allows an explosive effect of ageing that produces a number of retired women higher than working ones.

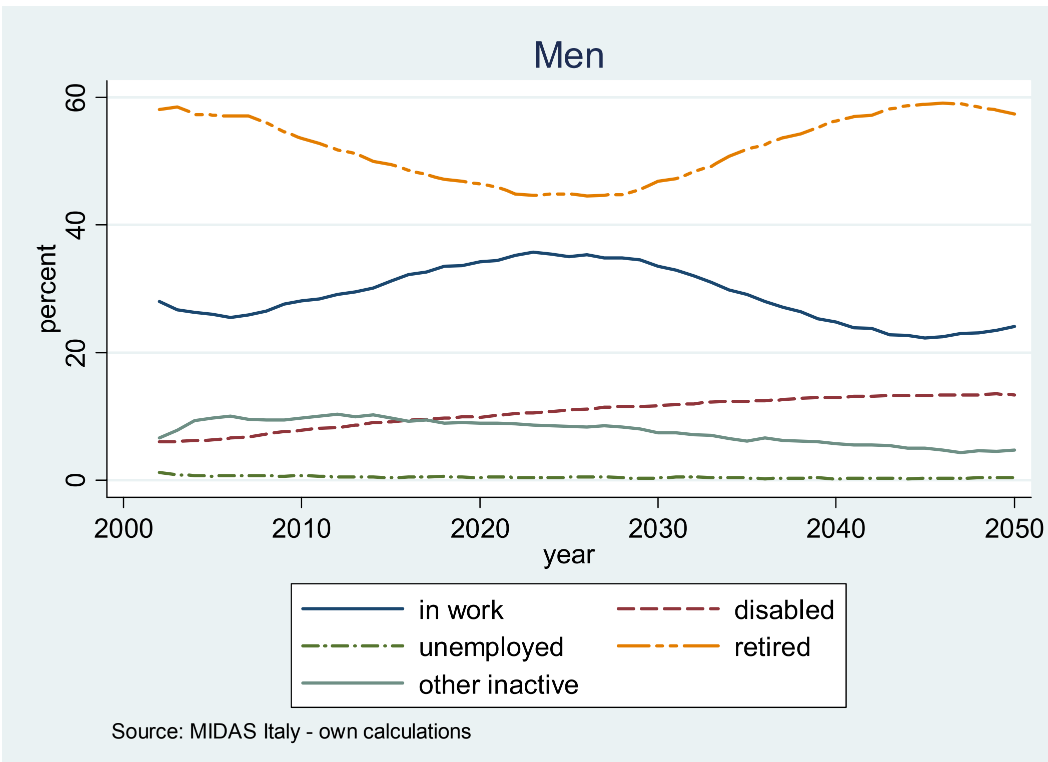
Figure 111: labour market status of individuals of 16 and older

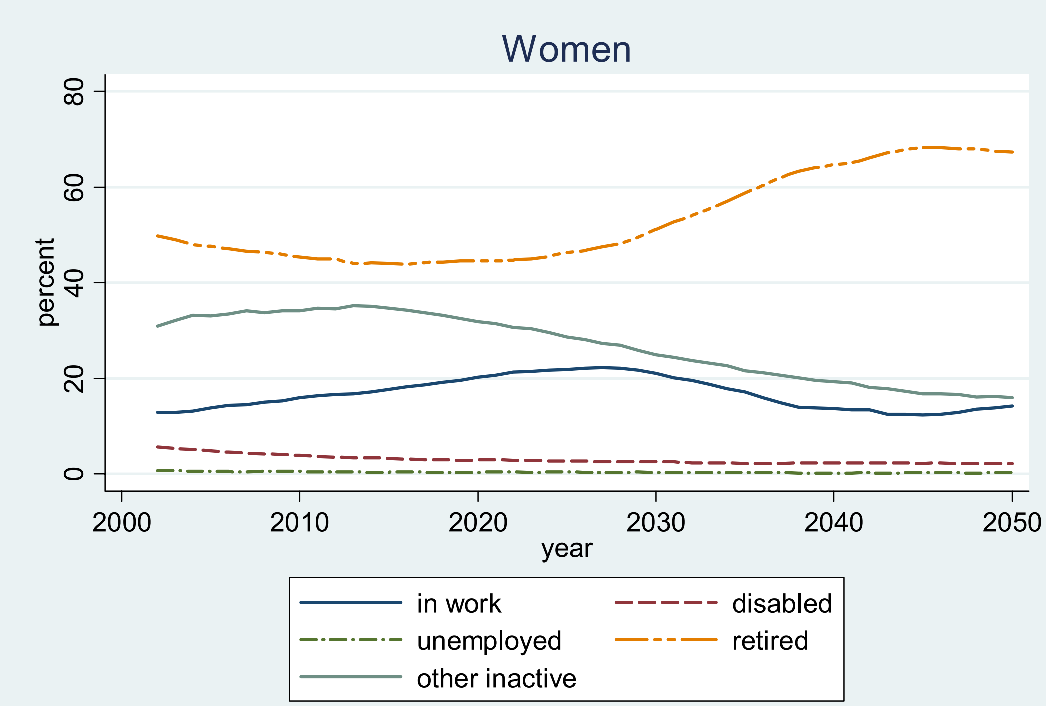




Given their lower probability of being at work and of being not active, it may come as no surprise that the state of being retired is the most important among the population aged 50 and older. The ageing effect is more evident during the last twenty years of simulation when the percentage of elderly increases considerably. There are no relevant changes in the other states, except that the percentage of disabled men increases somewhat, while it remains stable for women.

Figure 112: labour market status of individuals of 50 and older





Source: MIDAS Italy - own calculations

5.3.3. Retirement

As outlined in section 4.3.3., in last 15 years Italy has seen many pension reforms, concerning both requirements for being eligible to early retirement (i.e. for receiving a seniority pension) and the formula for computing benefits, that changed from an earnings related to a notional defined contribution one. However, both reforms are phasing in gradually: requirements for seniority pensions, tightened by the 2007 reform, are going to increase until 2013, while, as a consequence of the very slow phasing in of the 1995 reform which introduced the NDC formula, up to 2015 the bulk of retirees will receive a benefit wholly earnings related, while only after 2030 the most of individuals retiring from work will get a fully notional defined contribution pension. As a consequence, time-series results presented for Italy in this and in the following sections are clearly affected by the slow phasing in of the reforms.

The present section starts with presenting simulation results of the retirement age and the length of the career. Next, we analyze average values of pension benefits and replacement rates for streams of individuals entering into retirement in each year. Finally, we compare, for the stocks of workers and retirees, average earnings and retirement benefits. The next section 5.3.4 will then assess the adequacy of pensions by computing inequality and poverty indexes. Section 5.3.5 will then discuss some alternative scenarios, comparing the main results provided in these scenarios with those computed in the baseline one. Before doing so, however, two important points have to be made[45].

First of all, Italian pension benefits include four different items: "pure benefits" (i.e. computed according to pensionable wages and/or contributions paid), integration to the minimum pension (paid in mixed and earnings related schemes for topping up benefits lower than a specified threshold)[46], disability transfers and survivor pensions. In the analyses concerning average benefits (for stocks or flows of retirees) we refer to the sum of "pure" pensions and minimum integration, while inequality and poverty will be assessed referring to the sum of all four items afore mentioned.

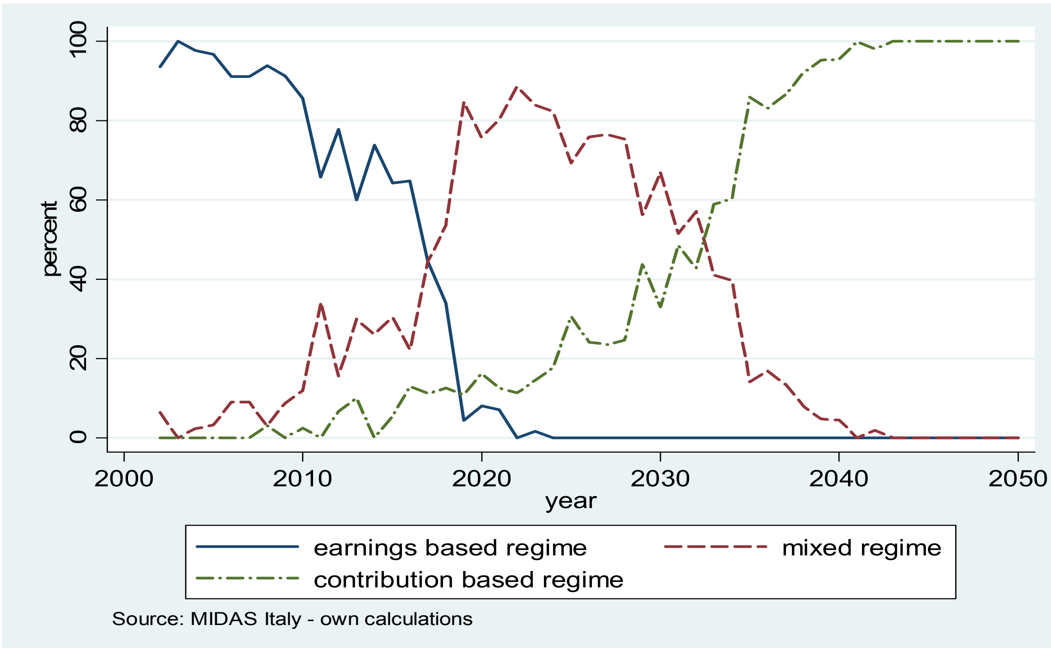
A second point concerns transitions within labour market states, i.e. between jobs performed as employees or self-employed. Results for Italy refer only to individuals retiring when working as employees (distinguishing private and public employees), i.e. excluding those finishing to work as self-employed. Then, it has to be pointed out that we compute pensions also for individuals transiting during their working life from self-employment to dependent work. Anyway it has to be remarked that, ceteris paribus, these individuals are characterized by lower pension entitlements because, as specified in chapter 4, in MIDAS-Italy – given that the great majority of self employed (about 70%) usually pay only the minimum contribution fixed by the law – we assume that all these workers only pay such contribution (and gain the proportional earning).

The gradual phasing in of the 1995 reform – which splits workers in three categories according their years of contribution at 1995 – clearly emerges from Figure 113, that shows the pension scheme (earnings related, mixed or NDC) which new retirees are enrolled in. In 2002 the whole of individuals entering into retirement (the so called "new retired") belongs to the earnings related scheme. Since 2010 a discrete share of individuals enrolling to the mixed scheme starts to retire; their share overcomes the one regarding the earnings based scheme before 2020, reaching more than the 80% in the following years, when new retired belonging to the earnings related regime disappear. At the same since 2020 the share of individuals belonging to the NDC regime begins to increase, becomes majority around 2035 and the whole totality of new retired after 2040.

45 Further, it has to be remarked that in simulation results regarding MIDAS-Italy pensions and earnings are always considered gross of taxes.

46 Minimum pension is guaranteed to individuals (with a seniority higher than a threshold) receiving a benefit lower than a threshold. However minimum pension is paid means-tested, including the test also components of family well-being (i.e. incomes from non labour or pension sources, as capital or wealth and housing) which are not included in MIDAS. Family incomes computed for the means tested requirements in the Italian model are then underestimated, because only pensions and incomes from labour are taken into account.

Figure 113: People entering into retirement by different pension schemes



Italian pension reforms tightened requirements for early retirement. In 2002 a private sector employee could retire when 57 (55 if working in the public sector) with 35 years of seniority. These requirements have been gradually increased. In 2013, a worker will be entitled to a 'seniority pension' only if aged 62 with a seniority amounting to 35, or 61 with 36 years of seniority (or 40 years of seniority, independently from age). Instead, requirements for old age retirement remained unchanged since the beginning of the 21st century: an individual is entitled to receive an old age pension if (over a minimum seniority) he/she is 65 if male, 60 if female; hence recent reforms made females requirements for seniority pensions tighter than the ones concerning old age pension.

However, women can freely decide to continue to work between the age of 60 and 64. In regressions driving early retirement choices, women are allowed to continue to work also after having reached old age limits (also in order to let them to receive higher benefits in the NDC scheme that links benefit to retirement age). Since their choices are driven by a regression describing early retirement, if women withdraw from work when being older than 60, we define them "seniority retired". As a consequence average age of women retiring for seniority can be higher than the total one (see Figure 114).

Figure 114: Average age of retirement

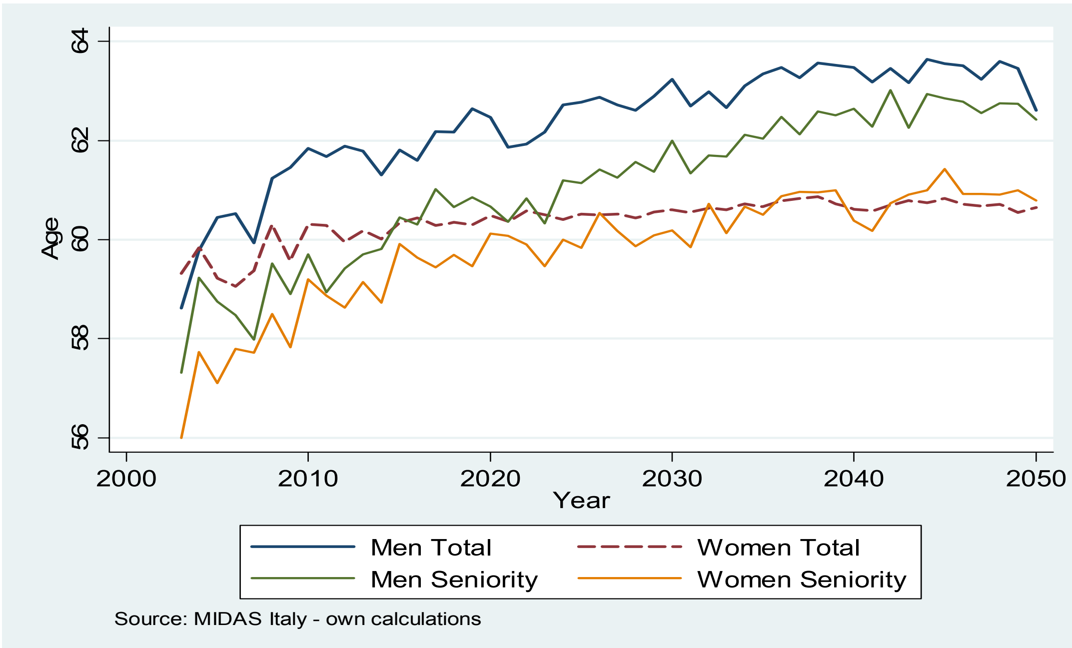


Figure 114 shows that, depending both on the increase of requirements and on individual choices to continue to work linked also to changes in pension computation formulas which create incentives for postponing retirement (in NDC, the benefit increases in an actuarially fair way with the age of retirement), the average age of retirement increases considerably both for men and women. In particular two phases have to be highlighted: the first one lasts until 2013, when the increase of new requirements is going to stop; the second one starts around 2030, when the most of retired belongs to the NDC scheme and then receives a higher benefit if postpones the withdrawal from labour market. In the whole simulation period the increase in total retirement age, for females and males respectively, amount to about 2 and 5 years.

All figures concerning the annual flow of people entering into retirement (see Figure 114 to Figure 117) can be somewhat erratic, due to the sometimes low numbers of people making the transition into retirement. Hence global trends emerging from these figures, rather than their punctual values, should be observed and assessed.

The increase of career length, assessed through seniority years, is lower than that of the average age of retirement (see Figure 115). This is because of two factors that counteract an increase in the age of withdrawal from work: an increase in the average age of labour market entry (due to higher educational attainments) and the decrease of the seniority requirements for receiving an old age pension in the NDC system (amounting to 5 years, while it amounts to 15/20 years in earnings related and mixed schemes). Finally, over the whole simulation period, male average career length increases, while female one is quite constant, maybe due to the higher share of women getting an old age benefit after having worked for few years.

Figure 115: Career length of individuals entering into retirement

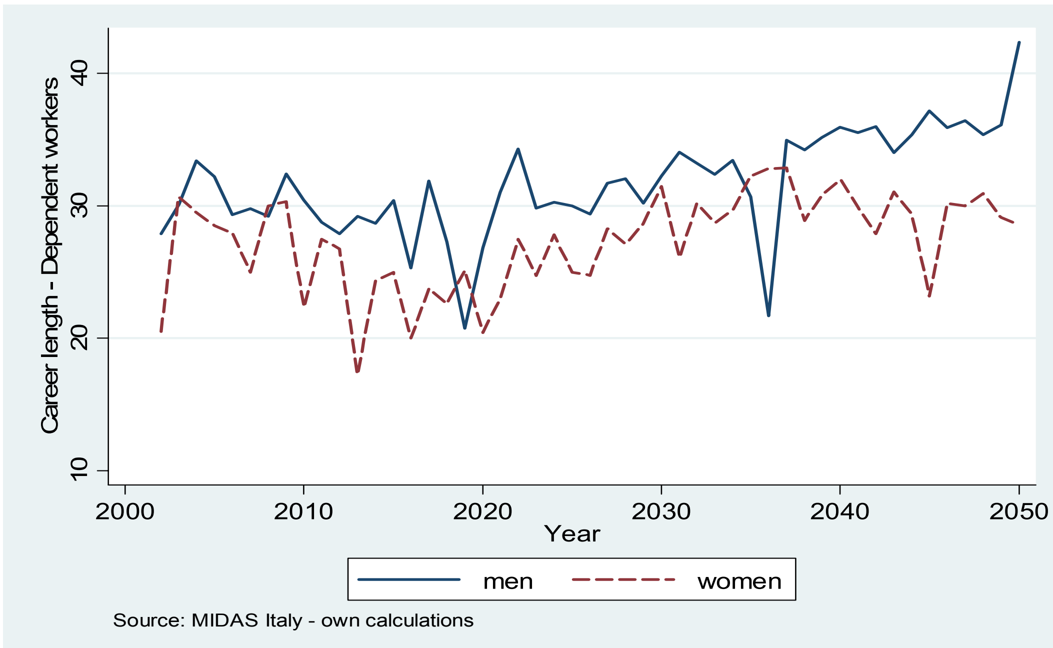
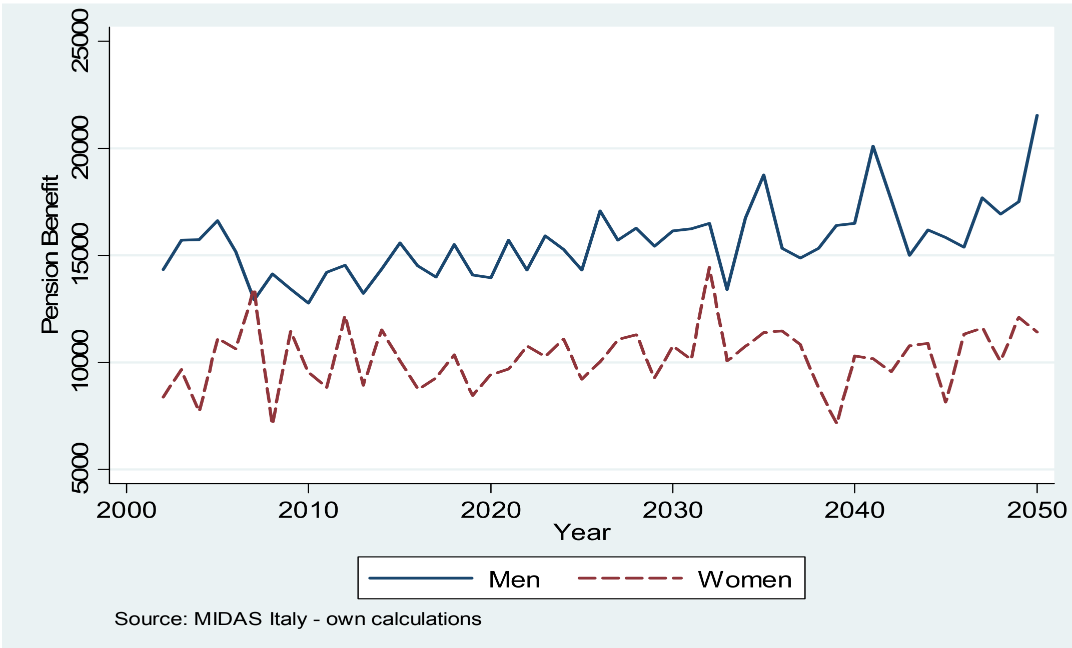


Figure 116 shows the average benefit (i.e. "pure pension" plus integration to the minimum pension, if it is provided) received by individuals entering into retirement. In the earnings related scheme, benefits depend on number of years of seniority and on earned wages (mainly in the last part of the career); in the NDC system they are linked to GDP growth rate (the rate of return paid on contributions), to wages earned during the whole working life (and, then, on seniority) and to retirement age, because pension increases when the retired individual is older. In particular, in the NDC, the link between retirement age and pension is managed through the so called transformation coefficients, whose values are periodically updated for taking into account the evolution of life expectancy (i.e. if it increases transformation coefficients decrease because the average period of pension payment increases)[47].

[47] The 1995 provided that these coefficients should be updated every ten years (in 1995, 2005 and so on), but the 2005 update has not still been made. Besides, the 2007 reform established that since 2011 coefficients will be updated every three years, in order to avoid the unfair huge decrease of pension for cohorts retiring immediately after the ten-year update. Further, such reform created also a technical commission for reviewing and changing the formula for computing coefficients. Because such change has not been introduced yet, in our simulation we continue to use the old coefficients, assuming that they are still updated every ten years.

Figure 116: Average pension benefit of individuals entering into retirement

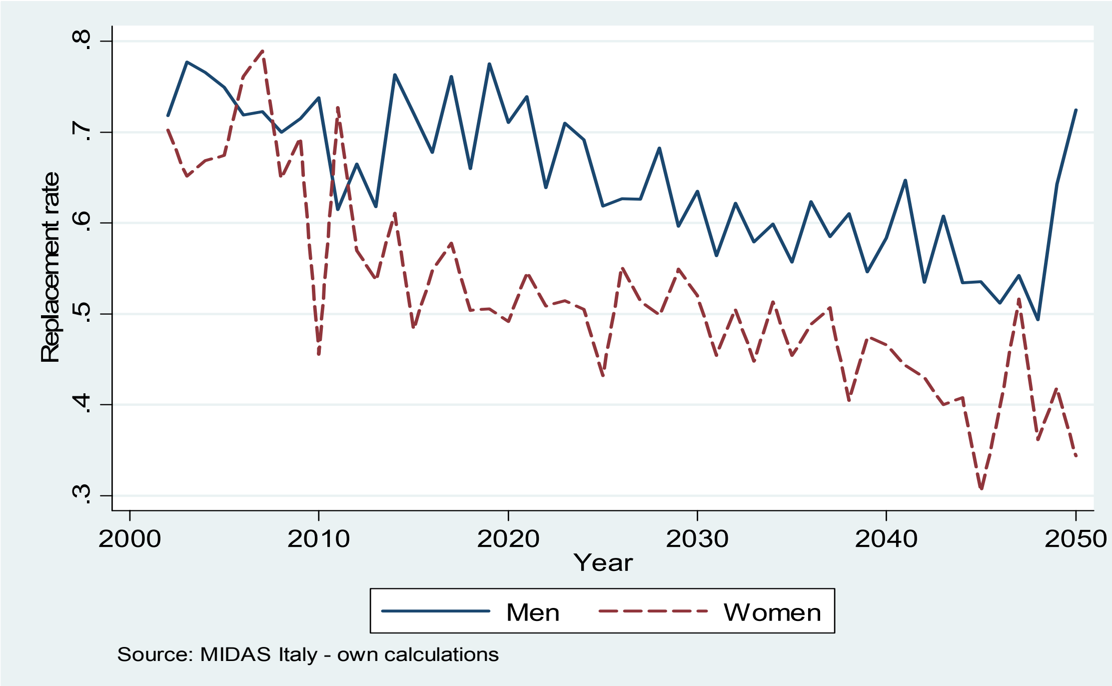


For males, the average benefit rises, mainly due to the real wage increase assumed in the MIDAS module (which, as discussed in previous chapters, is linked to the productivity growth). The depressive effect of the update of transformation coefficients in the NDC scheme on benefit, an update that happens every ten years since 2005, is evident observing the downturns of the curve when the update is introduced. Every update reduces male average pension to a value more or less equal to the one prevailing 10 years before.

