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# The long-term adequacy of the Belgian public pension system: An analysis based on the MIDAS model

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**Abstract** - This working paper describes the second version of MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability'), a dynamic population model with dynamic cross-sectional ageing. This model simulates the life spans of individuals in the base dataset, including with their interactions, for the years between 2003 and 2060. It enables to produce, on that period, adequacy assessment of pensions in Belgium that is coherent with the baseline budgetary projections of the 2009 report of the Study Committee for Ageing realized by the Federal Planning Bureau's semi-aggregated MALTESE model. Indeed, MIDAS aligns its socio-economic and demographic projections and its macro-economic assumptions on the 2009 report of the Study Committee for Ageing. The adequacy of pensions is analysed through the replacement ratio, inequality measures among pensioners and poverty risk indicators of the elderly.

**Jel Classification** - J14, D31, I32

**Keywords** - Adequacy, pensions, microsimulation

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# Executive Summary

Microsimulation models in recent years have gained popularity in the assessment of social security systems in terms of the adequacy they provide, and specifically pension policy. This working paper describes the second version of MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability'). 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 model then simulates the life spans of individuals in the dataset, including with their interactions, for the years between 2003 and 2060. Contrary to the first version of the model, which was intended for use in an international setting, this second version is intended for use in the Belgian context only. One of the consequences of this is that the MIDAS model aligns its adequacy assessment of pensions in Belgium on the latest budgetary projections and assumptions of the reference scenario of the 2009 Study Committee for Ageing report. These projections and assumptions take into account the consequences of the financial crisis. Also, the model is extended to include disability benefits and unemployment benefits so that the adequacy of pensions can be put into perspective with other inactive individuals.

The adequacy of pensions is reflected by the replacement ratio, inequality among pensioners and poverty risks of the elderly. During the first 20 simulation years, the replacement rate of women increases consequently while the replacement rate of men slightly decreases. The women's trend on that period is a result of the increasing length of their career, and the strong re-value of the minimum pension benefit from 2007 on. The period between about 2020 up to 2060 shows a parallel decreasing development of the replacement rate of men and women, where the average replacement rate of women is about 8% above that of men.

In the first stage, until the late 2020s, inequality among pensioners increases. This is because the increased labour market participation of women causes earnings to become more important as a source of income of pensioners. In the second stage, until around 2020 and the mid 2040's, income inequality among pensioners decreases. This among other things is the result of the increasing proportion of single pensioner's households and ageing among the elderly. And finally, between the mid 2040's and 2060, inequality among retirees increases again somewhat due to the relatively large cohort entering into retirement.

Probably the most appealing indicator of pension adequacy is the poverty risk indicator of retirees. This indicator is expected, first, to decrease the next 40 years, secondly, to stabilise under the level of the working population poverty between 2040 and 2050 and finally, to increase slightly over the last decade. The evolution during the first two periods is a result of the increasing length of career of women relative to that of men, and a strong increase of the guaranteed minimum for the elderly from 2007 on. The evolution during the last decade is due to the de-

coupling between the adjustment growth rate of minima and the wage growth rate that, finally, after 50 years, have an impact on the poverty level of pensioners. This second version of MIDAS also enables us to analyse the evolution of the poverty risk for the unemployed and disabled workers. Already more exposed to poverty than the average population, including the elderly, the poverty risk of the unemployed keeps rising over the whole simulation period.

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# 1. Introduction

One of the first social scientists to do research on poverty, Seebohm Rowntree, (1901, see Kangas & Palme, 2000, Zaidi, 2009, p 23, for a discussion) formalized the alternating stages of life, and recognized the increased risk of poverty pertaining to being in old-age. The introduction and maturisation of (public) pension systems of course have changed things for the better. Kangas and Palme (2000) concluded that the extension and maturisation of pension systems has resulted in a strong decrease of income poverty among the elderly.

Even though the income position of elderly cohorts as a whole has improved considerably[1], poverty among elderly remains an issue worth of analyzing, also since they have fewer possibilities to recover from a drop in income, for example by changing their labour market behaviour (Hurd, 1990, Cherchye et al., 2008). Furthermore, pockets of poverty remain, notably among single elderly and women of 65 and older (Belgian Study Committee on Ageing (High Council of Finances, 2009, Figure 4, p. 50)).