In the period 2002-2050 the increase of average benefit for new retired females is much smaller than for males. This could be caused by the fact that, as previously noticed, in the NDC, retiring with a very limited seniority (hence getting a very low benefit, being not provided in the NDC the minimum integration) is allowed. Among individuals retiring with a very low seniority the share of women is very high.

The counteracting effect played by 1) benefits remaining rather constant over time (see Figure 116) and 2) real wages, increasing steadily with the productivity growth level, emerges in the development of the replacement rates (i.e. the ratio between the first pension received and the last wage earned) in Figure 117. The more benefits are based on the NDC formula, the more replacement rates decrease both for males and females. The increases in career length and in age of retirement shown before are not enough for compensating this decrease in replacement rate brought about by the change from the earnings related to the NDC formula.

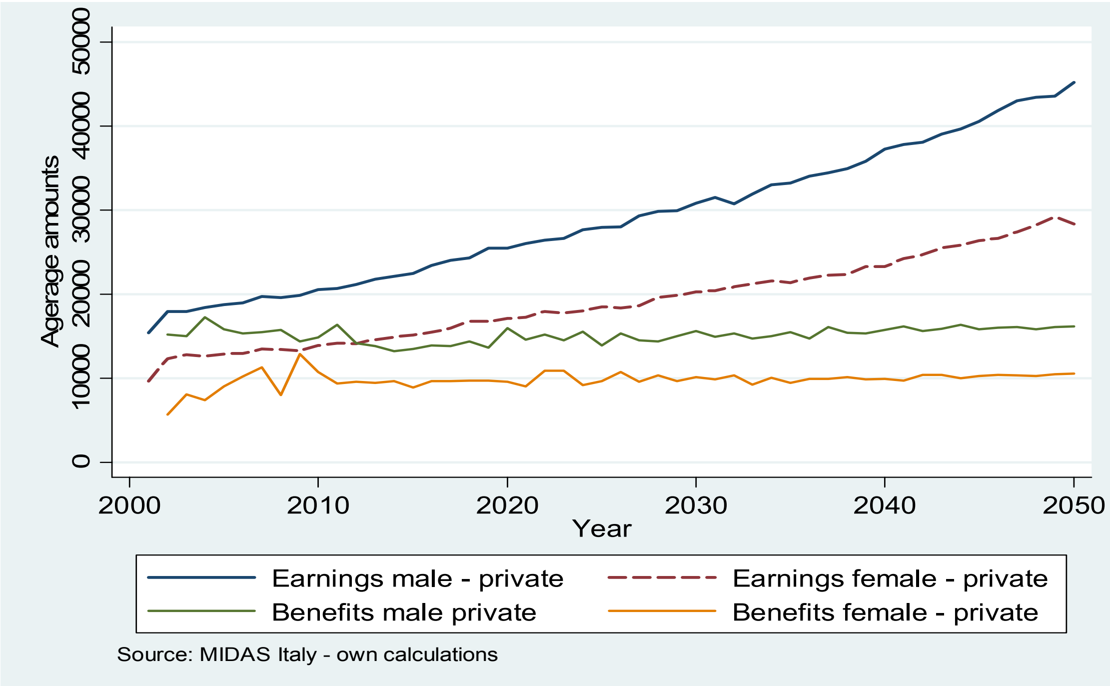
Figure 117: Average replacement rate of individuals entering into retirement



Turning to observe the whole stock of pensioners, rather than the annual stream of new retired, it is very interesting to compare average pensions to average wages (Figure 118 and Figure 119 concerning, respectively, private and public employees)[48]. However, we do not have information on the previous job (e.g. employees, self-employed) of individuals already retired in our base year. As a consequence, the sample is limited to those retired after 2001 (i.e. in 2002 the stock is composed only by the flow of new retired).

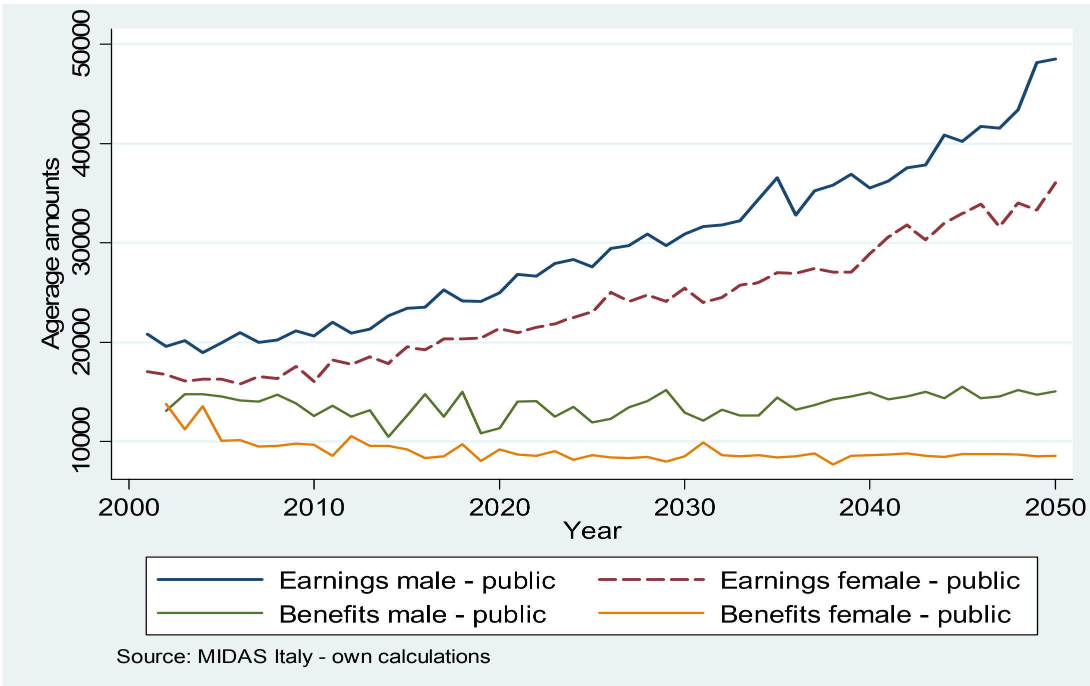
[48] Pensioners are identified according to their last job before retirement.

Figure 118: Gross earnings of private employees and retirement benefits of people having finished to work as private employees since 2002



Because of the assumption regarding average wage growth, earnings steadily increase in both sectors for both men and women (with a slight increase of the wage gap), and the shape of the curve is steeper after 2010 when AWG assumptions project a higher increase of Italian productivity. On the contrary, in both sectors and for males as well as females, average pension benefits keep quite constant in real terms. This result depends on two factors. The first refers to the absence of a real indexation for pension benefits in Italy: after the 1992 reform, these are indexed to prices only, and every link to real wage growth is absent. The second refer to the fact that, due to the very high life expectancy of Italian males and females, the stock of pensioners is usually old. So, on the aggregate, the effect of the increase in average benefit of male new retired is compensated by the large and increasing share of very old pensioners receiving low pensions.

Figure 119: Gross earnings of public employees and retirement benefits of people having finished to work as public employees since 2002



5.3.4. Inequality, poverty and the adequacy of pensions

This section analyzes the effect of incomes from pensions on inequality and poverty. Here we refer to a "full" concept of pensions, i.e. including also survivor and disability benefits.

The first tool used for assessing inequality is the Kernel density of the distribution of both gross earnings and pensions, which is observed in four reference years (2001, 2020, 2035, 2050; see Figure 120). As expected, in all years the median value of the distribution of pensions is lower than the one referred to wages. Further, it is interesting to note that in the last two observations (and mostly in 2050) the distribution of pensions is fairly polarized, i.e. it has a clear bimodality with equal shares of retired receiving benefits low or near to the average value. Being fairly constant average pensions, as shown in the previous section 5.3.3., the KDE of pensions does not move very much to the right, while the movement toward right of the wage distribution (whose median increases in the whole simulation period) is much larger.

However Kernel density is computed for individual and not-equivalent amounts; it is then too soon to infer conclusions about the evolution of poverty and inequality from Figure 120. Using equivalent household incomes computed through the modified OECD scale, we then pass to observe the Gini coefficient for earnings and pensions in the whole simulation period (Figure 121). In MIDAS-Italy, earnings inequality starts from a high level (the Gini is about 0.35), but it remains fairly constant in the whole period. On the contrary, the trend of the Gini coefficient of pension benefits is much more diversified. It starts from a value slightly higher than the one pertaining to wages (about 0.36 vs. 0.35), but it steadily increases until reaching 0.40 in the early 2010's. From 2020 onward, the Gini of pension benefits decreases, crosses the Gini of wages around 2035 and finally reaches a value around 0.31 in 2050. This trend of the Gini seems consistent with the evolution of the Italian pension system; at the beginning of the simulation the inequality of pension benefits increase because individuals with high pensions retire, then such increase is exacerbated by the coexistence of cohorts of retired belonging to different (and differently generous) schemes, while after 2025, the death of the most of individuals fully belonging to the more generous earnings related scheme contributes to reduce the pensions inequality.

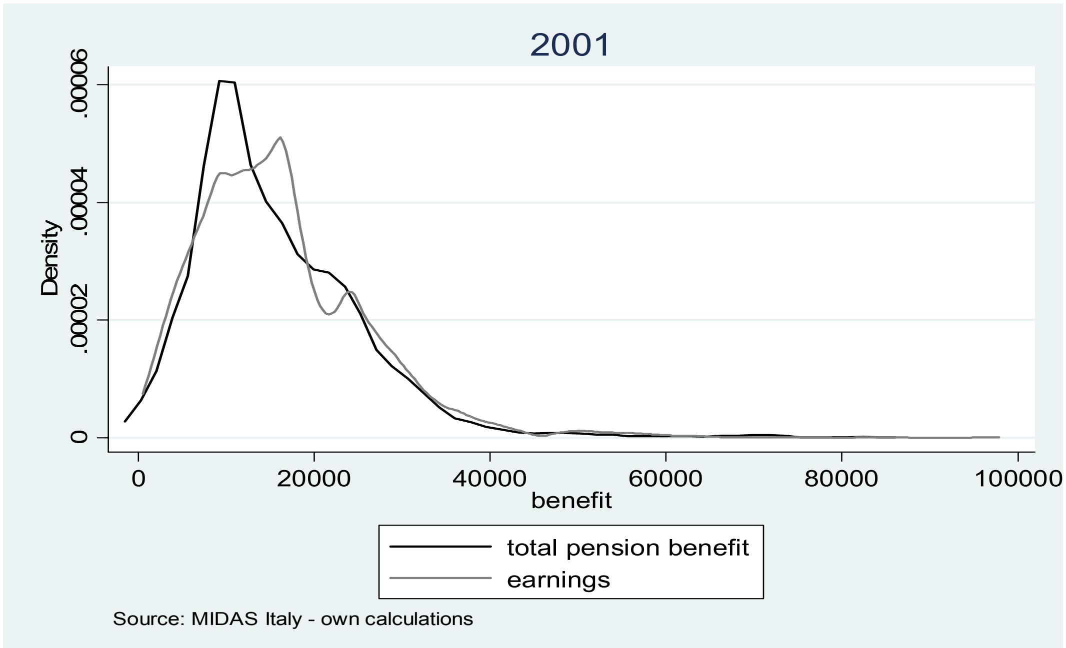
Earnings inequality is not differentiated by gender (Figure 122), while the inequality of pensions is higher for males than for females, apart from the decade 2025-2035 where the Gini coefficients by gender are equal.

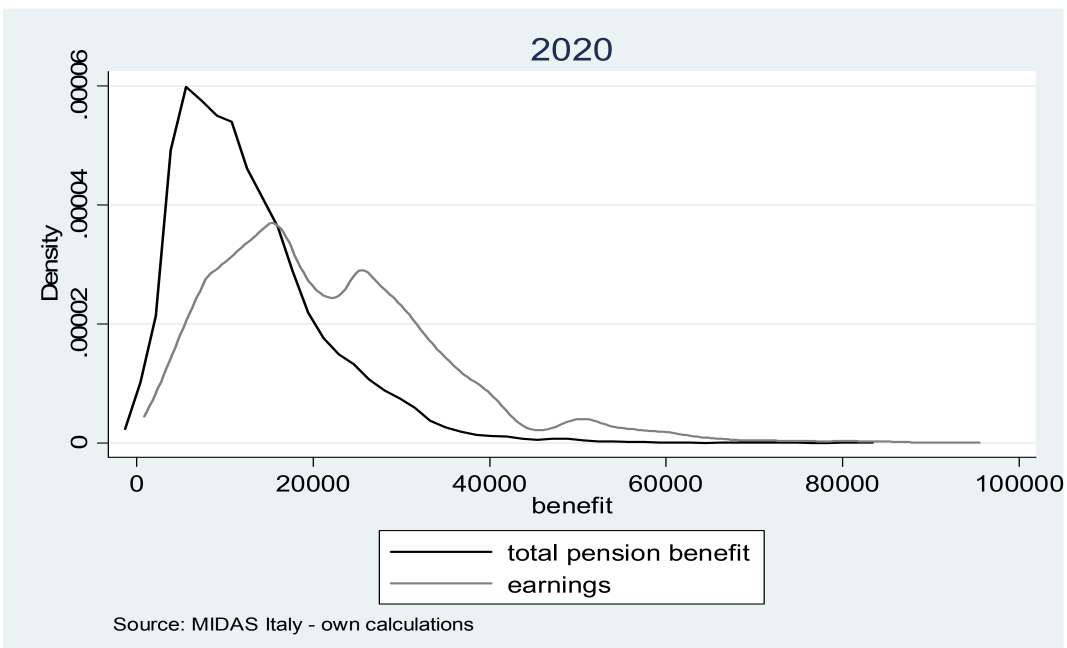
Then we turn to assess the effect of the total pension benefit on poverty[49]. Concerning the marginal effect of benefits assessed through the headcount ratio (Figure 123) the important poverty-reducing impact of pension benefits becomes visible. Such impact decreases at the beginning of the simulation and rises again after 2025. Assessing the marginal effect of retirement pensions on poverty through the poverty gap index (Figure 124) confirms the strong impact of these transfers. Furthermore, in this case, the marginal effect always rises in the period 2002-2050. Differentiating both poverty indicators by gender (in Figure 125 and Figure 126), these trends are confirmed and a slightly higher capacity of pension benefits to reduce poverty risks for females is shown. This is mainly due to the higher share of females receiving survivor benefits. These figures also confirm a higher total poverty risk for females, especially when computed through the head count ratio index.

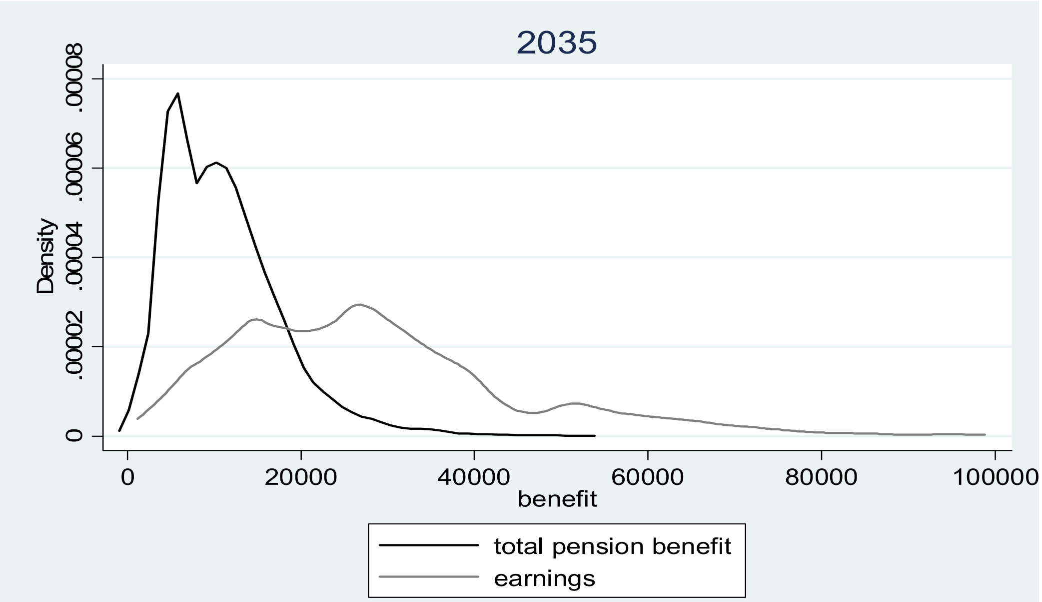
Apart from the marginal effect played by pensions as a tool for fighting poverty, it is crucial to observe the spread of poverty risks among the different groups of the population. These are shown in Figure 127 and Figure 128. Referring both to head count ratios or poverty gaps, the same picture emerges for Italy: during the whole simulation period the incidence of poverty among households receiving only pension benefits increases importantly, while it steadily reduces among households receiving earnings. After 2010, poverty risks are much higher for pensioners than for workers. This trend can be explained by the different evolution of wages, which steadily increases in line with productivity, raising then also the poverty threshold (the 60% of median income), while benefits, being not indexed according to the real wage growth, reduce their relative value compared to wages in all years of simulation.

[49] For the methodological aspects of the poverty analysis here followed see section 5.1.4.

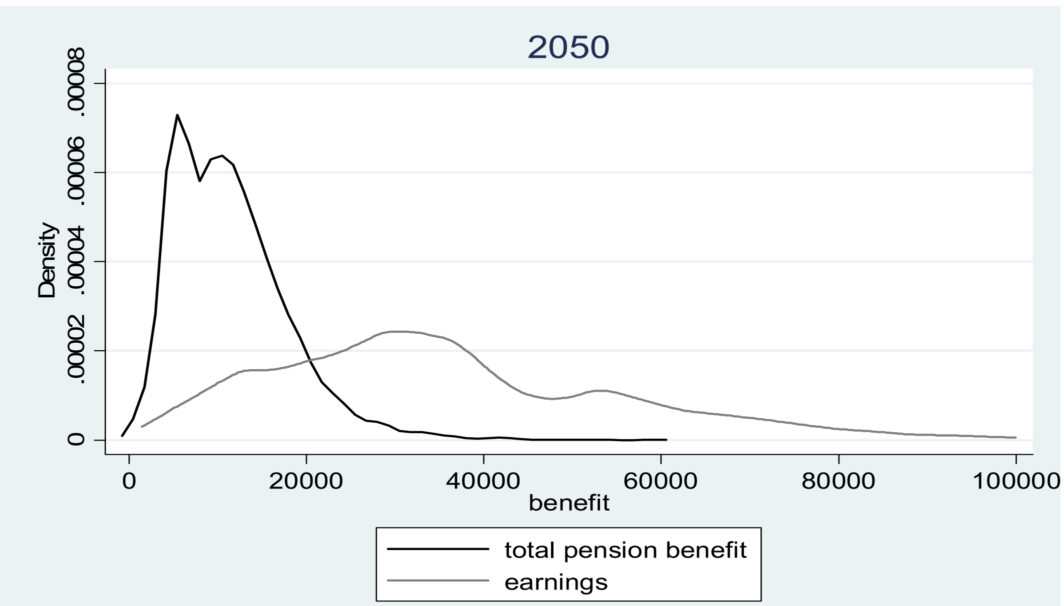
Figure 120: Kernel density estimator of gross earnings and retirement benefits in selected years







Source: MIDAS Italy - own calculations



Source: MIDAS Italy - own calculations

Figure 121: Gini coefficients of gross earnings and retirement benefits

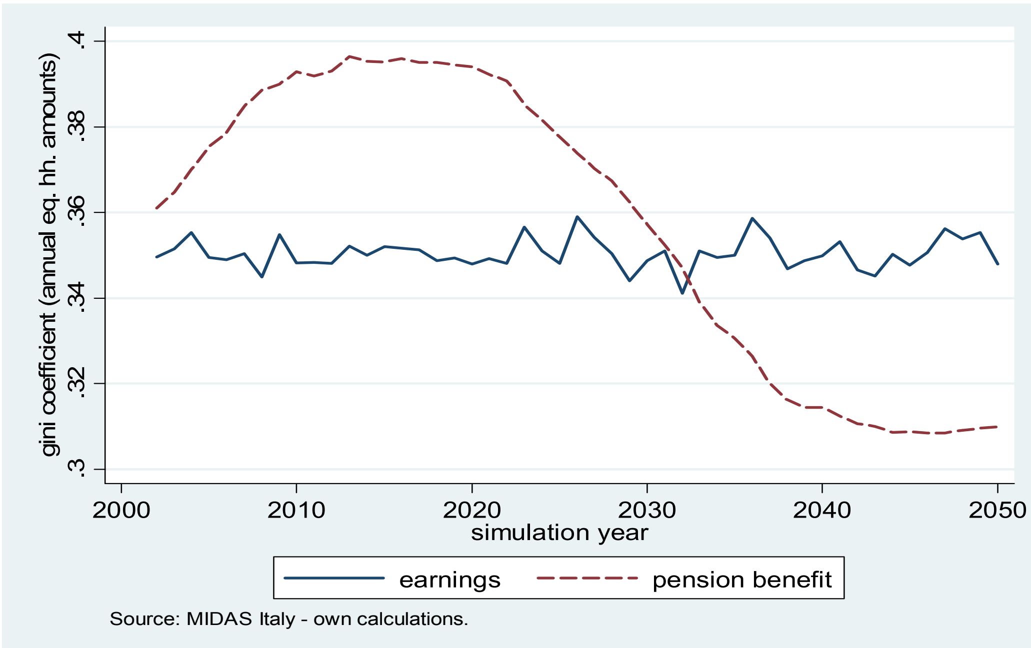


Figure 122: Gini coefficients of gross earnings and retirement benefits by gender

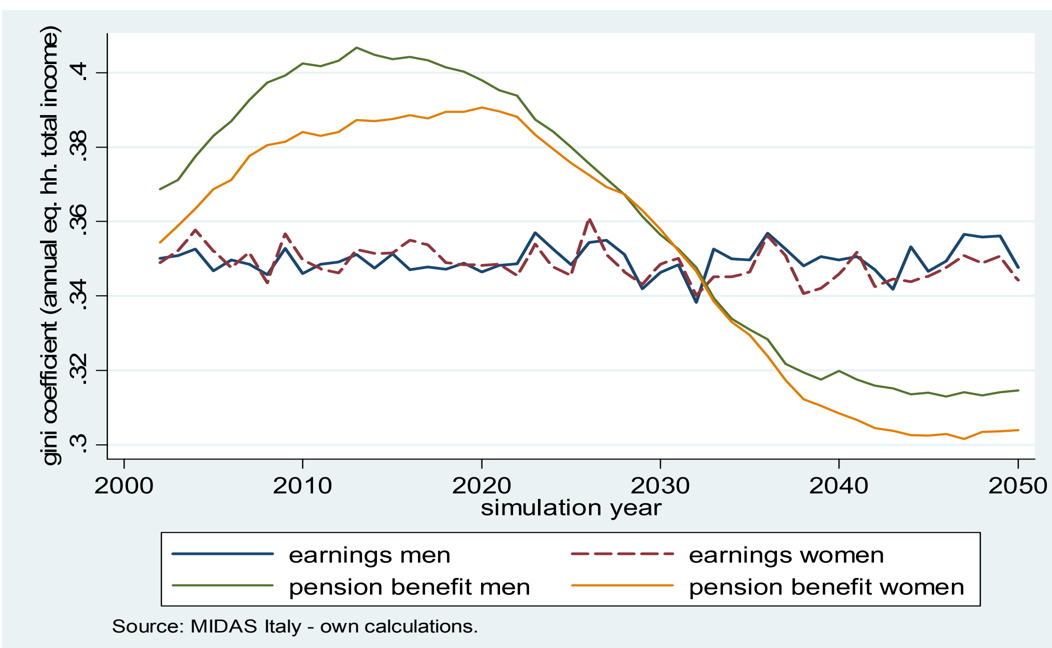


Figure 123: Incidence of poverty of total income and earnings: the marginal effect of retirement benefits

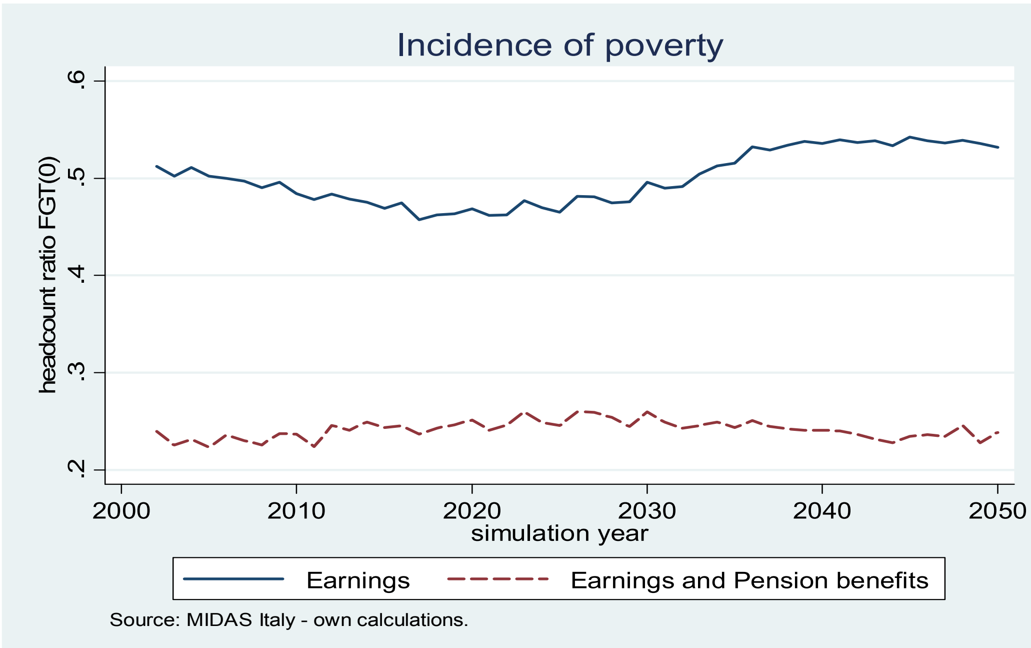


Figure 124: Intensity of poverty of total income and earnings: the marginal effect of retirement benefits

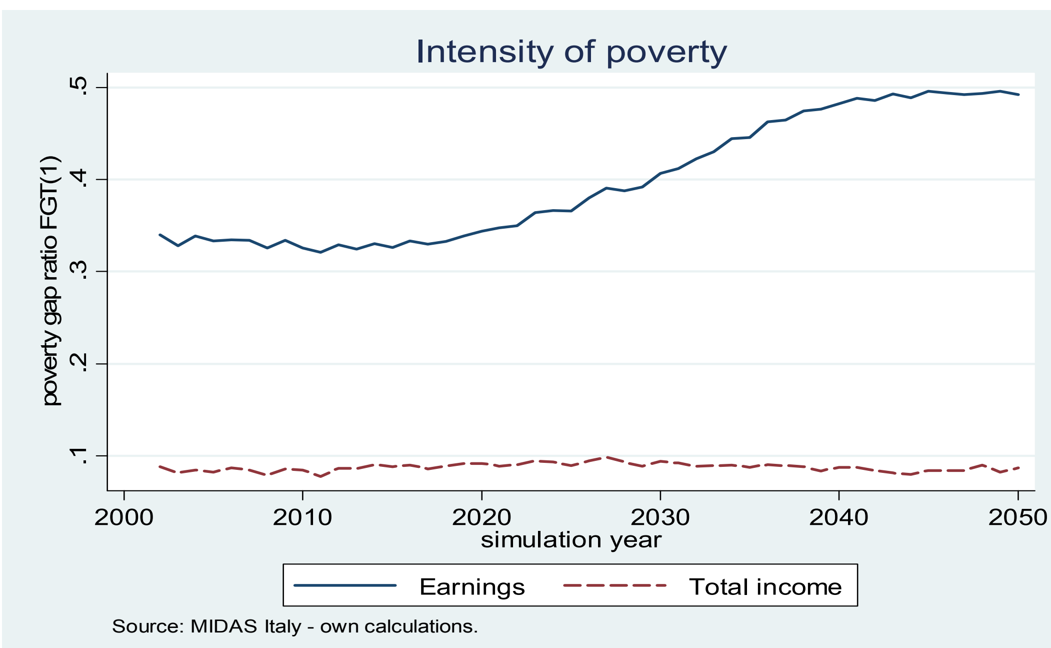
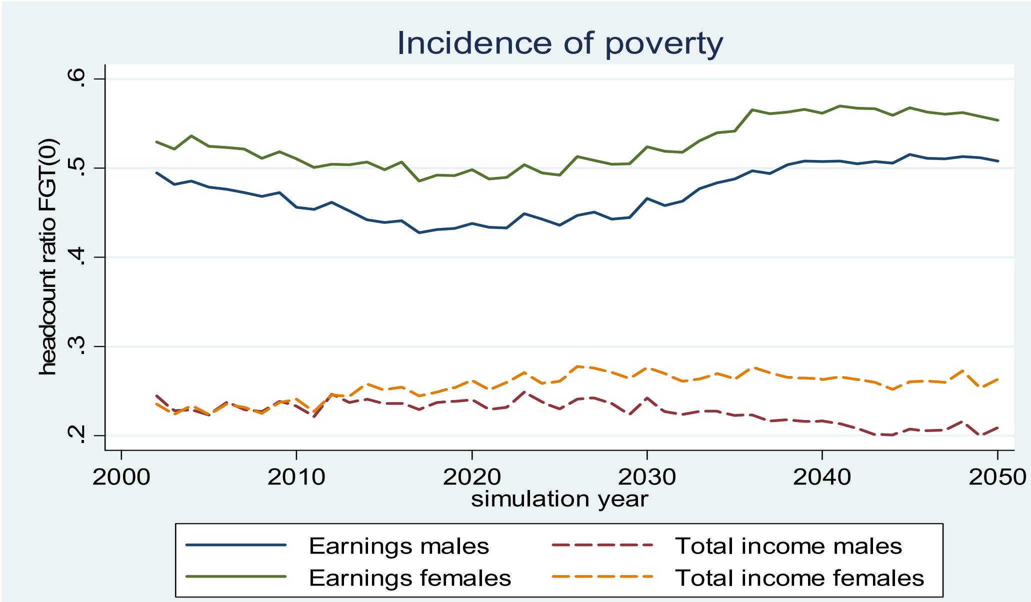
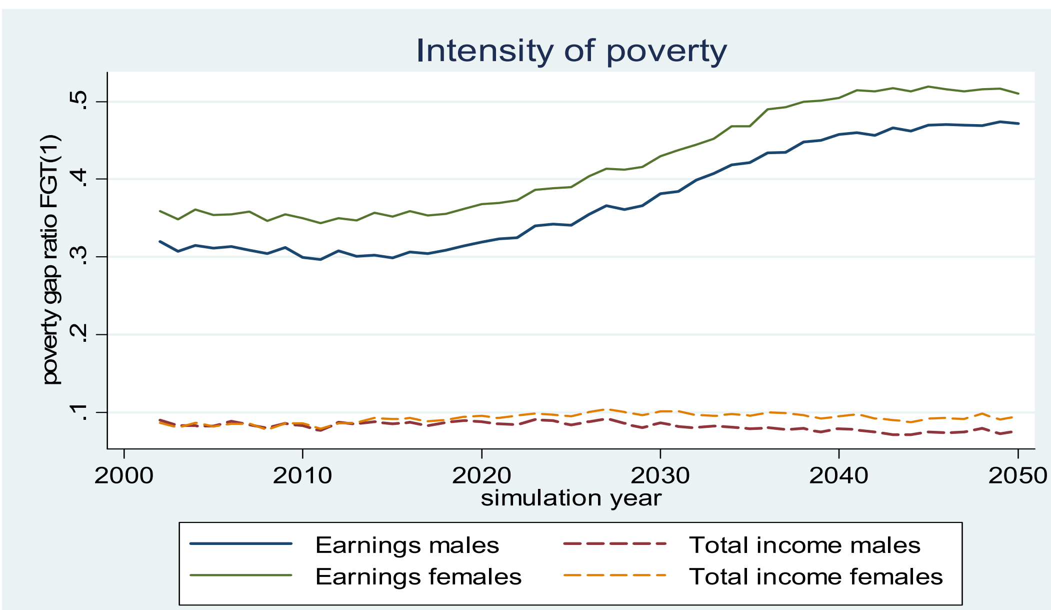


Figure 125: Incidence of poverty of total income and earnings: the marginal effect of retirement benefits



Source: MIDAS Italy - own calculations.

Figure 126: Intensity of poverty of total income and earnings: the marginal effect of retirement benefits by gender



Source: MIDAS Italy - own calculations.

Figure 127: Incidence of poverty by household's sources of income

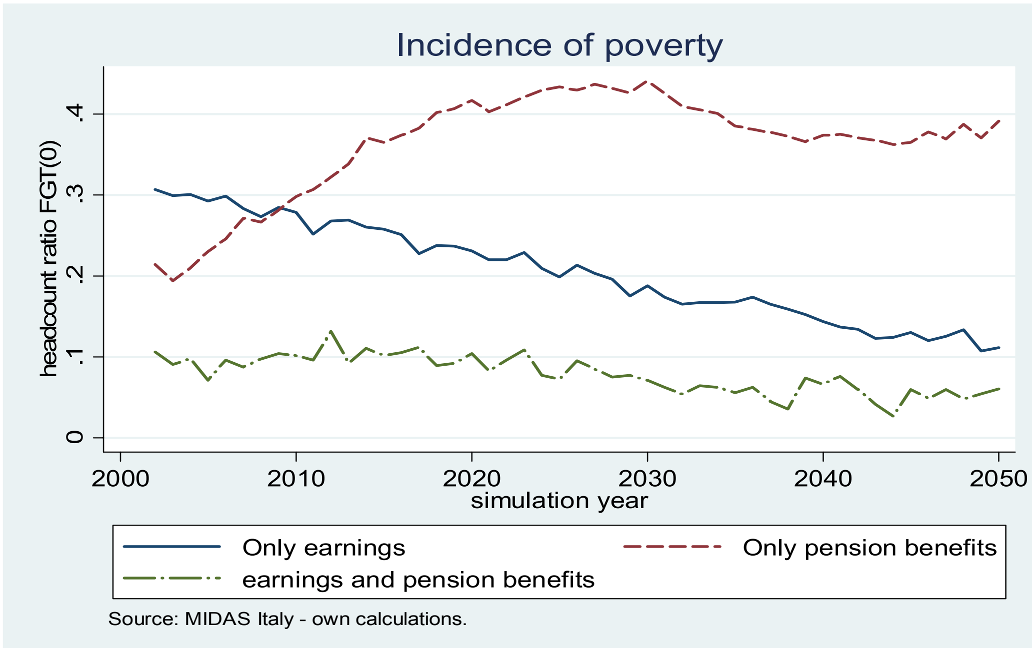
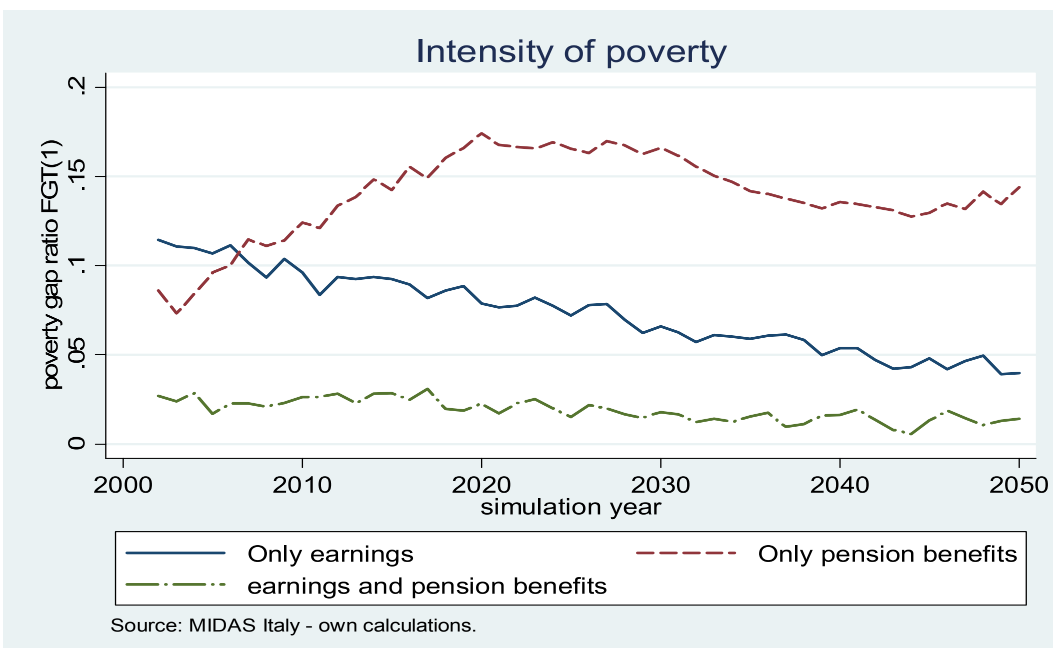


Figure 128: Intensity of poverty by household's sources of income



5.3.5. Alternative scenarios

In addition to the baseline scenario discussed so far, two alternative scenarios have been simulated for Italy. These differ from the baseline along the two following aspects:

- in the first one (in the following "scenario 1") we assume that every kind of pension benefits (i.e. "pure pensions", minimum integration, disability and survivors transfers) are indexed according to the growth of nominal wage, rather than simply according to the inflation rate.
- in the second one (in the following "scenario 1") we assume that transformation coefficients to be applied in the NDC scheme are not update every ten years, but they are kept constant at the 1995 level.

Apart from these two assumptions, respectively characterizing each alternative scenario, all other assumptions are the same used in the baseline scenario. Besides, it has to be pointed out that both alternative scenarios are "upper" scenarios; both provide in fact an increase in pension benefits, the first one linking all pensions to the positive real growth rate assumed in MIDAS, the second one not reducing future transformation coefficients (and, then, pensions) for individuals belonging to the NDC scheme.

We choose these two alternative scenarios mainly for two reasons: the first one refers to the fact that these measures have been often debated in Italy (and the 2007 reform provides in next years a further discussion about how to compute coefficients); the second one, concerning the wage indexation scenario, refers to a homogeneity with the alternative scenarios made in MIDAS-Belgium and MIDAS-Germany.

This section compares results of both scenarios to those of the baseline scenario, and does so for three dimensions: the average benefit paid to new retired[50]; the average benefit paid to the stock of individuals retired since 2002; the Gini level of all pension benefits.

Average benefit for the flow of individuals entering into retirement is assessed only for scenario 2, because in scenario 1 – differing it from the baseline only about the indexation of pensions already paid – the average value for new retired does not differ from the base case.

Not updating transformation coefficients greatly increases pension benefits only in the NDC scheme. As a consequence, as evident from Figure 129, the gap in average pension computed under the two scenarios increase steadily after 2025, when a large share of individuals (wholly or partially) belonging to NDC (ad then advantaged by the constancy of coefficients) starts to retire. Then Figure 129 clearly shows the strong impact on benefit played by the update of coefficients.

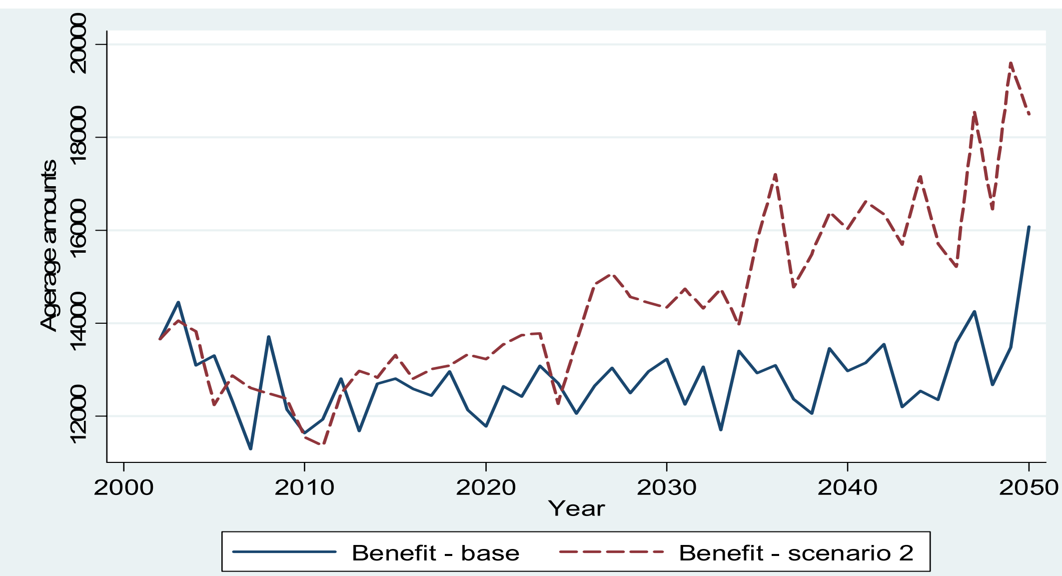
50 Only individuals retiring as employees (public or private) are taken into account.

Figure 130 shows, instead, the average benefit received by all individuals retired after 2001 (our base year). As previously argued, the alternative scenarios are both “upper” ones in that the average benefit is in both scenarios higher than in the baseline scenario. As expected, an important increase is immediately determined indexing benefits to the productivity, while, clearly, the effect of not updating coefficients happens late. Also at the end of the simulation period – when the great majority of pensioners enroll to NDC and the impact of scenario 2 is then larger – the upper effect of scenario 1 (i.e. of the real indexation) is larger.

Measures assumed in both alternative scenarios will then significantly improve the adequacy of pensions. However, their introduction currently seems not affordable, because of the high pension spending increase that would be brought about by them. Further, not updating NDC coefficients would undermine the philosophy of the notional defined contribution system, which is based on actuarial fairness and, then, implies that benefits are proportional to life expectancy in retirement.

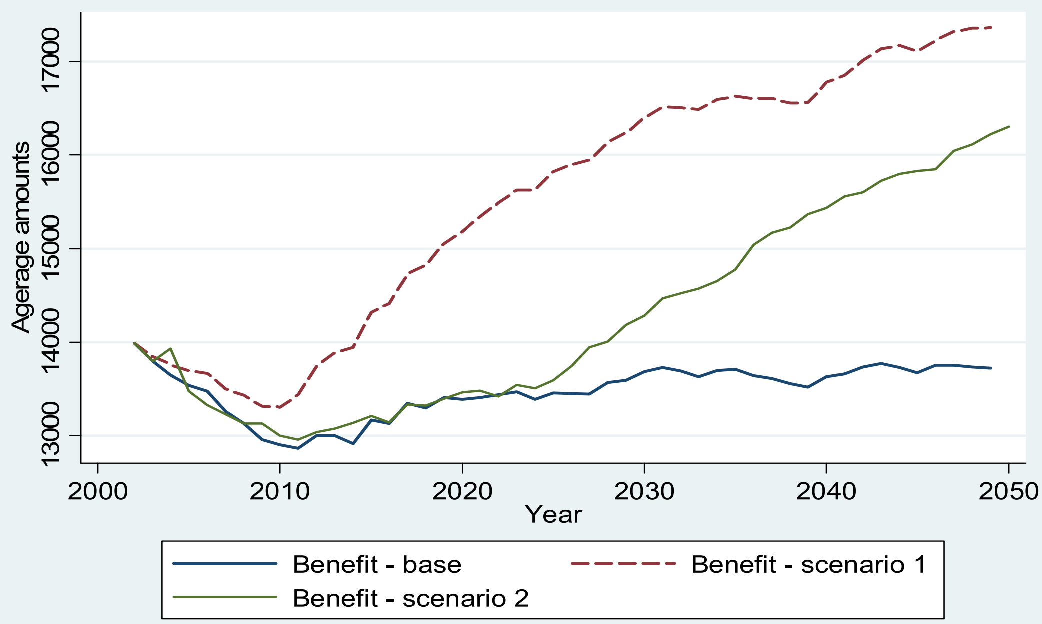
Inequality is assessed through the Gini coefficient (Figure 131). The Gini is computed only for the baseline scenario and scenario 2, because scenario 1 essentially introduces a proportional increase of all pensions, something which obviously equals the Gini describing the baseline scenario. In the two scenarios inequality does not differ very much. It is slightly lower in the alternative scenario, maybe due to the fact that increasing NDC pensions would reduce their distance from the usually more generous pensions paid by the old earnings related scheme.

Figure 129: Average pension benefit of individuals entering into retirement



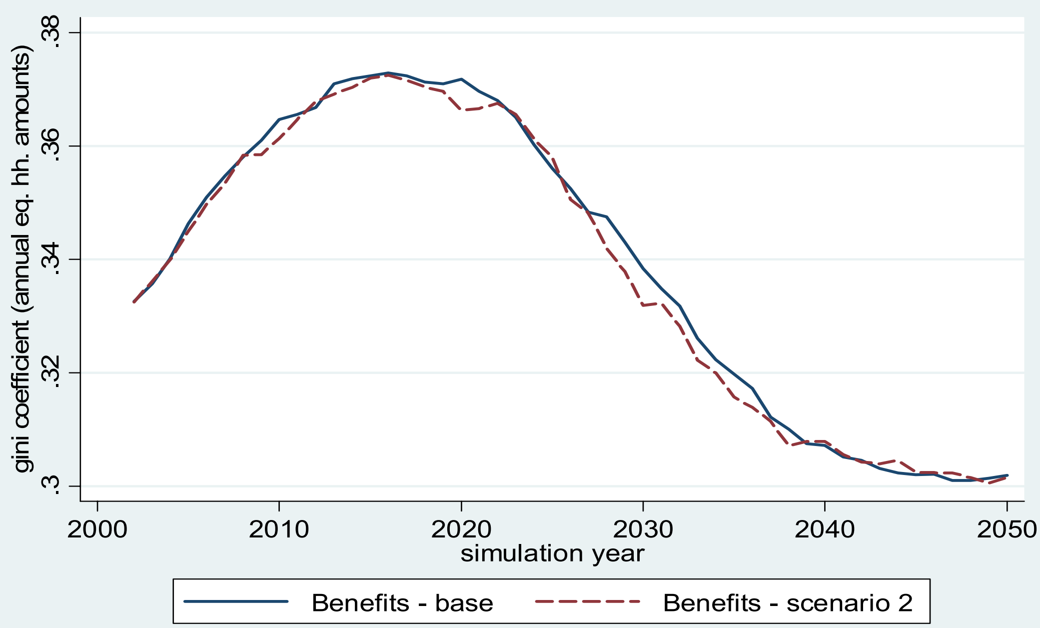
Source: MIDAS Italy - own calculations

Figure 130: Average pension benefit of individuals retired since 2002



Source: MIDAS Italy - own calculations

Figure 131: Gini coefficients of retirement benefits



Source: MIDAS Italy - own calculations.

5.3.6. Conclusions

The MIDAS-Italy has been built through four different modules: retrospective, demographic, labour market and pension modules.

A detailed retrospective module was built for getting retrospective information on individuals working lives (i.e. prior than 1994, the starting year of ECHP), that are needed for computing pensions in the earnings related scheme. Demographic module is organized in line with the general MIDAS one, while the main peculiarity of the Italian labour market module consists in the specifications of regressions (and then individual behaviours) about individual choices to withdraw from work and receive a seniority pensions when they reach the requirements needed for being entitled to such kind of early retirement benefit.