If the position of the elderly indeed improved, then this was not because the elderly received a larger share of social expenditures. Börsch-Supan (2007) concludes that European social expenditures increased gradually from 1995 on, after a relative retrenchment in the first half in the 1990's. However, the share of social expenditures dedicated to the elderly remained surprisingly constant. He therefore concludes that the improved position of the elderly in Europe, in terms of poverty, was due to more targeting, and higher incomes (other than social security pensions) for the elderly.

If targeting is an important factor explaining why there need not be a 'one-to-one' relation between spending on pensions and the risk of poverty, then specific instruments are needed to assess the consequences of pension policy (and social security policy in general) on the risk of poverty of (specific groups of) elderly.

In recent years, the social consequences of pension policy, and the role of the pension system in this, has been conceptualized –certainly in European context– to the 'adequacy of pensions'. 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 then define a pension system to be adequate when it provides means for individual consumption smoothing, and reduces inequality and poverty. Dekkers and Belloni (in Dekkers et al., 2009) argue that dynamic microsimulation models are best suited for the assessment of adequacy in this definition.

Microsimulation models in recent years have gained popularity in the assessment of social se-

1 Sierminska et al. (2007, 1) mention that most resource transfers between generations nowadays go from elders to children, and not vice versa.

curity systems in terms of the adequacy they provide, and specifically pension policy. Static as well as dynamic microsimulation models differ from (semi-)aggregate budgetary models in that they simulate the impact of policy measures and schemes on real people, and not averages or "representative agents" (Atkinson, 2009; 33). As a consequence, the level of modelling in microsimulation models is in line with the level at which policy takes effect. While semi-aggregate models consider averages and are therefore better suited for the year-to-year budgetary assessment of social policy, microsimulation models simulate at the individual level, and hence 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), in short on the adequacy of a social security scheme.

This working paper describes the second version of MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability'). 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 model then simulates the life spans of individuals in the dataset, including with their interactions, for the years between 2003 and 2060. So new individuals are born, go through school, marry or cohabit, enter the labour market, 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.

Contrary to the first version of the model, which was intended for use in an international setting, this second version is intended for use in the Belgian context only. One of the consequences of this is that the MIDAS model aligns to the projections and assumptions of the reference scenario of the 2009 Study Committee for Ageing report. This implies that the simulations of the budgetary and social impacts of demographic ageing and pension policy are as consistent as possible. The simulation results of this version of MIDAS therefore describe the consequences of the latest budgetary projections and assumptions on the projected adequacy of pensions in Belgium. Put differently, given the latest baseline budgetary projections of the 2009 report of the Study Committee for Ageing, what is the projected development of poverty and redistribution among the elderly in Belgium between 2002 and 2060? This is the central question of the working paper.

This working paper starts with a general presentation of MIDAS. First, the methods used to align state-variables as well as monetary aggregates will be discussed. MIDAS consist of three modules, demographics, labour market and social security, which will be discussed in turn next.

Finally, the simulation results will be presented and discussed at length. MIDAS itself produces an artificial dataset spanning the years between 2003 and 2060, and which can be used to derive all kinds of graphs and indicators. This paper chooses however to describe 'pension adequacy' by three relatively simple but powerful indicators, namely the replacement rate, the risk of poverty and finally redistribution described by the Gini coefficient.

# 2. The MIDAS model

The microsimulation model MIDAS consists of different modules, being the demographic module, the labour market module and the social security module. The calibration of the model is operated through the alignment procedure. This section contains first a brief comparison between this version of the model and the previous version of the model developed in the framework of an international research network. The second sub-section is devoted to the description of the alignment procedure. And finally sub-section three to five will contain a description of the three modules, followed by the estimation results of the behavioural equations.

## 2.1. A comparison between this version of MIDAS and the previous AIM version of the model

The original version of the dynamic microsimulation model MIDAS was developed by an international team of researchers in order to simulate the impacts of the assumptions and hypothesis of the Ageing Working Group (AWG) pertaining to the budgetary consequences, on the adequacy of pensions in Belgium, Germany and Italy. See Dekkers et al. (2009) for a discussion. Since this first version of the current model was simultaneously developed for three countries, it is necessarily rather general in structure. The version of the model presented in this working paper has been improved in five important aspects.