The Italian pension module reflects the complex institutional details of the Italian public pension system. Such complexity depends on the several measures introduced by the many pension reforms approved in the last 15 years, which mainly tightened requirements for being entitled to seniority pensions and changed the formula for computing benefit from an earnings related scheme to a notional defined contribution system.

However, both kinds of reforms are phasing in very gradually, especially that concerning the computation formula. As a consequence of such gradualness, in the whole simulation period three different public pension regimes coexist (each one with further differences inside it): 1) the fully earnings related scheme for individuals with at least 18 years of seniority in 1995; 2) the mixed regime for individuals having started to work at 1995 but with a contribution record lower than 18 years; 3) the notional defined contribution scheme for individuals entered in labour market since 1996.

Results simulated by the MIDAS-Italy model are then clearly affected by such overlapping of different (and differently generous) regimes and by the tightening of requirements for early retirement.

In particular, as discussed in depth in previous sections, our simulations find, as expected, a steep increase in retirement age, for both males and females, an increase of benefits paid to the yearly flow of new retired – increase that is mainly driven by the assumption made in MIDAS to align wages to real productivity growth – and a huge decrease of replacement rates (i.e. the ratio between pension and last wage), mainly due to the gradual phasing in of the less generous rules provided in the NDC scheme.

The overlapping of people belonging to three differently generous pension regimes affects also the inequality of pension benefits, measured by the Gini coefficient, whose value actually increases when first cohorts of individuals belonging to mixed and NDC scheme retire and then decrease at the end of the simulation period when the most of retired belongs to the same scheme.

Concerning poverty, a positive and increasing marginal effect of pension benefits for reducing incidence and intensity emerges. However the model simulates an increasing poverty risk, both in terms of incidence and intensity, among households where pensions are the only source of income.

Finally two alternative "upper" scenarios, concerning providing a pension indexation linked to productivity growth and not updating transformation coefficients in NDC, are compared to the baseline one. Simulations confirm that both alternative scenarios produce pensions more adequate, because average benefit increases steadily, while the effect on inequality of pension benefits seems very limited.

5.4. References

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6. Conclusions

The AWG projections of social security pensions in the European member states are an important tool in the assessment of their sustainability. To date, the projections that member states produce for the AWG include only a limited notion of adequacy, being the replacement rate. Other relevant aspects of pensions, specifically pertaining to the adequacy of pensions, are not considered. However, the sustainability and adequacy of pensions are two sides of the same coin, and a meaningful assessment of the current and future situation of pensions in a country should ideally take both sustainability and adequacy into account, and preferably in a consistent way. This project aims to set a first step into integration by assessing the consequences of the AWG-projections and assumptions on the adequacy of pensions in Belgium, Germany and Italy. Another goal is to develop a tool that will in the future allow for a more robust assessment of the consequences of pension policy measures on pension adequacy.

Lusardi *et. al.* (2008, 8) define a pension system to be adequate when it provides means for individual consumption smoothing, and reduces inequality and poverty. Simulating these aspects requires a micro simulation model. Furthermore, as the AWG projections are - indeed - dynamic, so should the simulations of adequacy. Hence, a dynamic microsimulation model MIDAS was developed for Belgium, Germany and Italy. It consists of three modules: the demographic module and labour market module are –as much as possible- the same for each country (apart obviously from the behavioural equations), so that differences are caused by the different AWG projections and the country-specific pension system regulations.

The simulation results pertaining to the adequacy of pensions show that the Belgian replacement rate will gradually decrease until the beginning of the 2030's, after which it will recover somewhat. The level of the replacement rate is lower in Germany, but the development over time is comparable to Belgium. This is not so for Italy: here, the replacement rate starts off (far) higher than in Belgium, but shows a continuous decrease as benefits from the earnings related system are replaced by benefits from the NDC pension system. This larger impact in Italy than in Belgium and Germany seems to be consistent with the findings of Zaidi and Grech (2007, Table 1, page 305)

Also, the difference between men and women in terms of their replacement rates is smaller in Belgium and Germany than in Italy. Seeing that the difference between men and women seems to appear only in the second half of the 2010's, it seems to be caused by the NDC pension system as well.

In Italy, inequality of (equivalent) earnings does not seem to change considerably as a result of ageing. In Belgium, changes are limited as well, but still more important than in Italy. Inequality of equivalent earnings increase at first, reaches a maximum around 2030 and then returns more or less to its starting level. The changes in the inequality of equivalent earnings are more important in Germany, and the development is again comparable with Belgium.

Inequality of equivalent pension benefits in all three countries are roughly alike in their development, but not in their level. The inequality of pension benefits increases at first, reaches a maximum in the early 2010's (late 2020's for men in Germany) and then decreases again. The redistributive effect of pensions (measured by comparing the inequality of earnings with that of pension benefits) will gain strength from the late 2020's on in Italy and Belgium, and from the early 2020's on in Germany.

The forces causing this development in equality of pension benefits are quite different, at least between Belgium and Italy. Using the terminology of Zaidi and Grech (2007), the increasing redistributive impact of pensions in Belgium is caused by the parametric reform of reinforcing the link between pensions and earnings. In Italy, the effect is caused by the systemic changes of pension system. This also explains why the effect is stronger in Italy than in Belgium. Furthermore, inequality of pension benefits in Belgium is in all years well below that of earnings. In Italy, it is the opposite in the period up to the first half of the 2030's.

Next, we discuss the difference between workers and retirees in terms of their relative risk and intensity of poverty. Here the differences are more outspoken. In Belgium and Germany, the risk and intensity of poverty of those receiving only pension benefits is in all years higher than for those living in households receiving earnings (as well). In Italy, the poverty risk of those receiving a pension benefit starts of lower than those receiving earnings (as well), but increases very considerably until about 2030. This suggests that the systemic reform in Italy has a more profound impact on poverty than the parametric reform in Belgium and Germany.

Next, we consider the development of the incidence and intensity of poverty of those living in households that receive only pension benefits. The developments are roughly comparable between the three counties, as was the case with inequality, but the levels are not. Furthermore, both the risk and intensity of poverty show a rising trend in Italy, and the 'common pattern' therefore surfaces in the speed of this increase, rather than in the change itself.

In the three countries, the risk as well as the intensity of poverty pertaining to pension benefit recipients increases at first, and then decreases again. In Belgium and Germany, this turning point is early in the 2020's, whereas it is late in the 2020's in Italy. Furthermore, relative to the preceding increase, the decrease of both risk and intensity of poverty is considerably stronger in Belgium and Germany than in Italy. As a result, the poverty rate of Italian pension benefit recipients show a positive trend, which is absent in Belgium and Germany. About a decade later after the first turning point (i.e. early 2030's for Belgium, and early 2040's for Italy), poverty risks stabilize and then starts a modest increase again. This last change is again stronger in Belgium than in Italy and Germany. The explanations for these developments in both countries are comparable as well, namely the link between the development of wages and pension benefits. In Belgium, however, the impact of the average age of the elderly seems to play an important role in conjunction with this linkage. This is not reported in the Italian case. On the whole, poverty among the recipients of social security pension benefits increases more in Italy than in Belgium and Germany, which for the first two countries confirms the tentative results of Zaidi et. al., 2006, Table 16, page 51.

In short, it seems that the parametric reform in Belgium and Germany and the systemic reform in Italy roughly have the same impact on (re)distribution and poverty, in terms of the development of various indicators of adequacy over time. However, the size of the impact is stronger in Italy than in Belgium and Germany.

Demographic ageing, in combination with projected growth rates of productivity and the assumed linkage between the development of earnings and pensions, has a profound impact on the future adequacy of pensions. Policies aiming to restore or improve sustainability therefore are bound to affect adequacy, and this makes it all the more important that both aspects of pension systems be assessed in unison.

Now where do we go from here? As with all research, this model and its results are subject to criticism (providing inspiration to further improvements of the models) and open possibilities for further research. There are several aspects of the MIDAS models that could be improved, and we therefore name just a few, pertaining to the dataset and to model itself.

First, we discuss potential improvements in the datasets. The three versions of the model are based on the PSBH for Belgium, SOEP for Germany, and the ECHP for Italy. For the first and last of these, the sample size may be somewhat limited. Also, retrospective information is limited to labour market status, and does not discern between workers in the public and private sector. Furthermore, in the case of Belgium, the pension benefit variable includes benefit from the first, second and third pension pillar. This affects the simulation results, especially in the first decade of the simulation period.

A first way in which the MIDAS model could be improved is by including net immigration. In the current version of the model, immigrants enter the simulation results in an indirect manner, namely via the fertility and mortality rates. A second and equally obvious shortcoming of MIDAS is that it does not include asset accumulation via private savings, home ownership and entitlements to social security and occupational pensions.

Thirdly, the modelling of the retirement is now either fully determined by alignment to the AWG-projections (Belgium) or simulated via a behavioural equation. This could be improved by applying more structural models, such as the option value approach. Also, the simulation results of the model could be described by a wider range of indicators of pension adequacy. Furthermore, the current version of the model only describes pensions for employees and civil servants (not in Germany), and a simplified version of the pension system of the self-employed (in the Belgian and Italian, but not in the German version of the model). Other replacement incomes, including unemployment benefits, welfare benefits to the non-elderly, are not taken into account. So MIDAS does not allow for general statements about poverty or inequality with respect to the whole population (see section 5.2.6).

The above criticisms stand witness to the fact that the current state of MIDAS is not yet definitive. Indeed, besides the aforementioned research goal, this project also had a methodological goal, namely the development of a tool that in the future can be used for policy simulations. In spite of the abovementioned shortcomings, this research project hopes to make the case that dynamic microsimulation models such as MIDAS can be a powerful tool for the assessment of the future adequacy of pensions, while taking into account sustainability. In this, it is a first step into the integration of both approaches to the assessment of pensions.

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7. Appendix 1: A short description of the AWG-projections

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This appendix contains a brief presentation of the main AWG projections on the sustainability of pensions in Belgium, Germany and Italy, together with the demographic and macroeconomic assumptions underlying them. The first section contains the main demographic projections concerning fertility and mortality rates and the expected trend of net migration as provided by EUROSTAT (in a specific "AWG variant" scenario). These are combined with macroeconomic assumptions (i.e. on labour market, productivity and GDP trends), discussed in the second section. In a third step, according both the results of demography and macro-economics, the developments of expenditure levels (on pension, health and long term care, education and unemployment benefits) are computed using the models of national authorities. These developments of sustainability are briefly presented in the third section, and reflect the current institutional features of national pension systems[51]. A main point however is that the entire projections exercise is made on the basis of "no policy change" scenario, i.e. only reflecting enacted legislation (by mid 2005) but not possible future policy changes (although account is taken of provisions in enacted legislation that enter into force over time). They are also made on the basis of the current behaviour of economic agents, without assuming any future changes in behaviour over time: for example, this is reflected in the assumptions on participation rates which are based on the most recently observed trends by age and gender. For a more extensive presentation and discussion, the reader is referred to EC (2006).

7.1. The AWG population scenario

The AWG population scenario results from assumptions pertaining to i) fertility rates, ii) life expectancy and iii) net immigration. Fertility rates for the EU10 member states are based on an analysis of postponement of childbearing and recuperation of fertility rates at a later age (EC, 2006, 25). Table 80 describes projected fertility rates in Belgium, Germany and Italy, as well as the EU15

[51] In contrast, the projections for health care, long-term care, education and unemployment transfers are made using common models developed by the European Commission.

Table 80: AWG baseline assumptions on fertility rates

	2004	2010	2020	2030	2040	2050
Belgium	1.62	1.66	1.69	1.7	1.7	1.7
Germany	1.35	1.41	1.44	1.45	1.45	1.45
Italy	1.31	1.38	1.4	1.4	1.4	1.4
EU15	1.53	1.57	1.6	1.6	1.6	1.61

Source: EC (2006), table 2-1, page 26.

Fertility rates in Germany and Italy are comparable and below EU15 average. In contrast, fertility rates in Belgium are higher than the EU15 average. In all three countries as well as in the EU15 as a whole, total fertility rates are projected to increase. Nevertheless, even in Belgium they remain well below the natural replacement rate of 2.1 that is required to stabilize the age structure.

Pertaining to life expectancy at birth, the AWG base scenario is based on an extrapolation of age-specific mortality trends observed during the last two decades. Eurostat assumes that the trend of decreasing mortality rates observed since 1985 will continue at the same speed until 2019 and slow down thereafter. This however results in divergences in life expectancies across member states, an even between neighbouring counties. Thus, the AWG base scenario introduces a convergence towards the average EU15 life expectancy at birth from the EUROPOP2004 baseline scenario. Table 81 shows the resulting projections.

Table 81: AWG baseline assumptions on life expectancy at birth for males and females

		2004	2010	2020	2030	2040	2050
Belgium	males	75.5	76.9	78.9	80.3	81.4	82.1
	females	81.6	82.9	84.8	86.1	87	87.5
Germany	males	76.1	77.2	78.9	80.2	81.2	82
	females	81.7	82.7	84.2	85.4	86.2	86.8
Italy	males	77.3	78.3	79.9	81.1	82.1	82.8
	females	83.2	84	85.3	86.4	87.2	87.8
EU15	males	76.4	77.5	79.1	80.4	81.4	82.1
	females	82.2	83.2	84.6	85.7	86.5	87

Source: EC (2006), table 2-2, page 28.

Life expectancy at birth increased by some 8 years in EU countries between 1960 and 2000, equivalent to a gain of some 3 months per annum (op.cit, 27). This increase is projected to continue, mostly as a result of decreasing mortality rates at older ages. Furthermore, the projected increases of life expectancies over time are somewhat higher for males than for females, so that they converge.

Net inward migration flows are modelled by national agencies, and are based on different approaches (op. cit., 32). Furthermore, information is often sketchy and difficult to project. Table 82 shows projected net immigration flows in thousands of persons.

Table 82: AWG baseline assumptions on net immigration flows (thousands)

	2004	2010	2020	2030	2040	2050
Belgium	24	20	19	19	19	19
Germany	270	230	215	205	200	200
Italy	150	150	150	150	150	150
EU15	1347	859	817	788	781	778

Source: EC (2006), table 2-3, page 31.

These projections are only mention for completeness' sake, but will not be discussed.

7.2. Participation, employment and unemployment rate assumptions

The labour force projection is based on an age-cohort methodology. The methodology takes into account explicitly the evolution of lifetime profiles of participation. It is based on the calculation of the probability of labour market entry and labour market exit for each of the latest cohorts available (based on the average rates between 1998 and 2003). These probabilities are kept constant reflecting an assumption of "no policy change".

In other terms the cohort methodology reflects the tendency for women belonging to any given cohort or generation to have their own specific level of participation, which is usually higher at all ages than the corresponding level of participation of older cohorts. Thus, the simulation produces an autonomous increase of female participation – referred to as a "cohort effect" – as older women are gradually replaced by younger cohorts.

Moreover such approach captures the effects of demographic change on the labour force. Besides, the reduction in the size of the working-age population (aged 15-64), caused by demographic forces (mainly low fertility rates), an ageing population also increases the share of older workers (aged 55-64) in the total labour force, whose participation rate is significantly lower than that of younger age groups (also by the effects of pension reforms postponing retirement age).

Projections on the future size and structure of the labour force are obtained by combing projections of activity rates (of each single year of age and gender of people in the labour market) with the baseline working-age population projection provided by EUROSTAT. Furthermore the potential effects of recently enacted pension reforms that will be phased-in in 17 EU Member States (included Belgium, Italy and Germany) are considered.

Current participation rates for Belgium, Germany and Italy (and EU15 for comparison) and their expected changes (always positive, especially for females, apart from the young Italians for the effect of the improvement in educational attainment before mentioned) up to 2050 are reported in Table 83 and Table 84.

Table 83: Participation rates by gender and age groups in 2003

	Total				Male				Female			
	15-64	15-24	25-54	55-64	15-64	15-24	25-54	55-64	15-64	15-24	25-54	55-64
Belgium	65.0	35.2	82.3	28.9	72.9	38.6	90.9	38.8	56.9	31.6	73.6	19.3
Germany	72.6	50.1	86.2	45.2	79.5	52.9	93.3	54.7	65.4	47.1	78.8	35.9
Italy	62.9	37.8	77.9	30.5	74.9	41.6	91.6	43.1	50.9	34.0	64.1	18.8
EU15	70.4	48.2	83.5	44.2	78.7	51.7	92.5	54.8	62.1	44.7	74.4	34.0

Source: EC (2005)

Table 84: Projected changes in participation rates up to 2050

	Total				Male				Female			
	15-64	15-24	25-54	55-64	15-64	15-24	25-54	55-64	15-64	15-24	25-54	55-64
Belgium	5.0	1.7	6.3	16.0	1.6	1.7	3.3	7.9	8.5	1.5	9.3	23.8
Germany	6.4	2.0	3.6	24.0	5.4	2.6	2.3	22.8	7.5	1.3	5.1	25.2
Italy	7.4	-0.8	6.3	24.8	4.3	-0.7	2.5	21.9	10.2	-0.9	9.7	26.8
EU15	5.7	1.4	5.1	17.8	2.8	1.3	1.9	12.9	8.5	1.4	8.2	22.2

Source: EC (2005)

To move from labour force (i.e. participation rates) projections to employment projections, one should look at the rate of unemployment. It was agreed in AWG that unemployment rates are going to converge to their structural level, or NAIRU by 2008 and that they remain constant thereafter. However for countries with a NAIRU rate in 2008 higher than the average rate of the EU15 (i.e. 7%) the convergence period is widened up to in 2015. Nevertheless, for avoiding significant changes in the rankings across countries, the structural unemployment rate is reduced by an additional 0.5 percentage points (to reach 6.5% in 2015) for Belgium and Italy.

The consequent projections for unemployment rates and, then (given the participation rates) for employment rates are presented in Table 85 and Table 86.

Table 85: Assumptions on unemployment rates

	2003	2010	2015	2025	2050	Change 2003-2025
Belgium	8.2	7.0	6.5	6.5	6.5	-1.7
Germany	9.9	8.5	7.0	7.0	7.0	-2.9
Italy	8.9	7.3	6.5	6.5	6.5	-2.4
EU15	8.2	7.0	6.1	6.1	6.0	-2.2

Source: EC (2005)

Table 86: Projected employment rates

	Total (15-64)				Females (15-64)				Older workers (55-64)			
	2003	2010	2025	2050	2003	2010	2025	2050	2003	2010	2025	2050
Belgium	59.6	62.1	64.7	65.5	51.8	56.0	60.3	61.0	28.1	33.2	42.8	44.4
Germany	65.4	70.9	73.2	73.5	59.3	65.8	67.8	68.3	39.5	56.4	65.8	65.7
Italy	57.2	61.0	63.6	65.7	44.9	50.0	53.9	56.1	29.4	35.9	49.4	54.6
EU15	64.6	68.1	70.5	71.5	56.5	61.2	64.6	66.1	41.4	48.6	58.0	60.2

Source: EC (2005)

7.3. Assumptions on productivity

AWG has estimated labour productivity growth using a "production function approach". Labour productivity (output per worker) is derived from the calculations based on the labour input projections, the assumptions concerning Total Factor Productivity (TFP) and the investment scenario. The growth rate of Total Factor Productivity (TFP) is assumed to converge to 1.1% (i.e. the US trend labour productivity growth) by 2030, with different speeds of convergence across Member States. As regards the capital deepening, AWG assumes the investment/ GDP ratio constant until 2010. A transition to a constant capital/ labour ratio assumption is introduced gradually (in a linear manner) over the period 2010 to 2030. Finally, the capital/labour ratio expressed in efficiency units (capital per effective worker) is held constant from 2030 to 2050. This implies that both the capital stock per worker and labour productivity grows at the same pace, which coincides with labour-augmenting technical progress (i.e. TFP growth - equal to 1.1- divided by the labour share, set equal to 0.65).

By combining the employment and productivity projections, a projection for potential growth rates up to 2050 is obtained (see table 5 and table 6 for per capita growth rates and levels), splitting growth rates in its determinants (i.e. employment and productivity). The projected decline in GDP per capita growth rates is less than the projected fall in potential output growth rates, since total population growth rates should drop over the period 2004-2050. Hence, living standards should hold up better than what is suggested by the trend in headline GDP growth rate.

Table 87: Projected potential growth rates and its determinants

	Potential growth			Labour productivity			Employment		
	2004-10	2011-30	2031-50	2004-10	2011-30	2031-50	2004-10	2011-30	2031-50
Belgium	2.4	1.8	1.5	1.5	1.8	1.7	0.9	0.0	-0.2
Germany	1.7	1.4	1.2	0.9	1.6	1.7	0.8	-0.3	-0.5
Italy	1.9	1.5	0.9	0.7	1.7	1.7	1.1	-0.2	-0.8
EU15	2.2	1.8	1.3	1.3	1.8	1.7	0.9	-0.1	-0.4

Source: EC (2005)

Table 88: GDP per capita growth rates and levels relative to EU15 average

	GDP per capita growth rates			GDP per capita (EU15=100)			Productivity levels (EU15=100)		
	2004-10	2011-30	2031-50	2004-10	2011-30	2031-50	2004-10	2011-30	2031-50
Belgium	2.1	1.6	1.6	108	107	109	122	115	115
Germany	1.6	1.4	1.5	101	94	95	94	88	88
Italy	1.6	1.6	1.3	100	97	94	116	108	108
EU15	1.9	1.7	1.4	100	100	100	100	100	100

Source: EC (2005)

7.4. Other assumptions

Concerning other variables to be used in MIDAS AWG fixed the following assumptions:

– *Real interest rates*: a real interest rate of 3% constant for the whole period is assumed.
– *Inflation*: an inflation rate of 2% constant for the whole period is assumed.
– *Growth of real wages:* it is assumed that real wages grow in line with labour productivity. As a result, the wage share will remain constant over the projection period.

7.5. Results: sustainability of pensions in Belgium, Germany and Italy.

These and other assumptions led member states to calculate prospective public and total pension expenditures (EC, 2006). Table 89 presents public pension expenditures as a percentage of GDP in Belgium, Germany and Italy, as well as for the EU15 and EU25 as a whole.

Table 89: Gross public pension expenditures as a share of GDP between 2004 and 2050.

	2004	2010	2015	2020	2025	2030	2040	2050	Change 2004-2050(2)
Belgium	10.4	10.4	11.0	12.1	13.4	14.7	15.7	15.5	5.1
Germany	11.4	10.5	10.5	11.0	11.6	12.3	12.8	13.1	1.7
Italy	14.2	14.0	13.8	14.0	14.4	15.0	15.9	14.7	0.4
EU15(1)	10.6	10.4	10.5	10.8	11.4	12.1	12.9	12.9	2.3
EU25(1)	10.6	10.3	10.4	10.7	11.3	11.9	12.8	12.8	2.2

Source: EC (2006) Table 3.3, page 71.

(1) Excluding Greece.

(2) Percentage points GDP.

The starting position in 2004 shows public pension spending about 10.6% of GDP in the EU member states. This percentage is the lowest in Ireland (4.7%) and the highest in Italy (14.2). Belgium is roughly on this average, whereas spending in Germany is somewhat higher than this average. The developments over time show an equally diverse picture, ranging from a decrease of 5.9 percentage points in Poland to an increase of 12.9 p.p. in Cyprus (EC, 2006, 71). In the EU15 member states, public pension spending is projected to increase by 2.3 p.p. of GDP. In Italy, as in Sweden, the increases are very small because the scheme is of the defined-contribution type. Like many EU15 member states including UK, France and the Netherlands, public pension spending in Germany show a relatively moderate increase. Projected increases are larger in Belgium (5.1 p.p.), but this is still far from the rates reported for the countries that face the largest challenges. This includes Portugal (9.7. p.p. GDP), Luxembourg (7.4 p.p. GDP) and Spain (7.1 p.p. GDP).

8. Appendix 2: Full description of country-specific pension systems

8.1. Full Description of the Belgian pension system

The description of the Belgian pension system that is proposed here presents the system regulations of 2005. As it has been mentioned previously, the Solidarity Pact between Generations – that has been introduced after 2006 - has not been modelled in the current version of the model and therefore is not present in this description.

8.1.1. The wage-earners retirement schemes

a. The conventional early leavers' scheme (CELS)

The CELS is essentially an unemployment scheme. It allows older wage-earners to exit the labour market and become unemployed at favourable conditions until the mandatory age of retirement. This scheme allows two different ways of withdrawal of the labour market: The full-time CELS and the mid-time CELS. The first one is a complete activity cessation while the second one permits the individual to work mid-time until the compulsory retirement age. The mid-time retirement is the only possible part-time retirement available in the CELS. Eligibility ages and the computation of benefits depend on the chosen retirement scheme. It has also to be said that this retirement decision is not only in the hand of the employee but is a joint decision of the employee and the employer. In reality, it is often advantageous for the employer to accept this kind of early-retirement.

The full-time CELS

The eligibility ages of the full-time CELS depend on the number of working years. The eligibility age is 60 if the career is at least equal to 20 years and 58 if the individual has worked at least 25 years.

The CELS benefit is compound of an unemployment benefit and a complementary benefit that comes from the employer. The unemployment benefit is equal to 60% of the last gross monthly earning which is submitted to an earning ceiling of €1,743.89[52]. As to the complementary part of the CELS benefit, it is equal to 50% of the difference between the reference net earning and the

[52] All Amounts indicated in the private sector section are amounts at the date of 01.08.2005, what corresponds to the CPI 116.15.

unemployment benefits. This reference earning is the last month earning whose gross amount is capped at €3,158.03.

The CELS benefits are subject to social security contributions and income taxation. The total social security contribution rate is 6.5%. This contribution payment cannot reduce the CELS benefit under the amount of €1,367.44 for an individual considered a head of household in the sense of the social security administration[53] and €1,135.26 for an individual that is not considered a head of household. Concerning the income taxation, Retirement benefits, as all replacement income, are subject to a favourable tax exemption.

The mid-time CELS

This benefit has not been implemented in this version of the model. We however discuss it for completeness' sake.

The eligibility age of the mid-time CELS is fixed to 58. A minimum of 25 working years is required to be entitled to this benefit.

The mid-time CELS income is compound of three different sources: the earning from the part-time work, the unemployment benefit and the complementary benefit paid by the employer. The first two sources are exogenous and will serve as a basis for computing the third one. The mid-time CELS worker is entitled to a guaranteed income that is equal to 50% of the sum of the full-time net earning (whose gross amount is capped at €3,170.67) and the full-time CELS benefits. The complementary benefit is then calculated as the guaranteed income minus the net part-time earning minus the unemployment benefits. This last component is equal to €343.98 per month.

A total social security contribution rate of 4.5% is levied on the mid-time CELS benefit. This deduction cannot reduce the mid-time CELS benefit under the amount of €686.46 for a head of household and €569.90 for a worker not considered as a head of household. The part of income that comes from the CELS follows the favourable fiscal treatment reserved to replacement incomes.

b. The disability scheme

There is no eligibility age for the disability benefit. However, we observe that someone who becomes disabled after age 50 has almost a zero probability to reintegrate the labour market. Becoming disabled after age 50 is therefore considered in this model as an absorbing state.

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[53] An individual is considered as a head of household in the sense of the social security administration when he lives with a partner without any income or with dependent children.

Disability benefit is equal to 40% of the last wage when the individual is cohabitant and 50% of the last wage when the individual is single. This amount is subjected to minimum and maximum. The maximum is obtained with a daily wage of €109.56 and the minimum is computed based on a daily wage of €69.34.

A total social security contribution rate of 3.5% is levied on the disability benefit. This deduction cannot reduce the daily disability benefit under €49.94 if the individual is head of household and €41.46 if the individual is not head of household. Income taxes on this amount are computed based on the replacement incomes rules.

c. The time-credit scheme

As the mid-time CELS, the time-credit scheme has not been implemented in this version of the model. We however discuss it for completeness' sake.

In 2002, the legislation relative to career interruption has been replaced by the one of the time-credit. This system includes a specific part for worker aged 50 and over. It allows old-age workers to change from a full-time regime over to a part-time regime until the retirement age. In addition to the requirement concerning the eligibility age, it is required to have a recorded career in the wage-earner regime of at least 20 years and to be employed in the same company during the last 5 years before the part-time retirement. Furthermore, the number of workers that is allowed to retire part-time through this scheme is limited to 5% of the company's workforce.

There exist two different regimes: The mid-time reduction and the reduction of 1/5 of the working time.

The old-age time-credit benefit is a fixed amount that is equal to €408.88 for the mid-time reduction and €189.92 for the 1/5 reduction (€229.19 for a single worker).

No social security contribution is due on this benefit. Income taxes on this amount are computed based on the replacement incomes rules.

This benefit has not been implemented in this version of the model.

d. The old-age employee retirement scheme

The mandatory retirement age of the old-age retirement system is 65 for men and is in a transitional period for women. It was previously fixed to 60. It is gradually increasing from 61 from 1997, 62 from 2000, 63 from 2003, 64 from 2006 and finally up to 65 from 2009 on. There exists also an early retirement age. Indeed, one can be eligible for early retirement from the age 60 on if one has reached a sufficiently long career. This latter condition concerning the length of the career has recently become more severe. While 20 years of work was sufficient before 1997, it became 22 years in 1998, 24 years in 1999, 26 years in 2000, 28 years in 2001, 30 years in 2002, 32 years in 2003, 34 years in 2004 and finally 35 years in 2005. This condition is the same for men and women.

Benefits are based on earnings during the period of affiliation. The benefit formula can be described as follows:

Benefit = n/N * average wage * k,

where *n* represent the number of years of affiliation with the wage earner's scheme, *N* the number of years required for a full career (45 years for men and again in a transition period for women, i.e. 41 years from 1997, 42 from 2000, 43 years from 2003, 44 years from 2006 and 45 years from 2009 on), and *k* is a multiplicative factor, which takes on the value of 0.60 or 0.75 depending on whether the social security recipient claims benefits as a single person or as a household. The average wage corresponds to the indexed average wage over the period of affiliation, with indexation on the price index combined with additional discretionary adjustments for the evolution of wages.

A particularity of the Belgian wage-earners retirement system is that periods spent on replacement income fully count as working years in the computation of the length of the career. The main periods assimilated to work periods – called herein assimilated periods - are unemployment, disability, time-credit and CELS early retirement periods.

If the number of years worked is larger than the required full career then lower income years are dropped out.

The average wage is composed of effectively paid wages and fictive wages for assimilated period of work. These fictive wages are whether equal to a fixed amount or equal to the wage earned the previous year, both amounts being indexed. This is depending on the calendar year. Indeed, from 1955 to 1967 a fixed amount is taken into account (these amounts being different for the period 1955-1958 between blue-collar workers and white-collar workers) and from 1968, the rule of the previous year wage is applied. In addition, an increasing for the evolution of growth is taken into account from the year 1974 onwards.

Effectively perceived wages are taken into account from 1955 onwards. For years before 1955 a unique fixed amount replaces wages for both blue and white-collar worker. This period of fictive wages continues for white-collar workers until 1957 with specific amounts for these three supplementary years. The effectively perceived wages are subjected to ceilings for the whole period for white-collar workers and from 1981 for blue-collar workers. These wages are multiplied by a re-evaluation index that includes a consumer price index but also an index for the growth of wages. This last component of the re-evaluation index is only applied for the period 1955-1974 and is abandoned for retirements occurring after 2004.

In addition to ceilings on wages, three types of minimum regulations render the system more redistributive, that is, less close to a purely Bismarckian system. These three minimum regulations are the replacement of effective wages by minimum amounts, a guaranteed minimum retirement benefit and the old-age guaranteed minimum income.

The first regulation is applied when effective wages are lower than a minimum amount. In that case effective wages are substituted by this minimum amount. This amount is equal to €14,810.70 and is adjusted on a proportional basis when the occupation is not full-time. This replacement by a minimum amount is operated only if the career in the wage-earners regime is at least equal to 15 years, if this occupation corresponds to at least one third of a full-time occupation and if the computed retirement benefit does not exceed €15,248.83 for a household or €12,199.05 for a single (amounts that are adjusted on the basis of the career ratio). This wage substitution is therefore operated as long as the computed retirement benefit does not exceed these maximum amounts.

The second regulation is the minimum retirement benefit that is allocated in case of a complete career. When the career is not complete - but only if it is larger than two thirds of the complete career – the guaranteed minimum retirement benefit is adjusted proportionally to the career ratio. This guaranteed minimum retirement benefit is fixed to €10,395.79 for a single and €12,994.74 for a household.

The last type of minimum regulation is the old-age guaranteed minimum income. This benefit is not specific to wage-earners and is therefore presented below as an independent scheme.

A vacation benefit is paid to retired worker of the wage-earner regime. This is a fixed benefit equal to €643.99 for a "household" old-age pension and €515.18 for a "single" old-age pension.

Social security contributions are levied on retirement benefit at a rate of 3.55%. This payment cannot have the effect to reduce the monthly retirement benefit under a minimum amount equal to €16,171.32 for a "household" benefit and €13,644.96 for a "single" benefit.

As it is the case for all types of benefits provided by the wage earners' social security system, the retirement benefits are covered against erosion by the means of inflation through an automatic consumer price index (CPI) adjustment. On top of that, there are irregular and ad-hoc welfare-adjustments for the group of retirees as a whole, or for selected vulnerable groups.

e. The surviving spouse benefit

The surviving spouse benefit can be obtained from the age of 45 and even younger if the surviving spouse has dependent children.

The amount of the surviving spouse benefit is based on the retirement benefit of the deceased spouse. The calculation of the surviving spouse benefit differs depending on whether the deceased spouse was already retired or not. When the deceased spouse was already retired, the widow(er) benefit is equal to 80% of its spouse retirement benefits at the household rate (what is exactly the same as 100% of the retirement benefit at the single rate, 80% of 75% being equal to 60%).

When the deceased spouse was younger than the retirement age, his theoretical retirement benefit is computed as if he decided to retire at the date of his decease. The complete career that is considered into the benefit formula is adjusted to take into account of the premature character of the decease. The length of the complete career is in this case the number of years between the 20th birthday and the age of the decease. This correction can sometimes make the benefit too generous for surviving spouses of workers whose career is very short compared to surviving spouses of workers whose career is longer. This situation is due to the fact that shorter careers include more recent wages that usually are higher. A limitation of the surviving spouse benefits avoids this unfair situation. This limit is equal to the career ratio (as explained here above) multiplied by another retirement benefit computed as follows: The assumption is taken that a complete career (e.g. 45 years for men) has been proved. The effective wages are taken into account for the effective activity period while the fixed amount for working years before 1955 (i.e. €11,910.95) is taken into account for the years that have to be added in order to obtain a complete career.

There exists also a minimum widow(er) benefit. This minimum benefit is fixed to €10,232.50 for a complete career. When the career is not complete - but only if it is larger than two thirds of the complete career – the minimum benefit is adjusted proportionally to the career ratio.

The combination of a widow(er) benefit with a legal retirement benefit is allowed until a certain ceiling equal to 110% of the widow(er) benefit for a complete career.

A vacation benefit is also paid to the recipients of a widow(er) benefit of the wage-earner regime. This is a fixed benefit equal to €643.99 for a survival spouse with dependent children and €515.18 for a survival spouse without dependent children.

Social security contributions are levied on survival spouse benefit at a rate of 3.55%. This payment cannot have the effect to reduce the monthly retirement benefit under a minimum amount equal to €16,171.32 for a survival spouse with dependent children and €13,644.96 for a survival spouse without dependent children.

Here again, surviving spouse benefits are covered against inflation through an automatic consumer price index (CPI) adjustment.

f. The divorced spouse's benefit

This benefit has not been implemented in this version of the model.

The divorced spouse of a wage earner is not entitled to a survival benefit. He is however entitled to a retirement benefit based on the ex-spouse's career performed during the marriage. This divorced spouse's retirement benefit is independent of the fact that the ex-spouse is still alive or not and has no influence on the pension right of the ex-spouse.

Entitlement conditions are the same of those prevailing for the old-age retirement benefit.

Computation rules are the same of those used for the old-age retirement benefit except that:
– only years worked during the marriage are taken into account;
– only 62.5% of the reference wage of the ex-spouse is taken into account;
– years worked by the divorced spouse in other regimes are not taken into account, except if he decides to abandon his divorced spouse's benefit.

g. The separated spouse's benefit

The separated spouse can obtain a total amount of pension (personal pension and separated spouse pension) equal to half of the pension of the other spouse (at the household rate). It has to be noted that half of the pension of the other spouse at the household rate (separated spouse's benefit) correspond to 62.5% of the retirement benefit of the ex-spouse at the single rate (divorced spouse's retirement benefit). The main difference with the divorced spouse retirement benefit is that the separated spouse benefit is taken out of the other spouse benefit.

The separated survival spouse can obtain a survival spouse benefit in the same way as the non-separated survival spouse.

This benefit has not been implemented in this version of the model.

8.1.2. The civil servants retirement schemes

Public sector pensions are considered as deferred income rather than old-age insurance. Indeed, public pensions are paid out of the general federal budget and therefore not by contributions of civil servants alone. The only official insurance aspects are the 7.5% social security contributions that public-sector employees have to pay to finance survivor benefits. Benefits are essentially individualized, that is, there are no difference between a "household" benefit and a "single" benefit.

Indexation rules of public sector pensions are different than the one that prevail for wage-earners pensions. Indeed, in addition to indexation to the CPI, public pensions are indexed to average wages. Civil servants enjoy therefore the benefits of productivity increases even when they are retired.

There exist three different retirement schemes for civil servants. The old-age retirement scheme, the invalidity retirement scheme and the survival spouse retirement scheme. Parallel to these three schemes, there exists a mid-time retirement scheme. This will be the first scheme presented below.

a. The mid-time retirement scheme

This benefit has not been implemented in this version of the model.

The mid-time retirement scheme allows civil servants to move out of a full-time work to a mid-time work during a period of maximum five years preceding the date of retirement. This program is available from the age of 55. The civil servant chooses the number of years he wants to spend on that regime and at the end of that period he is put on retirement. When this decision has been made, the individual cannot come back in a full-time regime or extend the chosen period of mid-time retirement.

In addition to 50% of his wage, the mid-time retired civil servant receives a benefit of €295.99.

b. The old-age retirement scheme

Civil servants' pensions are compulsory as of age of 65 for both men and women. An early retirement is possible from the age of 60 if at least 5 years of work as civil servant is proved. This 5 years condition is also necessary to be entitled to the normal age retirement benefit.

Public sector pensions are based on the income earned by an individual during the last five years before retirement. Benefits are computed according to a formula that can be represented as follows:

Benefit = n/N * reference earning,

where *n* is the number of eligible years spent in the public service, *N* is a benefit accrual factor and the reference earning is the average wage over the last five years. The number of eligible years spent in the public service includes the number of years worked as civil servant but also some absence periods (mainly the mid-time retirement, the partial or complete career interruption and the four days week regime)[54]. It has also be recognized that years of work as non-

[54] These periods are not fully taken into account for the computation of the number of eligible years. See Appendix A for computation rules.

statutory government employees that are followed by a definitive appointment in the public sector are considered as eligible years for the public sector pension.

The benefit accrual factor depends on the rank the person occupied in the hierarchy. It is in general equal to 60 but can vary from 55 for some teachers to 30 for university professors and magistrates.

There exist two types of limitations to the public sector pension benefit: a relative limit and an absolute limit. The relative limit is 75% of the reference earning and the absolute one is fixed to €46,882.74 per year

The relation between the benefit accrual factor N and the maximum career length max(n) is set such that after a full career, the civil servants is eligible to a pension benefit of 75% of the reference earning. So max(n)/N=0.75. As a consequence, the benefit accrual factor N determines max(n), the number of years n after which one reaches the full career. The benefit accrual factor N usually equals 60, which means that the civil servant needs to have a career of 0.75 times 60=45 years to receive the full pension benefit.

From 2001, a new legislation has been introduced that renders the activity continuing after 60 more attractive. Indeed, a financial complement or bonus is given for all retirement after age 60 that corresponds to a percentage of the pension. This percentage varies according to the age of retirement. It is equal to 1.5% for each additional year worked between 60 and 62 and 2% for each additional year worked after 62. The total bonus can therefore reach 9% of the retirement benefit for the individual who stays active until the normal age of retirement. This complement cannot be lower than a fixed minimum annual amount equal to €180 for years between age 60 and 62 and €240 for years after age 62[55].

When the pension does not reach a predetermined minimum amount, a complement is given in order to reach the guaranteed minimum. This complement is accorded to the individual with a minimum of 20 years spent in the public service. The guaranteed minimum amount is equal to €9,038.00 for a single retiree and €11,310.00 for a married retiree. This complement is a means-tested benefit for which partner's incomes are also taken into account. There exists however a base minimum for married retirees of €5,293.68 that is not means-tested.

A vacation benefit is paid to retired civil servants who are at least 60 years old and whose pension is lower than €1,300.00. This is a fixed benefit equal to €155.58 for single retirees and €207.44 for married retirees. A complementary benefit to the vacation benefit is given to retirees that

[55] All amounts indicated in the public sector section are amounts at the pivot-index 138.01. The multiplying factor corresponding to this index for the year 2005 is 1.3728.

benefit of the guaranteed minimum. This complementary benefit is equal to €235.21 for single retirees and €282.03 for married retirees.

Two types of contributions are raised on public pensions. First there is the usual 3.55% of social security contributions that is here levied on pensions higher than a determined amount. Secondly, a contribution of 0.5% is used to finance a funeral costs allowance that is actually equal to the last gross pension (with an absolute maximum limitation).

c. The disability retirement scheme

When a civil-servant is recognized to be definitively unfit to continue to work, he is given a disability retirement benefit. Neither minimum age, nor minimum working years is required for the disability benefit.

Disability retirement benefits are computed in the same way as the old-age retirement benefits. Disability retirement benefits are given for the entire rest of life and are not transformed into old-age retirement benefits when the individual reaches the eligible age.

Limitations of this benefit are the same as those prevailing for the old-age retirement benefit. The guaranteed minimum depends on the marital status of the individual. For a single retiree it is equal to 50% of the reference earning. This amount must be at least €9,228.00 and at most €13,234.00. For a married retiree the guaranteed minimum is equal to 62.5% of the reference earning. This amount must be at least €11,535.00 and at most €16,542.75.

Vacation benefits and complementary vacation benefits that are allocated to disabled retirees are the same as those for the old-age retirees. The same types of contributions than those raised on old-age pensions are levied on disability benefits.

d. The survival retirement scheme

The recipients of this survival retirement benefit are threefold: The survival married spouses, the survival divorced spouses and the orphans of the former civil servants.

The survival married spouse benefit

Entitlement conditions are the followings: The marriage must have lasted at least one year (except if they had dependent children), the deceased person must count at least five years of work as a civil servant and the survival spouse must have reached the age of 45 (except if he/she has dependent children).

The survival married spouse benefit is computed as follows:

Benefit = n/D * 0.6 * reference earning, where n is the number of eligible years of the deceased civil servant (see old-age retirement benefit), D is the number of years between the 20th birthday and the age of the decease (capped at 40 years) and the reference earning is the average wage over the last five years before death.

The survival married spouse benefit is limited with respect to a relative and an absolute maximum. On one hand, the benefit cannot exceed 50% of the maximum wage of the wage scale attached to the last rank of the deceased spouse or the reference earning if it is higher, multiplied by the fraction n/D. And on the other hand, the benefit cannot exceed an absolute amount fixed to €46,882.74 per year.

The survival married spouse benefit cannot be lower than a guaranteed minimum amount fixed to €7,889.00.

The combination of a survival spouse benefit with an old-age pension is allowed until a certain ceiling equal to 55% of the maximum wage of the wage scale attached to the last rank of the deceased spouse. The application of this ceiling cannot reduce the sum of the survival benefit and the old-age retirement benefit under the full survival benefit or under an amount equal to €8,850.70 per year. If, after the application of this ceiling, the sum of these pensions is lower than €11,310.00 then the reduction of the survival benefit is operated at a rate of 75%. This preferential reduction rate is applied until the sum of pensions reaches €11,310.00.

A vacation benefit is paid to survival spouses who are at least 45 years old and whose pension is lower than €1,040.00. This is a fixed benefit equal to €155.58. A complementary benefit to the vacation benefit is given to survival spouses that benefit of the guaranteed minimum. This complementary benefit is equal to €235.21.

The same types of contributions than those raised on old-age pensions are levied on survival benefits.

The survival divorced spouse benefit

The survival divorced spouse that has not entered into a new marriage is entitled for a survival benefit when (s)he is at least 45 years old or when (s)he has dependent children. The survival divorced spouse benefit is based on the number of years worked by the deceased person that are situated during the marriage period. Indeed, the benefit computed as if there had only one survival married spouse is multiplied by the ratio of the number of working years situated during the marriage period on the total working years.

In the case of coexistence of a married and a divorced survival spouse, the benefit allocated to the divorced spouse is subtracted from the married spouse's benefit. However, the survival married spouse benefit cannot be lower than 50% of the benefit he would have received if he was the only beneficiary.

Maximum limitations are taken into account trough the computation method based on the survival married spouse benefit that is itself limited. There is no guaranteed minimum benefit for the survival divorced spouse.

The rules that are applied for the combination of a survival divorced spouse benefit and an old-age pension are the same as those used for the combination of a survival married spouse benefit and an old-age pension.

The vacation benefit is computed in the same way as the vacation benefit of the survival married spouse.

The same types of contributions than those raised on old-age pensions are levied on survival benefits.

This benefit has not been implemented in this version of the model.

The orphans benefit

This benefit has not been implemented in this version of the model.

The orphans benefit is equal to 6/10th of the survival spouse benefit if there is one orphan, 8/10th if there are two orphans and the entire survival benefit if there are at least three orphans.

8.1.3. The self-employed retirement scheme

As already mentioned in section 4.3.1 the self-employed retirement benefit is not modelled using exact regulation as it is done for civil servants and wage-earners. Indeed, data concerning self-employed career are very often missing and it is therefore not possible to compute their benefits. For this reason it has been decided to give to self-employed retirees the minimum pension for self-employed. For those who have only a part of their career as self-employed, they receive the minimum pension computed at the pro rata of their career as self-employed. As 78% of "pure" self employed benefit from the minimum pension (Scholtus 2008), the output of this simplification might nevertheless be realistic.

The description that will be done of the self-employed retirement scheme is therefore limited to the part concerning the minimum self-employed benefit.

The eligibility age of the self-employed retirement is the same than for wage-earners. As to what concern the early retirement age, it is also the same except that for each year of anticipation compared to the legal age of retirement, the retirement benefit of self-employed is reduced by 5%.

The minimum retirement benefit for a complete career is fixed to €9,551.58 for a single self-employed and to €11,939.47 for a head of household.

8.1.4. The old-age guaranteed minimum income (GMI)

This scheme has been reformed in 2001 in order to render the system more in line with recent changes introduced into the social legislation. The model follows this more recent legislation. The eligibility age for this benefit is 65 for both men and women but there exists a transitional regime that render the GMI available from 62 years old from 2001, 63 years old from 2003 and 64 years old from 2006 until the end of 2008.

The amount depends on whether the individual lives alone or not. The base amount that goes to the recipient who shares his main residence with one or more other people is equal to €5,489.91. As to the amount that goes to the isolated recipient, it is equal to 1.5 times the base amount[56].

The base amount of GMI can be allocated to more than one person in the same residence if they are entitled to.

The GMI is a means-tested benefit. The average income of the household – excluding incomes of children - is the base of the means test. Retirement benefits that enter into the means test are taken into account at 90% of their amounts. As MIDAS simulates only earnings and retirement income, it underestimates the total means of a household. Consequently, the level of the GMI – and hence its impact of the adequacy of pensions- is somewhat overestimated. However, as low pensions or earnings can be expected to come with low or absent other means of living, the size of this overestimation is expected to be limited.

8.1.5. Accumulation rules

This section deals with the rules of accumulation of an employee pension benefit with a civil servants' pension benefit[57].

Suppose that a civil servant has a benefit accrual factor (also known as pension ratio) of N. This-means that (s)he earns (1/N) of his pension benefit per year worked. He or she therefore reaches the full career after .75*N years.