First of all, many small modelling problems were removed, together improving the general integrity of the model. Also, the simulation period was extended from 2050 to 2060.

Secondly, the model received some necessary improvements and adaptations to replicate more closely labour market as well as retirement transitions observed in Belgium. As a consequence, the model now includes all relevant policy changes between 2001 and the last observed year 2009. This will be shown to be a very important improvement, because the minimum pension, the minimum right per career year and the old age guaranteed minimum income increased considerably end 2006. Table 1 shows the development over time of these key parameters of the social security system.

**Table 1: The actual development of some key parameters in the MIDAS model (in current prices)**

| | Pension given a full career at the minimum right per career year | minimum pension (single rate) | Old age guaranteed minimum income (base rate) |
|---|---|---|---|
| 2003 | 705.94 | 818.39 | 619.37 |
| 2004 | 715.30 | 836.80 | 637.77 |
| 2005 | 732.04 | 856.39 | 664.24 |
| 2006 | 776.33 | 870.66 | 697.63 |
| 2007 | 889.63 | 889.53 | 796.78 |
| 2008 | 937.95 | 947.34 | 854.73 |
| 2009 | 972.69 | 992.67 | 890.04 |

*Notes*: (1) Monthly amounts of annual averages. (2) The old age guaranteed minimum income at single rate is 1.5 times the base amount. A couple receives twice the base amount, so the old age guaranteed minimum income at single rate is 75% of the couple rate. (3) The minimum household pension at household rate is 1.25 times the amount at the single rate. (4) The pension after a full career with the minimum right per career year equals 60% of the minimum right per career year in vigour in that year.

Between 2006 and 2007, the minimum right per career year as well as the old age guaranteed minimum income have increased with 17 and 14% respectively. The simulation results will show that these policy measures have a profound impact on adequacy measures.

Third, the coverage of MIDAS was extended from 'just' employees' and civil servants' pensions and Conventional Early Leavers' Scheme (CELS) to include unemployment benefits, disability pensions and social assistance. The scope of the model is therefore extended from just pensions to include other public social security systems. The assessment of the adequacy of pensions is therefore not done exclusively relative to earnings, as was the case in the previous version of the model, but also to beneficiaries of other social security benefits and those receiving social assistance.

Fourth, the previous version of MIDAS aligned various labour market states, including the employment rate, the unemployment rate, the proportion of disability pension recipients and CELS beneficiaries. This alignment is in the current version of the model extended to include the proportion of self-employed, the proportion of public sector employees, and the proportion of civil servants, all to age classes, gender and year of simulation.

Fifth and finally, the basis for alignment, originally the projections and assumptions of the European AWG, was replaced by those of the Study Committee of Ageing (High Council of Finances, 2009) as produced by the model MALTESE. This makes the simulations of adequacy by MIDAS complementary to – and consistent with - the sustainability projections of MALTESE, a model that is intensively used in the Belgian policy assessment process. This modification of the alignment basis has important consequences: as the previous version of the model was based on 2003 AWG projections, which were developed before the financial crisis. The MALTESE projections and assumptions currently used do take into account the consequences of the crisis. This is a reduction of employment and an increase in unemployment in the medium run. In addition, the 2009 Study Committee for Ageing baseline projections in term of long-run productivity differ from those of the 2003 AWG projections. The long-term assumption of the 2009 Study Committee for Ageing base scenario is an annual growth rate of 1.50% while it varied between 1.8 and 1.7 in the AWG assumptions for Belgium (Dekkers et al., 2009, Table 88, page 284). The next sections will discuss in more detail the alignment, starting with defining what 'alignment' is meant in the context of this model MIDAS.

The model MIDAS has undergone several improvements and extensions in this second version. However, there still is room for improvement. A first way in which the MIDAS model could be improved is by including net immigration. In the current version of the model, there is no inflow of immigrants. There is only an indirect impact of immigration, namely via increases of the fertility and mortality rates. Including immigration could mitigate the ageing process but is not likely to reverse it. 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. Third, the base-dataset is not weighed, which may limit its representativeness for the Belgian population. We hope to base the next version of the model on administrative data instead of the PSBH survey.