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[56] As for the private sector section all amounts are amounts at the date of 01.08.2005.
[57] Amounts in this section are amounts in 2004.

Suppose an individual who has worked for a years as an employee, and c years as a civil servant, given the above-mentioned regime. So, the career ratio of the individual as a civil servant is c/(.75N). Suppose furthermore that the years worked as a civil servant give the individual a pension of X euro per month.

The employees' pension benefit may be decreased, as a result of 'downsizing' the total number of years worked to the full career.

Step 1: calculate the total length of the career in 45th.

a + c*(45/.75*N) = TC

The private sector pension benefit should be recalculated, using a career a decreased by d=round-(TC-45), but only if two conditions A and B are met.

Step 2: Check condition A

The private sector pension benefit is decreased only if the recalculated amount ('omgerekend bedrag')

RC=(X times (1/career ratio)) exceeds €8585.78

Step 3: Check condition B

d = MIN(round-(TC-45), 15)

and suppose

z = round+[(RC-8585.78)/858.58], d = MIN(d, z)

Example:

An individual has worked 8 years as an employee, and 34 years as a civil servant. Suppose N to be equal to 50. For the latter, he earns a pension benefit of €12,500.

So: a=8, c=34, N=50, X=€12,500

Step 1: the total length of the career is TC = 8+34*(45/(.75*50)) = 48.8

d=round-(48.8-45) = round-(3.8) = 3

Step 2: RC = (X * ((0.75*N)/c)) = 12500*37.5/34 = €13,786.76. This is higher than €8,585.75 so condition A is met.

Step 3: 3 is less than 15 so the first part of condition B is met.

z = round+[(RC-8585.78)/858.58] = round+[(13786.76-8585.78)/858.58] = round+[6.06] = 7

So d = MIN(3,7) = 3

Three years are therefore left out of the calculation of the employees' pension benefit. The years omitted are those with the lowest income, as to minimize the effect of this omission on the pension benefit.

8.1.6. Computation rules for assimilated periods in the public sector

Some absence periods enter into the computation of the number of eligible years. These periods are:

- Partial or complete career interruptions
- Non-remunerated absence periods allowed for social or family raisons
- Mid-time retirement periods
- Four days week regime periods
- Off work periods prior to retirement

However, these periods are not fully taken into account. One period adds to the length of the career a fraction of 1, and this fraction depends on the date of birth of the civil servant.

Some of these periods are free eligible periods while others become eligible after a social security contribution payment validation. The rules of computation of these periods can be summarized as follows:

a. For civil servants born before the 1st January 1947

Above mentioned periods, except off work periods prior to retirement, are taken into account for 20% of effectively worked periods. Off work periods prior to retirement are fully taken into account.

b. For civil servants born between the 1st January 1947 and the 31st December 1950

Absence periods, including off work periods prior to retirement, are taken into account for 25% of effectively worked periods.

c. For civil servants born between the 1st January 1951 and the 31st December 1955

Absence periods, including off work periods prior to retirement, are taken into account for 20% + x/y times 5% of effectively worked periods. x is the number of months between the month of the 55th birthday of the civil servant and January 2011, and y is equal to 60.

d. For civil servants born after the 31st December 1955

Absence periods, including off work periods prior to retirement, are taken into account for 20% of effectively worked periods.

In all cases, absence periods of civil servants that are considered as assimilated periods can never exceed 5 years.

8.2. Full Description of the German pension system

The vast majority of gainfully employed persons in Germany are compulsorily insured in the public pension scheme (PPS). The most important exceptions are civil servants and most of the self-employed. Moreover, there is a petty employment ceiling. Thus, people working only a limited number of hours per week and meeting the ceiling are not compulsorily insured. For civil servants, a specific old-age provision system exists which is financed by the general tax revenue.

The description will be divided into three main parts: the public pension scheme (wage-earners retirement scheme), the civil-servants retirement scheme and the old-age guaranteed minimum income. A last section will briefly describe rules for the cumulation of pension benefits coming from different schemes.

The regulations described will normally refer to the year 2002. However, we will also take into account the most important changes in the legislation which were already enacted but will at least partly apply only in the future. The regulations, especially those in the public pension scheme, are extremely complex. This is mostly due to specific regulations for a large variety of groups of insured persons and the fact that most of new regulations have been and will be phased in over a longer period of time. It is obvious that due to the complexity and the lack of necessary information in the base data set, only the most important regulations can be considered and some simplifying assumptions have to be made.

8.2.1. The wage-earners retirement scheme

The core of the wage-earners retirement scheme is the old-age pension system. Eligible for these pensions are persons insured who have a minimum insurance record and have reached a certain age which at present differs between several groups of insured persons. Further important elements of the public pension scheme are disability pensions and surviving spouse benefits. Independent of their age, persons insured in the public pension scheme are eligible for a full (partial) disability pension if they are not able to work more than a fixed number of hours per day. In principle, the regulations for disability pensions are the same as those for old-age pensions and we will consider this special case after having treated the basic case of old age pensions. The amount of a surviving spouse benefit is a certain fraction of the pension of the deceased spouse and the pension is withdrawn to some extent if own income of the surviving spouse exceeds a certain threshold. Note that surviving spouse benefits are also granted in the case of disability pensions. We will thus consider these pensions after the description of old age pensions and disability pensions for insured persons.

Before describing the regulations for old-age pensions, we will consider briefly the relevant regulations for unemployment as a precondition for early retirement and part-time work for older employees. As most of the regulations for pensions in case of early retirement are the same as in the case of old-age pensions, we will include the detailed description of the rules for the entitlement and the amount of pension benefits in the case of early retirement in the description of old age pensions.

a. Regulations for early retirement due to unemployment and old-age part-time work

Unemployment as a precondition for early retirement

Until the year 1996, persons insured were eligible for an old age pension without any specific deductions at the age of 60 if they were unemployed, had a minimum insurance record of at least 15 years and made contributions to the public pension scheme for at least 8 out of the last 10 years prior to retirement (see Table 90 below). Starting from 1997, the retirement age without deductions was gradually increased to age 65 in the year 2001. However, there still exists the opportunity to retire early if deductions of 3.6% of the monthly benefits for each year of early retirement are accepted. The age threshold for eligibility for an old age pension with deductions after being unemployed was age 60 until the end of the year 2005. It will increase to age 61 in 2006, 62 in 2007, and 63 in 2008. After the year 2011, the specific regulations for the retirement age of unemployed will be abolished completely. Thus, unemployment prior to retirement is relevant in the simulations only in the period from 2002 to 2011.

Table 90: Retirement age during transition phase

		1996 and earlier	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013 (and later*)
women	earliest start without deductions	60	60	60	60	60 to 61	61 to 62	62 to 63	63 to 64	64 to 65	65	65	65	65	65	65	65		
	earliest start with deductions					60	60	60	60	60	60	60	60	60	60	60	60		
unemployed and old age part-time	earliest start without deductions	60	60 to 61	61 to 62	62 to 63	63 to 64	65	65	65	65	65	65	65	65	65	65	65		
	earliest start with deductions		60	60	60	60	60	60	60	60	60	60 to 61	61 to 62	62 to 63	63	63	63		
severely handicapped	earliest start without deductions	60	60	60	60	60	60 to 61	61 to 62	62 to 63	63	63	63	63	63	63	63	63	63	63
	earliest start with deductions						60	60	60	60	60	60	60	60	60	60	60	60	60
long career	earliest start without deductions	63	63	63	63	63 to 64	64 to 65	65	65	65	65	65	65	65	65	65	65	65	65
	earliest start with deductions					63	63	63	63	63	63	63	63	63	**63**	**63**	**63 to 62,5**	**62,5 to 62**	**62**

Notes: * Table does not include the regulations according to latest decisions to increase the regular retirement age to 67 starting in the year 2012.

Source: Author's compilation based on: Federal Ministry of Health and Social Security, 2005, Berlin.

Table 91: Average and income thresholds in the German public pension scheme

	Average Wage Income in Euro per year		Conversion factor East	Petty employment ceiling in Euro per month		Upper income threshold in Euro per month	
	West	East		West	East	West	East
1950	1616	1627	0,9931				
1951	1830	1742	1,0502				
1952	1969	1855	1,0617				
1953	2076	1985	1,0458				
1954	2165	2125	1,0185				
1955	2325	2182	1,0656				
1956	2477	2246	1,1029				
1957	2578	2327	1,1081	48		383	
1958	2725	2479	1,0992	48		383	
1959	2864	2643	1,0838	51		409	
1960	3119	2724	1,1451	54		435	
1961	3437	2783	1,2374	58		460	
1962	3747	2848	1,3156	61		486	
1963	3975	2909	1,3667	64		511	
1964	4329	2972	1,4568	70		562	
1965	4719	3052	1,5462	77		614	
1966	5058	3158	1,6018	83		665	
1967	5225	3280	1,5927	89		716	
1968	5543	3379	1,6405	102		818	
1969	6053	3495	1,7321	109		869	
1970	6822	3614	1,8875	115		920	
1971	7634	3726	2,0490	121		971	
1972	8352	3848	2,1705	134		1074	
1973	9354	3957	2,3637	147		1176	
1974	10421	4094	2,5450	160		1278	
1975	11150	4244	2,6272	179		1432	
1976	11931	4363	2,7344	198		1585	
1977	12754	4500	2,8343	217		1738	
1978	13417	4639	2,8923	199		1892	
1979	14155	4761	2,9734	199		2045	
1980	15075	4831	3,1208	199		2147	
1981	15799	4994	3,1634	199		2250	
1982	16463	5121	3,2147	199		2403	
1983	17022	5217	3,2627	199		2556	
1984	17533	5332	3,2885	199		2659	
1985	18041	5446	3,3129	205		2761	
1986	18727	5680	3,2968	210		2863	
1987	19289	5926	3,2548	220		2914	
1988	19887	6142	3,2381	225		3068	
1989	20484	6336	3,2330	230		3119	
1990	21447	9137	2,3473	240	112	3221	1380
1991	22712	13176	1,7235	245	128	3323	1636
1992	23939	16632	1,4393	256	153	3477	2454
1993	24633	17912	1,3739	271	199	3681	2710
1994	25126	19804	1,2687	286	225	3886	3017
1995	25905	21031	1,2317	297	240	3988	3272
1996	26131	21642	1,2209	302	256	4090	3477
1997	26660	22054	1,2089	312	266	4193	3630
1998	27060	22898	1,2001	317	266	4295	3579
1999	27358	22890	1,1857	322	271	4346	3681
2000	27741	22813	1,2160	322	322	4397	3630
2001	28231	23531	1,2003	322	322	4448	3732
2002	28626	23799	1,1972	325	325	4500	3750
2003	28938	24462	1,1949	400	400	5100	3850
2004	29428	24705	1,1912	400	400	5150	4350
2005	29569	24879	1,1885	400	400	5200	4400

The attractiveness of early retirement following a period of unemployment was in the past also due to a long entitlement period to unemployment benefits of older unemployed, especially compared to the young. Moreover, persons at age 58 were allowed to receive unemployment benefits even if they stated that they did not want to take up a job. However, these regulations were already changed or will be changed in the near future. In 2006, a new legislation came into force which reduces the eligibility period substantially for the highest age groups (from a maximum of 32 months to a maximum of 18 months). The specific regulation for unemployment benefits for those of age 58 and older will be abolished in the year 2008.

Part-time work for older employees

In 1996, a new regulation was introduced intended to increase early retirement by reducing the working time of older employees (Altersteilzeitgesetz). The basic idea of this regulation is that the working time of employees who take advantage of this regulation is reduced by 50% for a period between two and five years without a proportional reduction in earnings. That is, earnings at reduced hours of work have to be grossed up by at least 20% of previous earnings such that net earnings at reduced working hours are at least 70% of net earnings of the previously held full-time job. In addition, the firm has to pay contributions to the pension fund on the basis of at least 90% of full-time earnings.

The law does not specify in which form the working time has to be reduced, and both the employee and the employer have to agree to such an arrangement. However, in practice the so called "block"-model (Blockmodell) dominates collective bargaining agreements according to which the employee works full-time for the first half of the agreed period and does not work at all in the second, i.e. retires early. In case a substitute for the retired employee is hired and some other requirements are met, the firm is reimbursed for the expenses incurred for grossing up the worker´s earnings and paying the higher pension contribution by the Federal Labour Office.

Without a collective bargaining agreement, old age part-time is restricted to a duration of three years. With a collective bargaining agreement it may last up to 10 years. Eligible are employees who are at least 55 years old and were compulsorily insured in the social security scheme for at least three out of the last five years before the start of old-age part-time. Social security contributions and taxes are levied only on the basic wage earnings for old-age part-time (50% of gross earnings before old-age part-time). The additional earnings paid by the employer in order to ensure that the net income during old-age part-time amounts to at least 70% of the net income before old-age part-time are exempted from taxes and social security contributions.

b. Old-age employee pensions

Eligibility

An insured person is eligible for old age pensions if:

- he has a minimum insurance record, and
- the person reached the regular retirement age.

In the case of early retirement, further characteristics of a person insured are relevant:
- employment status prior to retirement,
- sex,
- severe handicap.

Eligible for regular old age pension benefits are insured persons who fulfill the condition of a minimum age of currently 65 years and have a minimum insurance record, known as waiting time, of at least 5 years (allgemeine Wartezeit, §§35, 50 SGB VI).[58] This waiting time includes periods with compulsory contributions and voluntary contributions ("periods with contributions"). According to the pension legislation, periods with compulsory contributions with respect to the waiting time condition of 5 years are:
- periods with contributions due to employment subject to compulsory insurance (including apprenticeship),
- military service (national service) and community service as alternative to military service,
- periods with unemployment benefits received from the federal employment office and benefits received from health insurance due to long-term sickness (since 1992),
- periods for which it is assumed that mandatory contributions were made. The most important case for periods with fictive contributions are the first 3 years of the upbringing of a child (1 year for births before 1992) (§55 SGB VI) for one of the parents, usually the mother,
- periods with care for relatives in need of permanent care for at least 14 hours per week (since 1995), contributions are made by the long-term care insurance scheme.
- periods with specific kinds of voluntary contributions (Nachzahlung).

Before the pension reforms of the 1990's, several groups of insured persons were eligible for old age pension benefits before the regular retirement age of 65 (early retirement) without having to bear specific deductions if they fulfilled a group specific waiting time condition. To these groups belong women (age 60), unemployed and people working "old-age part-time" (age 60), people with a long career of at least 35 years (age 63) and severely handicapped persons (age 60). For all these groups, the increase of the retirement age (in steps of one month) has already started. After the transition phase, the retirement age will be equal to the regular retirement age for these groups with the exception of the severely handicapped persons (age 63) (see Table 90).

Women had to fulfill a waiting time condition of 15 years in order to be eligible for early retirement. The waiting time condition of 15 years is based on the same type of periods as the waiting time condition of five years (see above). The transition for women started in the year 2000 with those born in January 1940 and will end at the end of the year 2009 with those born at the end of the year 1944.[59] Early retirement at age 60 remains possible for women born before the year 1953. However, in this case a deduction of 3.6% of the pension benefits (in each year of the remaining life) has to be accepted for each year retirement starts before the regular retirement age.

58 This waiting time condition also applies for disability pensions and surviving spouse benefits (see below).

59 The retirement age is increased in steps of one month. However, we will increase the retirement age in steps of one year at least in the first version of the model in order to keep the modelling manageable.

For women born after 1952 with at least 35 years of service (see below), early retirement will be possible starting at age 62 with deductions of 3.6% per year of retirement before age 65. The same will apply for men born after 1952.

Unemployed persons also had to fulfill the waiting time condition of 15 years. In addition, they had to have made compulsory contributions for at least eight of the last ten years prior to retirement. The increase of the retirement age of the unemployed and persons in old-age part-time started already in the year 1997 and was completed in the year 2001. Early retirement at the age of 60 remained possible until the year 2005. Deductions of benefits of 3.6% per year of retirement before age 65 had to be accepted. The earliest possible retirement age with deductions will be increased from age 60 to age 63 in the years from 2006 to 2008 (see Table 90). From the year 2012 on, the specific rules for unemployed will be abolished completely. Retirement before the age of 65 with deductions will then be possible at the age of 62 if the waiting time condition of 35 years of service (see below) is fulfilled.

In order to be eligible for early retirement due to a long career, a person has to fulfill the waiting time condition of 35 years. In addition to the periods with compulsory and voluntary contributions (see above), the so called "insured periods without contributions" (Beitragsfreie Zeiten §58 SGB IV) are considered:
- up to three years of education after somebody's 17th birthday,
- maternity leave (6 weeks before and 8 weeks after birth) if a compulsorily insured employment is interrupted,
- periods of inability to work due to sickness or rehabilitation which led to an interruption of a compulsorily insured employment and for which no contributions were made by the health insurance scheme,
- periods of unemployment which led to an interruption of a compulsorily insured employment and for which no contributions were made by the federal employment office,
- periods with a disability pension,
- the first ten years after the birth of a child. If a second child is born in the period of ten years, the total period considered lasts from the birth of the first child until the oldest reaches age 10.
- care of relatives in need of permanent care from 1992 to March 1995

The retirement age of persons insured with a minimum insurance record of at least 35 years was increased from 63 to 65 in the years 2000 and 2001. Retirement at age 63 will remain possible if deductions of 3.6% per year are accepted. The earliest possible retirement age with deductions will decrease to 62,5 in the year 2011, to 62 in the year 2012 and will remain constant thereafter.

For severely handicapped persons who fulfilled the waiting time condition of 35 years, the retirement age was increased from age 60 to 63 between the years 2001 and 2003. Early retirement at age 60 will remain possible in the future. However, as for the other groups, pension benefits are reduced by 3.6% for each year retirement starts before the regular retirement age for severely handicapped persons of 63.

According to contract of the new coalition formed after the elections in the year 2005, the regular retirement age of 65 should be increased gradually from 65 years to 67 years and the increase should be completed in the year 2035. Persons insured with compulsory contributions for at least 45 years should be allowed to retire at age 65 without deductions. In February 2006, the federal cabinet decided to start the increase of the regular retirement age in the year 2012 in steps of one month per year up to the age 66 (in the year 2024). Subsequently, the retirement age should be increased in steps of two months per year to 67 (in the year 2030). It was again stated that persons insured with compulsory contributions for at least 45 years should be allowed to retire at age 65 without deductions. Note that no decision was taken whether age thresholds for early retirement with deductions should also be changed. We assume that they remain at the levels mentioned above.

Pension benefits

Pension benefits of a person are mainly based on his former earnings relative to the average earnings of all employees in each year he makes contributions to the public pension scheme due to insured employment. The benefit formula (for a person i in year t) is given by:

$$PB_{i,t} = SEP_{i,t} * AF_{i,t} * AFTP * CPV_t ,$$

SEP represents the "sum of earnings points" of a person (Summe der Entgeltpunkte), AF the "access factor" (Zugangsfaktor), AFTP the "Adjustment Factor for Type of Pension" (Rentenartfaktor) and CPV the current pension value (Aktueller Rentenwert). While the first three factors are individual specific, the current pension value is identical for all persons (but at present different between West- and East-Germany).

Sum of earnings points (SEP)

There are several "sources" of earnings points. The most important category of earnings points are those due to compulsorily insured employment. A second category is based on actual or fictive contributions made by the state or the social security administration. A third category are earnings points due "assessed insured periods without contributions" (bewertete beitragsfreie Zeiten).[60] As no actual (or fictive) contributions were made for periods of the third category, these periods are valued at a specific average of all earnings points for the first two categories.

1. Earnings points due to compulsorily insured employment:

As mentioned above, the vast majority of gainfully employed persons in Germany is compulsorily insured in the public pension scheme. The most important exceptions are civil servants and

[60] For most of the periods of the third category it is assumed that a person was not able to contribute to the pension scheme due to reasons out of his control (bewertete Anrechnungszeiten).

most of the self-employed. However, also self employed persons and civil servants may have a pension right in the public pension scheme if they had been in dependent employment before getting self-employed or employed in the public or private sector before being appointed a civil servant. Thus, for every individual reaching the retirement age, it has to be checked for each year of his working life whether he was in dependent employment and not a civil servant in that year. The gross earnings in these years are the assessment base for contributions to the public pension scheme and thus constitute a pension right and determine the amount of the pension benefits.

The earnings points an individual receives for a certain year with compulsory insured earnings are equal to the ratio of the (gross) earnings of the individual within the limits of the petty employment ceiling and the upper threshold and the average labour income. The latter is fixed for each year by the government based on statistical information. For instance, if the earnings of an employee are equal to the average in one year, he or she will receive one earnings point. If the earnings are equal to half of the average, he or she will receive 0.5 earnings points. Due to the upper social security contribution threshold, the earnings points for one year of employment are limited to (about) 1.8.

2. *Further earnings points due to compulsory actual or fictive contributions. The most important sources are:*

– military service (national service) and community service as alternative to military service,
– earnings points due to contributions made by the Federal employment office based on unemployment benefits (after 1978),
– earnings points for periods of inability to work due to sickness and for periods of rehabilitation which led to an interruption of a compulsorily insured employment and for which contributions were made by the health insurance scheme from October 1974 onwards,
– earnings points due to home care of relatives in need of permanent care made by the long term care insurance scheme,
– earnings points due to child raising (fictive contributions).

The regulations for earnings points for military service (national service) and community service have changed several times in the past. The number of earnings points for military service are: until April 1961, 0.75 earnings points per year, Mai 1961 (January 1962 in East-Germany) until the end of 1981: 1 earnings point per year (West-Germany), 0.75 earnings East-Germany, 1982 until 1991: 0.75 earnings points per year, 1992 until 1999: 0.8 earnings points per year, from 2000 onwards: 0.6 earnings points per year.

The regulations concerning unemployment benefits have been changed several times in the past:

– Until July 1978, no contributions were made by the Federal employment office. Periods of unemployment are considered only in the final assessment of the whole working life (period from the age of 17 to the start of the pension) and will be treated below. [assessed insured periods without contributions]

- From July 1978 to the end of 1982, the Federal employment office made contributions to the public pension scheme on the basis of the gross labour income which constituted the claim for unemployment benefits. These contributions are treated equivalently to contributions of the insured person (and the employer) on labour income. [compulsory contributions]
- From 1983 to 1991, the Federal employment office made contributions on the basis of the unemployment benefits granted. However, due to technical reasons[61] periods of unemployment are only considered in the final assessment of the whole (potential) working life. [assessed insured periods without contributions]
- In the years 1992 to 1994, the Federal employment office made contributions on the basis of the unemployment benefits granted. The contributions of the Federal employment office are either regarded as equivalent to contributions on labour income [compulsory contributions] or considered as assessed insured periods without contributions in the final assessment of the whole (potential) working life[62] depending on which case is favourable for the insured person. These kinds of periods are called "insured periods with reduced compulsory contributions" (beitragsgeminderte Zeiten). [insured periods with reduced compulsory contributions]
- From 1995 to 1997, the Federal employment office made contributions on the basis of 80% of the gross labour income which constituted the claim for unemployment benefits. The contributions of the Federal employment office were either regarded as equivalent to contributions on labour income or considered in the final assessment of the whole (potential) working life depending on which case was favourable for the insured person. [insured periods with reduced compulsory contributions]
- From 1998 onwards, the Federal employment office made contributions on the basis of 80% of the gross labour income which constituted the claim for unemployment benefits. The contributions of the Federal employment office were regarded as equivalent to contributions on labour income and were not considered in the final assessment of the whole (potential) working life. [compulsory contributions]
- The regulations for unemployment benefits for long term unemployed (Arbeitslosengeld II) have been changed considerably in the year 2005. From this year onwards, contributions are made on a general assessment basis of €400 (per month).

In order to keep the modeling of periods of unemployment tractable, we will only differentiate between periods with compulsory contributions and assessed insured periods without contributions. Insured periods with reduced compulsory contributions are considered as periods with compulsory contributions.