## 2.2. Alignment

Contrary to the previous version of this model, which was intended for international comparison, this second version of MIDAS now aims to be applicable in the Belgian process of assessment of (pension) policy. As specified here above, it therefore no longer takes the AWG projections and assumptions as the point of departure, but those of the Study Committee of Ageing, instead.

A general definition of alignment is a procedure by which one imposes that an aggregate simulation result of the model be in line with a desired aggregate result, usually based on predictions of semi-aggregate models or social-policy scenarios. This 'aggregate simulation result' may be the average of an event probability or proportion, in which case we discuss the alignment of discrete (state) variables. This is the "classical" definition of alignment; what Morrison (2006) refers to as "event alignment". But if we define the 'aggregate simulation result' as an average or sum of a continuous variable (say, income), then the notion of alignment may pertain to the process of combining micro- and macro-sources of change to have a continuous monetary variable meet exogenous demands. We will start by discussing the first case, i.e. the event alignment of state variables.

### 2.2.1. The procedure for the alignment of state-variables

The objective of alignment is to ensure that output aggregates of the micro model MIDAS match external macro aggregates. The alignment procedure discussed here is always associated in this framework to binary discrete choice models, and is a key element of the software package LIAM that underlies MIDAS (see O'Donoghue, Lennon and Hynes (2009) and Dekkers et al., (2009(b)), chapter 3 for a more extensive discussion[2]). These types of behavioural equations combined with alignment are very often used in MIDAS to model different kinds of transitions.

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 $u_i < probit^{-1}(\alpha + \beta X_i)$), 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 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. Another reason for alignment may be the need for the model to 'replicate' circumstances that were not present when the survey was created, and that therefore are not reflected in the behavioural equation. A third reason for applying alignment may be to cover for differences in definition. When the goal of a model is to simulate the adequacy of social security regulations, the formal definitions of states (for example, unemployment, disability or being chronically ill) are relevant because they may be related to the conditions of receiving a benefit of some sort. The behavioural equations describing various states are however based on survey data. This means that there is no official clearly defined definition underlying notions as 'unemployment', 'disability' and being 'chronically ill'. For this reason, there is no reason why simulating on the basis of behavioural equations should lead to results that are consistent with 'formal' state proportions. Alignment can be used to restore this consistency.

The MIDAS model 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 distribution, as expressed by the stochastic component $\varepsilon_i$, the mortality distribution for disabled people will be higher.

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[2] The following discussion is a summary from the latter reference.

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

The deterministic component of the model will result in those with a higher risk, having a higher probability 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 procedure. Firstly individuals are grouped into the appropriate age and gender groups. As everyone in the relevant group will have the same age and gender, 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 $\varepsilon_i$ . This procedure leads to select to die, the people in the group with the highest probabilities of dying. As $\beta_1$ 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.

### 2.2.2. The alignment of monetary aggregates: two-stage uprating

Next, we turn to the simulation of aggregate continuous variables, usually aggregate monetary variables. This discussion is based on Dekkers et al., (2009). Suppose the following log-earnings equation that is estimated on N individuals in the year 2002.

$\text{Ln(Earnings)}_{i2002}$ = $ß_0$ + $ß_1$ $\ln(\text{age}_{i2002})$ + $ß_2$ $\ln(\text{age}_{i2002}^2)$+ $ß_3$ $\ln(\text{gender}_{i2002})$ + $ß_4$ ln(educational attainment $\text{level}_{i2002}$)

Denote $y^a_b$ the log of earnings in the year b simulated using an equation estimated on data from the year a. A more condensed formulation of the above log-earnings equation then is $y^{2002}_{2002}$=$ß_{2002}X_{2002}$. Here, X is the set of (logs of) explanatory variables, all in the observed year 2002. Simulation means applying simulated exogenous variables at *t* to this equation, resulting in $y^{2002}_t$=$ß_{2002}X_t$.Denote $Y^{2002}_t = \sum_{i=1}^{N} y^{2002}{}_{i,t}$ the aggregate of individual earnings from the '2002-equation', but in period t≥2002. Since the above model does not include a trend variable, the growth rate of $Y^{2002}_t$, (denoted $gY^{2002}_t$, t>2002) is a weighted sum of the proportional changes of the number of working individuals N, and changes of the distribution of $X_t$ between periods (in this case the distribution of age, gender and educational attainment levels). However, the regression itself remains unchanged, so the simulated 2002-incomes $y^{2002}_t$ must in some way be brought to the future year t (i.e. $y^t_t$), using exogenous information.

A practical example may clarify this problem. The above wage equation explains the level of wage using age and age squared. Suppose that the joint impact of age is positive, then the wage level increases as the average worker gets older. Now when a large cohort of people enter into retirement, then the average age of the worker decreases and the growth rate of wages therefore declines and may in extreme cases even become negative! This is of course unrealistic, since a decrease in labour supply that pertains with a large cohort of previously active people entering into retirement, will cause the wage rate to increase. Thus we may want to align the aggregate wage rate to an external source that takes this development into account. In models with static ageing, this procedure is known as 'uprating'[3]. In the case of models with dynamic ageing, however, a complicating factor is that the model $y^{2002}{}_t=ß_{2002}X_t$ by itself produces a growth rate, $gY^{2002}{}_t$.

Suppose we want this growth rate $gY^{2002}{}_t$ that the model produces to be equal to an exogenous time series $gXY_t$, for example one that comes from a (semi) aggregate model. We cannot just multiply the individual simulation results by $gXY_t$ as we would do in 'classical uprating', since the total in-between growth rate would then be $(1+ gY^{2002}{}_t)(1+gXY_t)$.

We therefore need a corrected growth rate that must be applied to $y^{2002}{}_t=ß_{2002}X_t$, so that the resulting actual growth rate becomes $gXY_t$ and not $gY^{2002}{}_t$. Obviously, this is

$$gXY_t^c = \frac{y_{t-1}^{t-1}(1+gXY_t)}{y_{t-1}^{t-1}\left(1+gY_t^{2002}\right)} = \frac{(1+gXY_t)}{\left(1+gY_t^{2002}\right)} .$$

and this aggregate correction is then applied to all individuals $1..N_t$.

A two-tier approach therefore does the trick. First, run the model with the original micro-level behavioural equation $\ln(\text{earnings}_i)=ßX_i+u_i$, and derive the series of uncorrected growth rate of aggregated earnings $gY_t$. Next, the model is simulated again, while applying the corrected growth rate, so that $Y_{t-1}$ is corrected for each simulation year.

This way of uprating monetary variables does not change the within-group order of the simulation results. Since only the intercepts of the earnings equation is changed, differences between groups of earnings recipients remain unaffected. Hence, within group inequality and poverty rates will remain the same, and the uprating will only affect between-group inequality and poverty-risk differences, as it changes the growth rate of earnings relative to other sources of income.

Note that, contrary to the previous version of the model, this version applies monetary alignment separate to men and women in the model. This is because the earnings equation is separate to gender. As a result, in the previous version, the monetary alignment condition imposed an exogenous aggregate growth rate on earnings of men and women together, without considering them separately. Hence, changes in the labour market participation rate of one category could change the earnings rate of the other category. For example, suppose that women cet. par. have lower earnings. Suppose furthermore that the labour market participation rate of women increases (as is the case in reality). Then the aggregate earnings growth rate of men and women before the monetary alignment process decreases, and the monetary alignment process then

3 Harding (1996, 3) defines uprating as "attempts to adjust monetary values within the original micro data to account for estimated movements since the time of the survey or anticipated future movements".

uprates the earnings of men as well. Hence, any change in the activity rate of one gender category impacts via the monetary alignment process the earnings of the other gender category.

This is now no longer the case, since the monetary alignment process is applied separately to men and women. Hence, we adopt the assumption that the aggregate exogenous growth rate is the same for men and women, and a change in the labour market activity rate of one gender category will only affect the uprating of earnings of that same category in order to maintain the exogenous growth rate.

The assumption that the earnings growth rate of men and women is the same is of course also arbitrary. However, we do not have more specific information at the moment, and having such an assumption seems preferable over having one imposed growth rate and not caring about the underlying gender-specific consequences of this imposition.