The regulations for periods of inability to work due to sickness and rehabilitation which led to an interruption of a compulsorily insured employment have also been changed several times. At least during some periods, the evaluation depends on whether contributions were made by

[61] The contributions of the Federal Employment Office were not stored in the files of the public pension scheme for the insured persons.
[62] This is done in the second stage of the final assessment, the so called comparative assessment.

the health insurance scheme. Unfortunately, there is no separate information on benefits received nor contributions made in the case of inability to work due to sickness and rehabilitation in the SOEP. Thus, we will neglect these periods.

Since the year 1995, the public long-term care insurance pays contributions to the public pension scheme for persons who care for relatives in need of permanent care for at least 14 hours per week. Contributions are related to the degree of the need of care of the relative and hours cared. The contributions granted range from 26,6% to 80% of the contributions for the average labour earnings (Bezugsgröße, §18, SGB IV = average labour earnings two years before the year under consideration,). The amount of contributions depends on the number of hours cared and the degree of need of care (low, medium, high). As only the number of hours cared is available in the data, we use the total number of persons in each category for the degree of need of care in the year 2005 (see Federal Ministry of Labour and Social Affairs, 2005, p. 494) as weights for the combinations of hours and category to compute average earnings points for each hours group. Unfortunately, the information for the hours cared is available in the data only for the years from 2001 onwards.

The first three years of the upbringing of a child (first year for births before 1992) are regarded as equivalent to contributions from wage income for one of the parents, usually the mother. For each of the three years, women are granted just one earnings point. In principle, these earnings points are additive to earnings points granted for employment income during the same year. However, the sum of both may not exceed the earnings points granted for wage income at the upper threshold. This means that the earnings points for one year may not be higher than 1.8.

Upgrading of earnings points for periods of child-care

Since the year 2002, earnings points due employment in the first ten years after the birth of a child are upgraded by 50% for one of the partners (the same who is eligible for earnings points for the upbringing of a child) under certain conditions:

- the date of birth was in 1992 or later, for earlier births only the years from 1992 until the child reaches age 10 are considered.
- the insured person (normally the mother) must have an insurance record of at least 25 years at the age of retirement
- The sum of earnings points in a year
  - due to earnings points for a child in the first three years after birth (see above),
  - due to employment and
  - due to the upgrading

  may not exceed 1. Thus, the regulation is not relevant in the first three years. In the fourth year after birth and the following years, the maximum amount of additional earnings points is 0.333. This is the case if the insured person has wage income of 0.666 percent of the average.

In addition to this regulation, persons (in the case of couples only one of the partners) who care for two children both younger than ten receive 0.33 earnings points per year if one of the partners is not employed.

Minimum pension

There are two kinds of minimum regulations for old age income:
– replacement of low earnings points before the year 1992 by a minimum amount,
– a guaranteed minimum retirement benefit (Grundsicherung).

Only the first regulation is an integral part of the public pension scheme and will be described in the following. The guaranteed minimum retirement benefit (Grundsicherung) will be considered separately below in section 3.

If earnings points for "unrestricted compulsory contributions" (Vollwertige Pflichtbeiträge) before the year 1992 are on average lower than 0.75 per year, they are increased by 50% with an upper limit of 0.75 if the waiting time condition of 35 years (see above) is fulfilled. "Unrestricted compulsory contributions" are contributions due to compulsorily insured employment (point 1) and the compulsory actual of fictive contributions mentioned under point 2 above.[63] Note that some periods mentioned under point 2 are "assessed insured periods with reduced compulsory contributions" and are not considered for the minimum pension according to the pension regulations. However, as already mentioned, we will not differentiate between periods with compulsory contributions and periods with reduced compulsory contributions. The latter are regarded as equivalent to compulsory contributions. Thus we will take these periods into account for the minimum pension.

3. Earnings points for assessed insured periods without contributions:

Earnings points are granted for several kinds of periods where neither contributions were made due to labour income (see point 1) nor the conditions for point 2 were fulfilled. These periods will be called "assessed insured periods without contributions"[64], in the following (although in the case of periods of unemployment between 1983 and 1991 contributions were made but not recorded, see above). The following periods will be considered:[65]
– earnings points for up to three years of education after somebody's 17th birthday (to be abolished for new retirees in steps until 2009 except for periods with technical college)
– earnings points for women during pregnancy or on maternity leave if a compulsorily insured employment is interrupted,

[63] Note that some of the periods discussed under point 2 are "periods valued as assessed insured periods without contributions". They are not considered for the minimum pension.
[64] Beitragsfreie Zeiten, im Wesentlichen Anrechnungszeiten, §58 SGB IV.
[65] These periods also include periods of inability to work due to sickness and for periods of rehabilitation which led to an interruption of a compulsorily insured employment before 1974 and for which no contributions were made by the health insurance scheme between 1974 and the end of 1983. However, the data do not provide the necessary to treat these periods separately.

– earnings points for periods of unemployment before the year 1978 and periods with unemployment benefits between 1983 and 1991,
– earnings points for periods with a disability pension.[66]

Earnings points for these periods are granted on the basis of a specifically defined average of the earnings points due to contributions (see point 1 and 2 above). However, for most of these periods a restriction is imposed on the number of earnings points attributable to these periods:
– Earnings points for education are equal to 75% of the average of earnings points due to contributions and may not exceed 0.75 earnings points per year.
– Earnings points due to unemployment before July 1978 and due to unemployment with unemployment benefits between 1983 and 1991 are limited to 80% of the average of earnings points due to contributions.

According to the regulations, the evaluation of assessed insured periods without contributions is done in two steps: a "basic total assessment" and a "comparative assessment". The higher value for the "average of earnings points due to contributions in both steps will be granted for assessed insured periods without contributions. In general, the comparative assessment is of rather limited importance although it might be of some relevance in specific individual cases.[67] We will thus neglect it.

Basic total assessment

$$TCV = \frac{SEP\_c\_c + FEP\_ch\_care}{TAP - SIPWC - PP}$$

with:

TCV	total contribution value (per month). This value (number of earnings points) is attributed to assessed insured months without contributions.
SEP_c_c	The sum of earnings points due to compulsory contributions was defined above as the sum of contributions due to earnings (SEP_earnings), due to the upraising of children (SEP_children), due to care for relatives in need of permanent care (SEP_care) and due to specific periods of unemployment (SEP_unemployed).

66 It is obvious from the enumeration that these periods will lose their importance in the future.

67 The comparative assessment is mainly important if in single months contributions were made due to earnings (for example for one day) and the rest of the month is considered as an eligible insured period without contributions. Another case for the "comparative assessment" are periods of unemployment with unemployment benefits of mothers during the first ten years after the birth of the latest child. A comparative assessment is also made if labour earnings and pensions arise in the same month.

FEP_ch_care — earnings points for fictive contributions during the first ten years after the birth of a child and for the care of relatives in need of permanent care in the years 1992 to 1995. In favour of women with no or earnings below the average earnings of all employees in the first ten years after the birth of a child, fictive earnings points, one for each year, are considered in total assessment. Note that this period has no direct effect on pension benefits but only leads to higher values for assessed insured periods without contributions. The first ten years after a birth themselves are normally not regarded as assessed insured periods without contributions. If a second child is born in the period of ten years, the total period considered lasts from the birth of the first child until the oldest child reaches age 10. (Berücksichtigungszeiten).

TAP — total assessment period (number of years between age 17 and begin of pension)

SIPWC — Sum of "Insured periods without contributions". These periods include the assessed periods without contributions and additionally not assessed insured periods without contributions which are not valued themselves. The most important are:[68]

- periods with unemployment but without unemployment benefits after the year 1978,
- up to three years of education (school, university) after somebody's 17th birthday (from the year 2009 onwards)

PP — periods with pensions (including periods with disability pensions)

Example: Assume a person starts working at age 20 and contributed to the pension scheme for 46 years and his/her earnings were equal to average earnings in each year. Thus, the sum of earnings points is 46 and the total contribution value is 46/41. That would mean a bit more than one earnings point for each year of education from age 17 onwards (up to three years). However, for this category a specific restriction is valid: Only 75% of the unrestricted amount of earnings points according to the total assessment are considered up to maximum of 0.75 earnings points (see above). Thus, for the three years a maximum of 2.15 earnings points are granted.

[68] These periods also include periods of inability to work due to sickness and for periods of rehabilitation which led to an interruption of a compulsorily insured employment and for which no contributions were made by the health insurance scheme from 1984 onwards. However, we are not able to treat them separately due to the lack of the necessary information in the data.

The total sum of earnings points SEP which enters the benefit formula stated above thus includes the sum of earnings points due to compulsory contributions and the sum of earnings points for assessed insured periods without contributions evaluated in the total assessment.

Divorce

In the case of a divorce, pension rights for which both partners qualified during the period of marriage are divided equally between the two partners: In a first step, the full pension rights at the end of the marriage are computed separately for each partner. This step is necessary because pension rights accumulated during marriage may to some extent depend on contributions made before the marriage if there are periods during the marriage which are evaluated according to the total contribution evaluation (see above). In a second step, the pension rights for each year resulting from the first step are summed up taking into account only the period of marriage. Half of the difference in the pension rights between the partners is added to the sum of pension rights of the partner with the lower claim and subtracted from the pension rights of the partner with the higher claim. Both amounts are converted to earnings points using the actual current pension value.

Reunification

In principle, the pension regulations are the same in East- and West Germany since reunification in the year 1990. However, some differences have to be considered:

- For insured persons who lived in the German Democratic republic before 1990, earnings points are in principle computed according to the same rules as for persons who lived in the Federal democratic republic. However, earnings were actually much lower in East Germany. Thus, conversion factors were introduced in order to make earnings in Eastern Germany comparable to those in Western Germany.
- The retirement scheme in the German Democratic Republic was composed of a basic element, a voluntary additional insurance and special schemes for a large variety of groups. In principle, the pension rights in all these schemes are relevant for the pension rights after unification. However, due to the lack of information in the data used for the simulation model, we will consider those elements directly based on earnings and make simplifying assumptions in order to meet the average level of pension rights.
- At present, the most important differences remaining between West- and East-Germany are differences in the upper income threshold for contributions and the current pension value.

Access Factor (AF)

The access factor should equalize advantages of retirement before the regular retirement age and disadvantages of retirement after the regular retirement age. The factor has the value of one if a person insured retires at the regular retirement age (see above). For each month someone retires before the regular retirement age, the access factor is reduced from 1.0 by 0.3 percent.

Thus, a whole year of early retirement leads to an access factor of 0.964. Postponing of retirement after the age of 65 increases the access factor by 6% per year.

Adjustment Factor for Type of Pension (AFTP)

This factor values pensions according to the extent to which they are based on own contributions to the system and thus differentiates between old-age pensions, disability pensions and survivor pensions. It has a value of one for all old-age pensions and for the full disability pension. The factor is 0.5 for a partial disability pension and two thirds for an occupational disability pension (see below). Survivor pensions (surviving spouse) have an adjustment factor of 0.25 (small survivor pension) or 0.55 (large survivor pension) (for the description of disability pensions and survivor benefits, see below).

Current Pension Value (CPV)

The current pension value is known until the year 2006 and differs between West- and East Germany. For the years after 2006, the following (slightly simplified) adjustment rule has to be applied:

$$\mathrm{ARW}_t = \mathrm{ARW}_{t-1}\frac{BE_{t-1}}{BE_{t-2}}\left[\frac{100 - AVA_{t-1} - RVB_{t-1}}{100 - AVA_{t-2} - RVB_{t-2}}\right]\times\left(\left(1-\frac{RQ_{t-1}}{RQ_{t-2}}\right)\alpha + 1\right)$$

with:

ARW_t	new current pension value (valid from the 1st July)
ARW_{t-1}	old current pension value
BE_{t-1}	gross wage per employee last year
BE_{t-2}	gross wage per employee in the year before last year (corrected by a factor relating to differences in wage growth between civil servants and employees in the private sector)
AVA_{t-1}	share of subsidized private provision for old-age last year
AVA_{t-2}	share of subsidized private provision for old-age in the year before last year
RVB_{t-1}	average contribution rate to the public pension scheme last year
RVB_{t-2}	average contribution rate to the public pension scheme in the year before last year
RQ_{t-1}	ratio of pensioners to employees last year

RQ_{t-2} ratio of pensioners to employees in the year before last year

The value of the parameter α ist 0,25.

Social security contributions

Social security contributions are levied on retirement benefits for health insurance at a rate of about 7% (rates differ between health insurance companies) and for long-term care insurance at a rate of 0.85% before April 2004 and 1.7% since April 2004. Since 2005, persons born after 1940 without children are levied with a supplementary charge of 0.25% in the long term care insurance.

Income taxes

Pensions from the statutory public pension scheme are deemed to be "other income" in the German income tax law (§22 EStG). Not the total amount of pension benefits is assessable but only a fraction which is related to the (notional) interest on capital (starting at retirement). This fraction depends (only) on the age at which the individual retired. The fractions fixed in §22 of the German income tax law decreases with the retirement age. For example, the fraction of pension benefits which is tax assessable amounts to 31% for an individual who retires at age 61 and 27% for an individual who retires at age 65.

Pensioners may moreover deduct a flat sum for income-related expenses (§ 9a EStG) and another flat sum for special expenses. In case that pension benefits are high or the pensioner receives other kinds of income it is important for the tax load on pensions that pensioners make contribution to the health and long-term care insurance scheme. As far as actual contributions exceed the flat sum deductible for special expenses they may be deducted up to limits specified in § 10 EStG and thus diminish taxable income.

The taxable part of old age pensions was increased in the year 2005 to 50%. It will further be increased for new retirees in steps of 2% per year up to 80% in the year 2020 and afterwards in steps of 1% per year to 100% in the year 2040.

c. Disability pensions

The regulations for disability pensions have been reformed in the year 2001. In principle, there are three types of disability pensions: a pension for partly disabled persons, fully disabled persons and a pension in case of “occupational disability”. Occupational disability pensions are only granted to persons born before 1961.

Persons insured are considered to be partly disabled if they are only able to work between 3 and 6 hours per day for five days a week under the usual conditions of the labour market in the foreseeable future due to sickness or a handicap.[69] Persons insured are considered to be fully disabled if they are only able to work less than three hours per day for five days a week under the usual conditions of the labour market in the foreseeable future due to sickness or a handicap. If a person eligible for a partial disability pension is unemployed and cannot be offered a job within a year, the full disability pension will be granted and backdated to the start of the partial disability pension.[70] If a person insured is eligible for a partial disability pension, is of age 60 or older and unemployed, it is assumed that he will not get a job and is thus granted the full disability pension instead of the partial disability pension.

Occupational disability means that a person is not able to work in his or her occupation at the usual intensity under "normal" circumstances, but can work in some other occupation. This implies that an occupational disability pension is intended to supplement a person's earnings from a job in some other occupation which is supposedly associated with lower earnings relative to occupation-specific work. As only persons before 1961 are eligible for occupational disability pensions, we will neglect these pensions in the following.

Given that a person is eligible for a disability pension due to sickness or a handicap, benefits are in principle granted according to the same regulations as apply for old-age pensions. Especially the minimum insurance record of five years is the same (see above). The following differences between disability pensions and old-age pensions have to be considered:
- There is no age limit for disability pensions.
- Compulsory contributions must have been made for at least 3 years during the last five before the beginning of the pension.
- While receiving a full disability pension, additional labour income may not exceed a ceiling of 1/7 of average labour earnings of all employees, otherwise the pension will be withdrawn in several discrete steps which depend on earnings in the last years before retirement. In order to keep the model tractable, we assume that the withdrawal is equal to one.
- Partial disability pensions are not affected if additional employment earnings are lower than 50% of the average earnings in the last three years before retirement. If additional earnings are in the range between 50 and 75% of past earnings, half of the partial disability pension will be withdrawn. If the additional earnings exceed 75% of past earnings, the pension will be withdrawn completely.
- In case that the health status improves, the disability pension will no longer be granted.
- Disability pensions are converted to old-age pensions when a person will reach the retirement age for an old-age pension.
- The time period between the start of the disability pension and age 60 ("attributed times", (Zurechnungszeit)) will be added to the times (years) which are relevant for the amount of the pension benefits (see above). This increases the pension benefits roughly at the same

[69] Please note that *severely handicapped persons* are not necessarily eligible for disability pensions. In case that they are able to work full time, they are only granted some advantages for early retirement which were described above.

[70] In case unemployment benefits were granted during this year, they will be deducted from benefits of the full disability pension.

amount that would have resulted if the person had continued to work until age 60 and would in these years have had (on average) the same earnings as before disability occurred.

– The pension type factor is 1 for a full disability pension and 0.5 for partial disability pension (see above).
– If an insured person receives a disability pension before the age of 63, 3.6% of the pension benefits will be deducted for each year before age 63 with a maximum of 10.8% (Federal Ministry of Labour and Social Affairs, 2005, p. 284).

d. The surviving spouse benefit

Surviving spouse benefits (as well as orphans' pensions) are intended to replace the maintenance that the deceased insured person was obliged to provide for his/her dependants. The regulations for surviving spouse benefits have changed considerably due to a reform which was enacted in the year 2002. However, for some groups of insured persons the old regulations will remain relevant: persons already receiving a pension and persons who married before 2002 and at least one of the partners had already reached age 40 at the end of the year 2001. In the following, we will mainly consider the new regulations.

A surviving spouse may be eligible for a "small" or a "large surviving spouse benefit". The small surviving spouse benefit is granted if the insured person fulfilled the waiting time condition (minimum insurance record) of five years before his death. According to the new regulations, the small surviving spouse benefit is limited to two years after the death of the insured person while there was no time limit according to the old regulation.

The large surviving spouse benefit is granted if in addition to the fulfillment of the waiting time condition the surviving spouse is at least 45 years old or disabled or a dependent child is present. The amount of the pension benefit depends on the amount of the pension of the deceased spouse and own income of the surviving spouse.

The amount of the surviving spouse benefit is based on the sum of the personal earnings points and thus the retirement benefit of the deceased spouse. The pension benefit of the surviving spouse (PB_ssp) is determined by the following equation:

$$PB\_ssp = SEP\_dsp * AF\_dsp * AFTP\_ssp * CPV,$$

where the personal earnings points of the deceased spouse are given by the product of the sum of earnings points of the deceased spouse (SEP_dsp) and his/her access factor (AF_dsp), AFTP_ssp is the pension type factor for surviving spouse benefits (see below) and CPV is the current pension value.

Three cases have to be considered: (1) the death occurs at the age of 63 or later, (2) the death occurs during early retirement, (3) the death occurs before (early) retirement.

– In the first case, the amount of the old-age pension at the date of death is relevant for the surviving spouse benefit (independent of whether the insured person had already retired or not). The access factor is equal to one if retirement was not postponed after the regular retirement age(see above).

- In the second case, the early retirement pension of the deceased person is relevant for the surviving spouse benefits. Early retirement pensions are in principle equal to old-age pensions, however deductions have to be accepted (see above). In the case of surviving spouse benefits, a specific rule has to be applied: the access factor is adapted depending on the number of months the death occurs before the regular retirement age. For example, if the regular retirement age for the deceased spouse was 65 and he actually retired at age 62, the access factor was (1-0.108=0.892). If he dies a year after retirement (age 63), the access factor will be increased to (1-0.036=0.964).
- In case that the death occurred before retirement, the sum of earnings points will be determined along the same lines as in the case of a disability pension. That means that benefits are in principle granted according to the same regulations as for old age pensions. Especially the minimum insurance record of five years is the same. The time period between the death and age 60 ("attributed times", (Zurechnungszeit)) will be added to the times (years) which are relevant for the amount of the pension benefits (see above). This increases the pension benefits roughly at the same amount that would have resulted if the person had continued to work until age 60 and would have had (on average) the same earnings during these years as before the death occurred (see the description of disability pensions above and note that the deductions for disability pensions received before the age of 63 also apply for surviving spouse benefits).

The essential difference between the pension of the insured person and the surviving spouse benefit is the different adjustment factor for type of pension. While the adjustment factor is one for the regular old-age pension, it is 0.25 for the small surviving spouse benefit and 0.55 for the large surviving spouse benefit. The pension type factor for the large surviving spouse benefit was 0.6 according to the old regulations independent of the number of children. However, according to the new regulations, a surviving spouse is granted additional earnings points if she/he was the partner who received earnings points for the upraising of children (see above). Two additional earnings points are granted for the first and one additional point for each following child. Thus, persons with children might be better off under the compared to the old legislation.

In both cases, the small and the large surviving spouse benefit, own income above a certain threshold leads to a withdrawal of surviving spouse benefits. Under the old regulations only employment income, unemployment benefits and own pensions are considered. Under the new regulations all kinds of income are considered. The relevant own net income is equal to own gross income minus flat fees which differ for different sources of income. The threshold is defined as 26.4 times the current pension value plus 5.6 times the number of dependent children times the current pension value. Income above this threshold leads to a withdrawal of benefits at a rate of 40%. Note that the surviving spouse benefit normally ends if the surviving spouse marries again.

The regulations for social security contributions and income taxes do not differ between old age pensions and surviving spouse benefits.

8.2.2. The civil servants retirement scheme

The pension scheme for civil servants is an independent system beside the public pension scheme which applies to employees in the private sector as well as to normal employees in the public sector. The pensions are completely paid by taxes and follow in structure and extent the so called "principle of full-alimentation". This principle means that the public employer guarantees his employees and their families a good standard of living during the working life period as well as in retirement.

In order to achieve the goal of full-alimentation, the pension scheme for civil servants granted up to 75% of the last labour income for persons who retired before the year 2003. In the following years, the maximal replacement rate of 75% decreases gradually in eight equal steps to 71.75% and will presumably be constant from the year 2010 onwards.

The civil servant retirement scheme grants pension rights to the civil servant due to his service and additional provision for surviving dependants. First we will describe the basic retirement scheme and later on we will discuss the case of benefits for surviving dependants.

a. Old-age retirement scheme

Eligibility / Age of retirement

The old-age pension is provided without any deductions for all civil servants as of age of 65 for both men and women if they were in service for at least five years. Early-retirement is possible if the civil servant is at least 63 years old. Since 2003, early-retirement contains in addition to the lower pensionable length of service a deduction of the replacement rate by 3.6 percent per year. This deduction was introduced in equal steps between 1998 and 2003.

Amount of pension benefits

The amount of the pension benefits is based on the last wage (the reference earnings) and the length of service. The "reference earnings" are determined by the last income which the civil servant received for at least three years. The "length of service" is determined by the sum of years actually served and additionally by periods of military service as well as necessary periods of education. The allowance for education is restricted to out-of-school education after the age of 17 and, since 1997, to a maximum length of three years.

Since 1991, there is a constant relation between the number of years of service and the replacement rate. For each year of service, the replacement rate increases by 1.875 percentage points (benefit accrual factor). Therefore, the replacement rate reaches its maximum of 75% after 40 years of service.[71]

Since the year 2003, the maximum replacement rate of 75% gradually decreases in eight equal steps to 71.75% in 2010. The benefit accrual factor decreases from 1.875% to 1.79375%. The relation between the benefit accrual factor (N) and the maximum career length (n) is set now such that after a full career of 40 years, the civil servant is eligible to a pension benefit of 71.75% of the reference earnings.

Benefit = n * N * reference earnings

The retired civil servants receive an additional yearly benefit which equals about 50% of the personal monthly pension benefit ("Christmas allowance"). Since 2003, this allowance is determined by the current employer and therefore it can differ between the several German States and the federal level.

Until the year 2004, the taxation of pensions of civil servants followed in principle the taxation of labour earnings and thus was largely different from the taxation of benefits from the public pension scheme. However, one major difference existed between the taxation of labour income and of the pensions of civil servants. Retired civil servants were granted a specific tax allowance: 40% of the pension benefits up to a maximum of €3,072 per year were tax exempted. According to the new regulations enacted in the year 2005, the value of 40% will be reduced for each new retiring generation between 2005 and 2020 by 1.6 percentage points and between 2021 and 2040 by 0.8 percentage points. The maximum value will be reduced by €120 per year until the year 2020 and by €60 per year between 2021 and 2040. Under the old regulation retired civil servants were granted a lump sum allowance for income-related expenses (€920 in the year 2002). In the year 2005, this allowance was reduced to an amount of €102 and at the same time, a new specific allowance for retired civil servants was introduced in order to make up the loss at the moment. However, this specific allowance will be gradually reduced for new pensioners to zero until the year 2040.