### 2.2.3. The MALTESE model as a reference for alignment

In 1987, at the request of the government, the Federal Planning Bureau started developing the MALTESE system of models in order to assess long-term social expenditure within the overall framework of public finances. Between 1987 and 2001, MALTESE has been constantly developed, sophisticated and used several times to support economic and social policy-making. In 2001, the Law "guaranteeing a continuous reduction in public debt and the setting up of the Ageing Fund" was ratified. This Law also created the Study Committee for Ageing, which has to publish a yearly report about the budgetary and social implications of ageing (estimate of the budgetary cost of ageing and specific studies). The Federal Planning Bureau has been entrusted with the technical and administrative secretariat of the Study Committee for Ageing. So every year, the MALTESE system of models is applied to produce a long-term projection of all social expenditure for the yearly report of the Study Committee for Ageing.

First, a brief description of the MALTESE system of models will be given. Secondly, the different states that are aligned on the aggregate projections of MALTESE will be described. In addition to that, MALTESE assumptions that are used by MIDAS will also be discussed. And finally, in order to put conclusions of this paper into a general perspective, the cost of aging projected by MALTESE will be reminded.

#### a. A brief description of the MALTESE system of models

MALTESE is a system of meso-economic models with one central model and several specific peripheral models (computing the number of beneficiaries of social security schemes, including pensions, health care, etc.). The global accounting frame of the system relies on the national accounts. The central model, as well as the peripheral models, are accounting models adequate for translating demographic projections into budgetary developments like social security account and overall public finance account. Special attention is paid to modelling social expenses according to the calculation rules (legislation), often by scheme, gender, age and categories for the number of beneficiaries (new and other) and the corresponding average benefits (ceiling, minimum, indexation rules, etc.). A very detailed database is used for this purpose.

The projection proceeds in five steps:

– The first step is the projection of the population by age and gender given the hypotheses about fertility rates, life expectancy and migration flows.
– Given the behavioural hypotheses, legal parameters of eligibility and the macroeconomic framework, the population is, in a second step, split into different socio-economic groups: school population, labour force (working and unemployed), old-age long-term unemployed, people on a full-time career break, disabled persons, pensioners, early retirement and other non-participating population. This socio-economic projection results from transition probabilities from one status to another one. In general the methodology uses probabilities of transition from category X to category Y in different age and gender classes for successive generations, based on behaviour in recent years, under the assumption of no change in legal and institutional context but including effects of reforms already decided. The socio-demographic projection leads to a coherent projection of the number of beneficiaries in the different social security schemes.
– In a third step, the benefits in the various schemes are projected on the basis of the number of beneficiaries and of the different institutional arrangements (wage ceilings, adjustment to living standards, etc.). Average benefits are calculated by regime, gender, age groups and categories, except for healthcare expenditure (which depends on consumption of healthcare by age group and gender and on GDP growth).
– In a fourth step, the dynamics of the benefits obtained in the third step are applied to the corresponding aggregates of national accounts.
– Finally, the social security expenditures are included in a projection of the public budget. This consolidation of the social security sector with the rest of public finance is necessary because of several links between the social security budget and other aspects of the budget. Firstly, social expenditure is not only financed by contributions, but also by social security taxes and transfers from the federal budget. Secondly, the civil servants' pensions are financed by the federal budget. As for projections with "no change in policy" scenarios, average tax and contribution rates are assumed to be constant over time, as are the calculation rules of the social benefits. The evolution of all revenues and primary expenditure leads to the calculation of public debt and interest payments.

### b. Aggregate projections of MALTESE for alignment

The projections of the MALTESE system of models (in its version for the 2009 report of the Study Committee for Ageing) compose the data that MIDAS uses to align the developments of the state-variables. Table 2 summarizes assumptions that lead to these projections. The population projections suppose that the fertility rate in the long run stabilizes around the most recent observed average, while the life expectancy at birth continues to slowly increase. The socio-economic assumptions make it possible to breakdown the population by socio-economic categories like employment, unemployment, disability, students and pensioners. The following list gives the different states that are aligned based on the baseline aggregate projections of the 2009 report of the Study Committee for Ageing:

– mortality (by age, gender and year of simulation)
– fertility (by age, gender and year of simulation)
– employment rate (by age classes, gender and year of simulation)
– unemployment rate (by age classes, gender and year of simulation)
– proportion of self-employed (by age classes, gender and year of simulation)
– proportion of public sector employees (by age classes, gender and year of simulation)
– proportion of civil-servants (by age classes, gender and year of simulation)
– proportion of disabled (by age classes, gender and year of simulation)
– proportion of CELS recipients (by age classes, gender and year of simulation)

Even if the proportion of retired individuals is not in the list of aligned aggregates, the number of retirees and the 'other inactives' are indirectly aligned, since these are the residual states. For individuals younger than 60, the 'other inactive' state is the residual state. For those of 60 and over, the retirement state is the residual state when employment, unemployment, disability and CELS states are determined.

Because some required aggregates are not produced by MALTESE, the alignments of the divorce and the cohabitation separation procedures are based on statistics from the Directorate-general Statistics Belgium. As, by definition, we have observed statistics and not projections, we made the assumption that the proportion of divorcees and cohabitation failures do not change over time.

### c. Assumptions of baseline projections of the 2009 Study Committee for Ageing

In addition to the calibration on the output aggregates of the 2009 report of the Study Committee for Ageing, MIDAS uses the same assumptions of those of this report. These assumptions are summarised in Table 2. The projections of the social sustainability of the pension system are therefore based on the same hypotheses as the projections of the financial sustainability.

The assumptions on the macro-economic environment are for the mid-term based on the economic forecasts for the period 2009-2014 of the Federal Planning Bureau (FPB, 2009), also discussed in the 2009 report of the Study Committee for Ageing (High Council of Finances, 2009). In the baseline scenario the average annual growth rate of labour productivity or wage growth goes from 1.25% in 2014 (last year of the mid-term projections) until 1.50% in 2018, after which that level is maintained. The structural unemployment rate in the long-term will be 8% (coming from 14.7% in 2014 and the 8% will be reached at the end of the decennium 2030). Given the projected development of the labour force, this translates into an employment rate of 68.5%.

The social policy hypotheses concern the growth of wage ceilings, the adaptation to living standards of the non lump-sum benefits, the real growth of lump-sum benefits and the indexation to wages of public sector pensions. The assumptions are based on the law of the Generation Pact (December 2005). This law establishes a structural mechanism to adapt social benefits (scheme of employers, self employed and social assistance) to living standards. In practice, the government must calculate for each scheme a two-yearly budget covering:

– An annual adjustment to living standards of 0.5% for the non lump-sum allowances in the social security;
– An annual adjustment to living standards of 1% for the lump-sum allowances;
– An annual growth of 1.25% for the wage ceilings (used in the calculation of retirement benefits);
– An annual growth of 1.25% for the minimum right per working year.

The government has to approve the budget. After that, they need to decide about the assignment of the budget, on the base of the advice of different organs. The concrete assignments of the two-yearly budget 2009-2010 were introduced in the 2009 Study Committee for Ageing baseline projection. As from 2011, the social policy hypotheses are based on the parameters for the adaptation to living standards used to calculate the budget (see above), and the benefits were adjusted accordingly.

**Table 2: Assumptions of MALTESE for the Study Committee for Ageing 2009: a summary**

| **Demographic hypotheses as from 2008** (see «Population projections 2007-2060[4]») | 2007 | 2030 | 2050 | 2060 |
|---|---|---|---|---|
| Fertility rate | 1.81 | 1.76 | 1.76 | 1.77 |
| Life expectancy at birth: men | 77.3 | 81.2 | 84.0 | 85.3 |
| Life expectancy at birth: women | 83.3 | 87.0 | 89.7 | 90.9 |

| **Socio-economic hypotheses** | |
|---|---|
| Educational attainment rate | Remained at the most recently observed value |
| Activity rate: men | Methodology which uses probabilities of transition from one socio-economic category to the other for successive generations, by gender and age category, and including effects of reforms |
| Activity rate: women | |
| Transition from the working status towards invalidity, old-age unemployment, early retirement and retirement | |