Civil servants do not pay any compulsory social insurance contributions. They receive a 50% contribution towards the cost of health and nursing care, co-insured spouses receive 70% and children 80%. The civil servants just have to insure privately the missing part.

Child-allowance

For children born before 1992 the parental leave was a pensionable period as long as the child became six months old. For children born in 1992 or later, one parent gets for every child an allowance. This allowance does not depend on periods of parental leave and is gettable for one of the parents who mainly parents the child. One year of parenting entitles the parent to pen-

[71] Until 1991, the replacement rate grew with a degressive factor and its maximum was given after a length of 35 years of service. Only civil servants which retired till the end of 2001 are entitled to receive benefits according to the old legislation.

sion benefits which accord with one year of service. The allowance per child is limited to three years of parenting.

One parent can be entitled for an additional pension bonus if he parents two or more children up to an age of 10 years or if he is in service alongside. This bonus is given by a supplemental factor for the pension benefit of 0.0278 earnings points in the case of several children and 0.0208 earnings points for one child.[72]

Additional incomes

Benefits during early retirement are withdrawn to a certain extent if a person receives labour income or other benefits at the same time and these additional incomes exceed a certain ceiling. This ceiling is given by the last income level of an active civil servant in a salary-group which equals the basis for the calculation of the pension. Everything that the pensioner or widower will earn above this ceiling will be deducted from his pension. However, at least 20% of the original pension have to remain with the pensioner. If the pensioner is 65 or older the ceiling applies only for employment incomes earned in the public sector. Any other income does not affect the level of the individual pension.

The ceiling for handicapped and disabled persons for additional labour income during early-retirement is lower than the regular ceiling. Until the age of 65 it is given by 75% (71.75%) of the last wage depending on the calculation base of the pension. The ceiling in the case of a surviving spouse benefit equals 75% (71.75%) of the regular pension that the deceased civil servant would have received at that point in time.

b. Severely handicapped persons

Severely handicapped persons may retire at age 60 and thus before the regular retirement age of 65. If severely handicapped persons retire before the age of 63 they have to carry a 3.6 percent deduction per year (max. 10.8%), introduced in the year 2001.

This deduction of the replacement rate in the case of handicapped persons does not apply for civil servants which retired before the year 2001. For the years 2001 to 2005 it is necessary to verify if the retired civil servant is born in the years 1941 to 1943. If this happens, the civil servant does not have to carry the full amount of the early-retirement burden and if he is older he does not have any deductions in consequence of early-retirement.[73]

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[72] Since the year 1995, the public long-term care insurance grants contributions to the public pension scheme for civil servants who care for relatives in need of permanent care at least for 14 hours per week. In principle, this regulation also applies for civil servants. However, periods of care for relatives have no impact on the benefits from the civil servants retirement scheme. Thus, we refer to the section on the public pension scheme for this topic.

[73] 2001-2005:
- if born before 1941 or registered as handicapped at the 16.11.2000 and born before the 15.11.1950: no deduction of the replacement rate
- if born in 1941: no deduction if retired early at the age of 61 or later
- if born in 1942: no deduction if retired at the age of 62 or later
- else: deduction of 3.6% for each year retired before the age of 63

c. Disability pensions

If a civil servant is definitely unable to continue work, he gets a retirement benefit without an age restriction. Since the year 2001, retiring because of invalidity causes an additional deduction of the pension benefit of 3.6% per year if it happens before the age of 63. This deduction is restricted to a maximum of 10.8%.

Disabled civil servants which are born before 1942 don't have to carry this deduction, if they have a length of service which is longer than 40 years. Civil servants which retired between 2001 and 2003 didn't have to carry the full amount of the pension discount. This deduction was gradually introduced between 2001 and 2004 in equal 0.6 percentage steps out from a level of 1.8%. With the exception of these deductions, disability retirement benefits are computed the same way as the old-age retirement benefits.

If the early-retirement pension for disabled persons does not ensure a minimum livelihood, a complement is given in order to reach the guaranteed minimum. This complement enables civil servants to live without need for social assistance. The guaranteed minimum amounts to 35% of the reference earnings. Optionally, the guaranteed minimum amounts to 65% of €1760.20 (Endstufe Besoldungsgruppe A4, status: 01.01.2003) with an additional bonus of €30.68.

d. Mid-time retirement scheme

If a person is eligible for the mid-time retirement, she or he may choose the number of years she or he wants to spend in that system and at the end she/he is put automatically in retirement. The individual has to declare bindingly before to retire when she or he reaches the official age level.

The minimum age for mid-time retirement programs is the age of 55. The civil servant has to have been working part-time for at least three years in the last five years prior to mid-time retirement. In addition to 50% of her/his wage, the mid-time retired civil servant receives a bonus of the difference between 83% of the net payments in the case of full-time employment and the net payments from mid-time retirement. The years of mid-time retirement are added to the "length of service" and are regarded as equal to 90% of a full year of service (full-time employed). The reference earnings are based on the last three years of service before the period of mid-time retirement.

e. The surviving spouse retirement scheme

Surviving dependants are qualified for benefits if the deceased person had a service record of at least 5 years and the couple was married for at least one year. The regulations for surviving dependants have changed considerably in the year 2001. The old legislation is applicable for persons who already receive benefits and couples who married before the year 2002 and at least one of the partners was 40 years or older at the end of the year 2001.

Widows or widowers for that the new legislation applies are entitled to pensions which amount to 55% of the pension benefits the deceased person would be entitled to at that point in time. An surviving spouse with children is additionally entitled to an monthly amount equal to two times the current pension value in the public pension scheme for the first child and an monthly amount equal to the current pension value in the public pension scheme for each further child.

Before the new legislation was introduced in the year 2001, the surviving spouse assistance was defined as 60% of the regular retirement benefit of the deceased person. Without the entitlement for an additional pension benefit in consequence of the number of children.

If the regular pension benefit is deduced because of the early retirement of the civil servant the calculation basis for the married widow or widower benefit is diminished in the same amount. The married widow(er) benefit is reduced as well if the age difference between the spouses is larger than 20 years and if they do not have any children. The child-assistance contains 20% of the regular pension in the case of orphans and 12% for half-orphans.

If the married widow(er) benefit not ensures a minimum livelihood, a complement is given in order to reach the guaranteed minimum. This complement follows as well the principle of full-alimentation and enables the widow or widower to live without need for social assistance. The guaranteed minimum amounts 60%, currently 55% (see above), of the minimum pension of 35% of the reference earnings. Optionally, the guaranteed minimum can contain 60%, or 55%, of 65% of €1760.20 (Endstufe Besoldungsgruppe A4, status: 01.01.2003) with an additional bonus of €30.68.

The combination of a survival spouse benefit with an old-age pension or labour earnings is allowed until a certain ceiling. This ceiling is given by 75% down to 71.75% after the current deduction scenario of the last income level of an active civil servant in an income-group which equals the basis for the calculation of the individual widow's pension. Everything what the survival spouse will earn above this ceiling will be subtracted from the pension. The receiver of survival spouse benefits and such second incomes has to get at least 20% of the original benefit.

f. Pension rights adjustment in case of a divorce

In the case of a divorce one of the divorced spouses is entitled to receive a splitting-benefit from the other. This benefit is based on the difference between the pension rights each partner qualified for during the marriage. The spouse with the smaller entitlement gets one half of this difference. The divorced spouse of a civil servant is not entitled to receive a pension from the pension scheme for civil servants. Instead, the divorced spouse with the lower pension rights is entitled to an additional benefit in the public pension scheme. This monthly entitlement results from the splitting-benefit at the date of divorce raised by the percentage increase in the reference earnings of the civil servant in the following years.

The decision about the pension right adjustment is made by the domestic relations court and the amount of this splitting-benefit will be automatically subtracted from the monthly pension entitlement of the former spouse. However, the wage level of the civil servant will not be affected. The splitting-benefit will persist if the divorced spouse marries again or if he receives another pension.[74]

If the divorced spouse survives the other, he is entitled to receive an alimony whether he is originally entitled to maintenance from his deceased spouse. The requirement for this alimony is that the spouse is older than 60 years or that he parents a child which is entitled for orphan-assistance and that he does not married again.

8.2.3. The old-age guaranteed minimum income (GMI)

The old-age guaranteed minimum income was introduced in the year 2005 and is not financed by contributions but by taxes. Eligible are persons of age 65 and older (and severely disabled persons from the age of 18 on) independent of whether they are insured in the public pension scheme or not. The benefits are means (income, wealth) tested. Before the year 2005, needy people were entitled to social assistance payments. Social assistance is the basic means-tested income support system in Germany.

The main difference between GMI and social assistance is the less strict means-test for GMI. Contrary to social assistance no claims are made on relatives (children, parents) as long as their income is below €100,000 per year.

GMI is not granted individually but to the household. The members of a household create a single entity and all members are liable to provide maintenance for one another according to family law. All household members have to use their incomes and wealth to finance the requirements of the household before being eligible for GMI. With some minor exceptions for specific kinds of income, benefits are withdrawn at a rate of 100% for own income. A small allowance is granted for financial wealth (€2.300 per person). An adequate owner occupied home is not considered as wealth and thus has not to be sold before getting eligible for GMI.

The amount of the benefits in GMI is equivalent to the amount of the social assistance benefit (Federal Ministry of Labour and Social Affairs, 2005, p. 343). The first component of GMI are standard rates for regular assistance which differ slightly between the Federal States. Transfers are higher in West-Germany (around €345 per month for the household head) than in East-Germany (around €331 per month). The transfers for the other members of the household are lower than that one for the head of household. Members of the household which are older than 14 years are entitled for 80% of the normal standard rate and members which are younger receives 60% of this transfer.

[74] If a divorced spouse has received maintenance from the former partner (civil servant) until his/her death and she/he is 60 or older or parents a child, maintenance payments will be made by the pension scheme for civil servant. We will neglect this in the model.

In addition to the standard rates for regular assistance, a household may receive non-recurring benefits to cover needs that are not considered in the standard rates, such as clothing and household goods. Moreover, social assistance pays the rent for an adequate accommodation including heating costs.

Because of the imperfect information in the SOEP about direct relatives outside the household, we will assume the applicability of the GMI as well for the years before 2005. This simplifying assumption is necessary because, before the GMI was introduced, direct relatives were liable to provide maintenance for one another

8.2.4. Accumulation rules

Other income is relevant for benefits in the public pension scheme as well as in the pension scheme for civil servants only in case of early retirement, disability pensions and survivor benefits.[75] The general regulations for other income in both systems have already been treated above. What remains to be considered are specific regulations for civil servants who in addition to their benefits from the civil servants' retirement scheme are entitled to benefits from the public pension scheme due to employment before they became a civil servant. Note that the opposite case is normally not possible. If a civil servant quits service without (readily) being entitled to receive a pension[76] he will be insured in the public pension scheme. For all years of service, the public employer has to make contributions to the public pension scheme for the (former) civil servant. The amount of the pension benefits for the former civil servant depends on the ratio of his earnings (up to the upper earnings threshold in the public pension scheme) and the average earnings of all employees in each year of service. Comparable to normal insured persons in the public pension scheme the former civil servant receives "earnings points" which determine the amount of his pension benefit. As contributions were paid for the years of service, these years are regarded as periods with compulsory contributions and thus are considered for the waiting time conditions in the public pension scheme (see above).

For civil servants who receive benefits from the public scheme in addition to their pensions from the civil servants' retirement scheme, two different cases have to be considered. In one case, the retired civil servant was employed in the private sector before he was given the status of a civil servant. In the other case, he already worked in the public sector without having the status of a civil servant.

In the first case, the civil servant is entitled to receive benefits out of the public pension scheme and as well out of the pension scheme of civil servants. In that case, the old-age pension for the civil servant will be only paid up to a certain ceiling. This ceiling is given by the possible pension benefit in response to the "pensionable length of service" (see above) and additional to the

75 Note that one minor exception occurs in the regulations for the civil servants' retirement scheme (see above).

76 In order to be entitled to pension benefits, the civil servant has to fulfill the condition of minimum years of service *and* he has to be of age 63 or older (for exceptions see above). A civil servant is not automatically insured in the pension scheme if he hadn't worked for at least five years or if he is younger than the relevant age level (see above).

length of employment which is relevant for the calculation of the public pension. The subsequent membership to different pension schemes shouldn't enable to a higher amount of pension entitlements than the membership only in the pension scheme for civil servants. Everything above the pension ceiling will be subtracted by 100% from the civil servant retirement benefit.

In the second possible case, the civil servant generated two different pension entitlements from her/his employment in the public sector as employee and later on as civil servant. In this case she or he receives between 75% and 71.75% (see scenario of the past reform above) of her/his reverence earnings if he does not have any early-retirement deductions and if he does have worked for at least 40 years. The time before the public employee became a civil servant is classified as pensionable length of service and will be set off with the entitlement of the public pension scheme. The civil servant is treated like the other life-time civil servants. Whether the civil servant did not worked in the public sector before he does not have this privilege. If so, he has only the restriction that the combination of both pensions is not higher than 75% (or 71.75%) of his reference earnings.

Suppose an individual who has worked for a years as an employee, and c years as a civil servant, given the above-mentioned regime. In the case without early-retirement, the old-age retirement pension of the civil servant is given by $RB = c * N * \hat{w}$ and the public pension of the employee by PB.

8.3. Full Description of the Italian pension system

The following tables summarizes the main features of the Italian pension system for private and public employees

Table 92: Mandatory Pension scheme - Old Age and Seniority Pension - Private Employee

		Requirements
Old regime (*)	**Old age**	**Age** : 65 (60 for female)
		Years of contribution (AC): 15 years or more
	Seniority	**Age**: 57 years of age but + 35 years of contribution
		or younger than 57 but 38 (39 since 2006, 40 since 2008) years of contribution accrued.
		Since 2008, apart from individuals recording 40 years of contribution which can retire independently from age, requirements for seniority pensions are increasing according to the following scheme:
		Since 2008: 58 years of age + 35 of contributions.
		Since 2009: 59 + 36 or 60 + 35 (the so called "quota 95").
		Since 2011: 60 + 36 or 61 + 35 (quota 96).
		Since 2013: 61 + 36 or 62 + 35 (quota 97).
Transition (*)	**Old age**	**Age** : 65 (60 for female)
		Years of contribution (AC): 20 or more
	Seniority	As in the old regime
New Regime (*)	**Old age**	**Age** : 65 (60 for female)
		Years of contribution (AC): 5 years or more
	Seniority	As in the old regime. Anyway retirement before old age limits is allowed only if the benefit accrued is at least 1.2% of the social pension.
		Formula to compute the benefit
Old regime	**Old age and seniority pension**	Before the reform of 1992: P_{or}= RP*C*AC_{tot} where RP equal to the average of earnings of the last 5 years, increased by inflation After reform of 1992: P_{or}= RP_{92}*C_1*($AC_{before92}$/$AC_{tot)}$+ RP_{p92}*C_2*($AC_{after92}$/AC_{tot}) RP_{92} is equal to the average of earnings - increased by inflation - of the last 5 working years and RP_{p92} is equal to the earnings - increased by inflation plus 1%- of the last 10 years of work. The increase up to 10 years is applied gradually (5 years+50% of the years of contribution accrued in the period 1993-1995 and + 66.6% of the years of contribution accrued after1995). Values of C_1 and C_2 in 2006 are the following: RP_{92} — C_1 Up to 38,642 euro — 2% 38,642 – 51,393.86 euro — 1.5% 51,393.86 – 64,145.72 euro — 1.25% 64,145.72 euro and over — 1.0% RP_{p92} — C_2 Up to 38,642 euro — 2% 38,642 – 51,393.86 euro — 1.6% 51,393.86 – 64,145.72 euro — 1.35% 64,145.72 – 73,419.80 euro — 1.15% 73,419.80 euro and over — 0.90%

		A means test integration to a fixed **minimum pension** (Pmin) is provided. The annual amount of minimum pension is 5,558 euro in 2006. If the income of pensioner is <= 5,558 euro he/she is eligible for the full integration; a partial integration is applied if 5,558 <income <= 11,117 euro. If pensioner is married the sum of pensioner and spouse's income is considered and ceilings become respectively 16,676 and 22,234 euro.
Transition	**Old age and seniority pension**	$P_{tr} = P_{or} \cdot (AC_{before95}/AC_{tot}) + P_{nr} * (AC_{after\ 95}/AC_{tot})$ RP_{p92} in P_{or} is equal to the average of earnings - increased by the inflation - of the last 5 working years plus the number of years of contributions accrued after 1992 (e.g. in 2006 earnings of the last 18 years), increased by inflation plus 1%. A means test integration to a fixed minimum pension is provided (as in the old regime).
New Regime	**Old age and seniority pension**	P_{nr}= MC*Coef Where MC is the total amount of contribution paid accumulated according the GDP growth rate and Coef are the transformation coefficients, which are used to convert MC into an annuity. These coefficients are fixed by law and they should be updated every ten years (every three years after the 2007 reforms, however still not phased in) in order to take into account the demographic evolution. Currently values of Coef are: Coef Retirement Age 4.720% 57 4.860% 58 5.006% 59 5.163% 60 5.334% 61 5.514% 62 5.706% 63 5.911% 64 6.136% 65 No minimum pension is guaranteed in the new regime.

The reforms introduced in 1992 and 1995 split workers in different pension regimes according their seniority accrued until the date of the reform. In particular:

Old regime is applied to workers with at least 15 years of contribution in 1992 and at least 18 years of contribution in 1995; the Transition is applied to workers with less of 15 years of contribution in 1992 and less of 18 years of contribution in 1995; the New regime to workers starting to pay contribution since 1995.

Table 93: Mandatory Pension scheme – Survivor - Private Employee

	Requirements
Old regime (*)	5 years of contribution if the dead person was still working. It can be provided to the spouse, even if divorced, and to dependent children or other dependent relatives.
Transition (*)	As in the old regime
New Regime (*)	As in the old regime
	Formula to compute the benefit
Old regime	60% for the spouse plus 20% for every dependent child. These amounts are reduced by 25% if personal income of survivor exceeds 3 times the minimum pension, by 40% if personal income of survivor exceeds 4 times the minimum pension, by 50% if personal income of survivor exceeds 5 times the minimum pension
Transition	As in the old regime
New Regime	As in the old regime

Table 94: Mandatory Pension scheme - Old Age and Seniority Pension - Public Employee

	Requirement
Old regime (*)	Before 1992 reform: Old age benefit: Age = 65 both for man and woman civil servants (60 for other public employee); and at least20 years of contributions (25 for local public employee). Seniority pension: 20 years of contributions for civil servants (25 for local public employee), independently from age. 1992 and 1995 reforms gradually equalized requirements for public and private employees
Transition (*)	As private employees
New Regime (*)	As private employees
	Formula to compute the benefit
Old regime	P_{or}=RP_{92}*CP*($AC_{before92}$/AC_{tot})+RP_{p92}*CP1*($AC_{after92}$/AC_{tot}) With RP_{92} equal to the last monthly wage and RP_{p92} equal to the average of earnings - increased by inflation plus 1%- of a number of years increased gradually up to 10 years since 2008. CP= 2.33% (2.5% for public employee not civil servants) for the first 15 years of contribution and equal to 1.8% for following years; CP1= 2% (but decreasing percentages are used if the RP is higher than a ceiling as for private employee). A means test integration to a fixed minimum pension is provided
Transition	P_{tr}= P_{or} * ($AC_{before95}$/AC_{tot})+ P_{nr} *($AC_{after\ 95}$/AC_{tot}) RP_{p92} in P_{or} is equal to the earnings - increased by inflation - of the last 5 years plus the number of years of contribution accrued after 1992 (e.g. in 2006 18), increased by inflation rate plus 1%. A means test integration to a fixed minimum pension is provided
New Regime	As for private employees

Table 95: Mandatory Pension scheme – Survivor - Public Employee

	Requirement
Old regime (*)	As for private employees
Transition (*)	As for private employees
New Regime (*)	As for private employees
	Formula to compute the benefit
Old regime	As for private employees
Transition	As for private employees
New Regime	As for private employees

Both for private and public employee is guaranteed:

– a **disability pension** if the worker has a reduced (2/3 short) ability to work and at least 5 years of contribution whose 3 just before the retirement.
– an **inability pension** if the worker is unfit to work and has at least 5 years of contribution whose 3 just before the retirement. As a bonus the worker accrues a virtual seniority until the eligible age for retirement. The eligible age is reduced to 60 (55 for woman) if the inability is at least 80% or if he/she is blind. In new regime the eligible age is 60 both for men and women.

A **social benefit** (4962,35 euro in 2006) related to old age is provided to at least 65 aged person with low income. If the person is single the income has to be lower or equal to 4,962.35 euro in 2006; if married the ceiling is 9,924.71.

In short:

Two pension regimes could be identified – the old regime and the new ones emerging from the full application of the reforms.

The amount of pension benefit in the old regime depends on coefficient paid for each seniority year (on average 2% for private employee, 2.33 percent for the first 15 years of contributions and 1.8 for the following years for public sector employees), on earnings considered for computing pension and on seniority (linked to the entry age in the labour market and to the frequency of job interruptions. Unemployment periods are considered for pension if the worker receives unemployment benefits). A means tested integration is provided in old and transition regimes if pension is lower than a minimum. As a consequence for means testing family income is relevant. After the retirement, the pension grows in line with the inflation rate (no real indexation is guaranteed).

In the new regime the amount of benefit depends on: transformation coefficients, (that currently ranges from 0.00472 if one retires at 57 to 0.06136 if one retires at 65), the amount of contributions paid, and the GDP growth rate (which is the return accrued on accumulated contributions). After the retirement, the pension grows in line with the inflation rate.

In the transition phase, pension is computed through the (so called) pro rata method, i.e. benefit is computed through both old and new formulas according to the proportion of the entire seniority accrued before and after 1995.

8.4. References

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About AIM (Adequacy & Sustainability of Old-Age Income Maintenance)

The AIM project aims at providing a strengthened conceptual and scientific basis for assessing the capacity of European pension systems to deliver adequate old age income maintenance in a context of low fertility and steadily increasing life expectancy. The main focus is on the capacity of social security systems to contribute to preventing poverty among the old and elderly and more generally to enable persons to take all appropriate measures to ensure stable or "desired" distribution of income over the full life cycle. In addition it will explore and examine the capacity of pension systems to attain broad social objectives with respect to inter- and intra generational solidarity.

Furthermore it will examine the capacity of pension systems to allow workers to change job or to move temporarily out of the labour market and to adapt career patterns without losing vesting of pensions rights. The project will also address the specific challenges with respect to providing appropriate old age income for women.

A general objective of the research project is to clearly identify and analyse the potential trade-offs between certain social policy objectives and overall stability of public debt.

AIM is financed under the 6th EU Research Framework Programme. It started in May 2005 and includes partners from both the old and new EU member states.

Participating institutes

- Centre for European Policy Studies, CEPS, Belgium, coordinator
- Federal Planning Bureau, FPB, Belgium
- Deutsches Institut für Wirtschafsforschung (German Institute for Economic Research), DIW, Germany
- Elinkeinoelämän tutkimuslaitos, (Research Institute of the Finnish Economy), ETLA, Finland
- Fundación de Estudios de Economía Aplicada , FEDEA, Spain
- Social and Cultural Planning Office, SCP, Netherlands
- Instituto di Studi e Analisi Economica (Institute for Studies and Economic Analysis), ISAE, Italy
- National Institute for Economic and Social Research, NIESR, United Kingdom
- Centrum Analiz Spolleczno-Ekonomicznych (Center for Social and Economic Research), CASE, Poland
- Tarsadalomkutatasi Informatikai Egyesules (TARKI Social Research Informatics Centre), TARKI, Hungary
- Centre for Research on Pensions and Welfare Policies, CeRP, Italy
- Institute for Economic Research, IER, Slovak Republic
- Inštitut za ekonomska raziskovanja (Institute for economic research), IER, Slovenia