| **Macro-economic hypotheses** | Mid-tem From 2008 till 2011 | Mid-tem From 2011 till 2014 | Long-term | |
|---|---|---|---|---|
| Yearly productivity growth and wage growth by employee | 0.01% | 1.28% | Yearly productivity growth and wage growth by employee | 1.50% |
| Unemployment rate[a] in 2014 | 14.7% | | Long-term structural unemployment rate[a] | 8% |
| Employment rate[b] in 2014 | 62.7% | | Long-term employment rate[c] | 68.5% |

| **Social Policy hypotheses** 2009-2010 | From 2011: calculation of the budget intended for the adaptations to living standards | |
|---|---|---|
| Current legislation: Rules of the social partners and the government | Wage ceiling | 1.25% |
| | Minimum right per working year | 1.25% |
| | Welfare adjustment (employee and self-employed)[d] | 0.50% |
| | Welfare adjustment for lump-sum benefits | 1.00% |

a. Including the old-age unemployed.

b. In % of the population at working age (15-64 year).

c. At the long-term, the employment rate is the result of the projection of the labour force, in combination with the assumption of the structural unemployment rate.

d. The welfare adjustment for pensions of the public sector ("perequatie") is based on the wage growth minus the wage drift of 0.5% (observed difference in the past). Hence 1.5-0.5=1%.

## d. Some key conclusions on the financial sustainability of pensions

The model MIDAS uses the projections and hypothesis of the 2009 Study Committee for Ageing as produced by MALTESE as its point of reference. With this, both models are as complementary as possible in their assessment of the financial sustainability and social adequacy of, among other things, pensions in Belgium. Even though the point of focus of this paper is the long-term adequacy of the Belgian public pension system, the conclusions of this paper should be considered in conjunction with the conclusions pertaining to the financial sustainability. The following paragraph therefore briefly discusses the FPB's latest projections on social expenditures (High Council of Finances, 2009, Table 1, page 6).

4 Federaal Planbureau, Algemene Directie voor Statistiek en Economische Informatie, met de medewerking van het Wetenschappelijk Begeleidingscomité, "Bevolkingsvooruitzichten 2007-2060", Federaal Planbureau, Planning Paper 105, mei 2008.

Between 2008 and 2060, social security expenditures are expected to increase from 23.2% of GDP to 31.3% of GDP, that is, an increase of 8.2% of GDP. This increase is by 5.3% GDP caused by pension expenditures. Pension expenditures therefore represent a large part of the increase of total social security expenditures. The increase in pension expenditures is particularly strong until 2030 (4.2% of GDP) and slower from 2030 to 2060 (1.1% of GDP). The last ten years of projection show a stagnation of pension expenditures.

Next, we turn back to the microsimulation model MIDAS and its simulation results. First, however, we discuss the modules of MIDAS, and the behavioural equations they include.

## 2.3. Demographic module

The first module of MIDAS 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[5].

### 2.3.1. Description

#### 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 therefore are fully driven by the alignment procedure, reflecting the 2008 demographic projections created by the Federal Planning Bureau and the FPS Economy – Directorate-general Statistics. These are also the demographic projections used by the MALTESE model. For lack of a behavioural equation and using only the alignment procedure, the selection of women that are going to give birth only depends on their age, but not on background variables such as marital status or level of education. Future mothers are selected randomly from all women between 15 and 50 so that alignment fertility rates are reproduced.

#### b. The survival process

For the same reason as with the birth process, the mortality process is completely determined by the survival probability tables of the demographic projections described here above and used by the MALTESE model. 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 simulated individual is by chance 'assigned' a level of education. The below Table 3 con-

5 Since the structure of this module did not change between this version of the model and the previous one, presented in Dekkers et al., 2009, the below text does not differ considerably from paragraph 4.1.2 in the previous reference.

tains the codes of the International Standard Classification of Education (ISCED) and the group variable used and simulated by MIDAS.

**Table 3: 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 4 below. Of course, this is only done for unobserved individuals born after 2002 and for those whose education level is not present in the base dataset.

**Table 4: Observed education levels (percentages of age groups)**

| | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-54 | 55-64 |
|---|---|---|---|---|---|---|---|---|
| 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 |

Source: Own calculations on data from the Labour Force Survey, OECD[6].

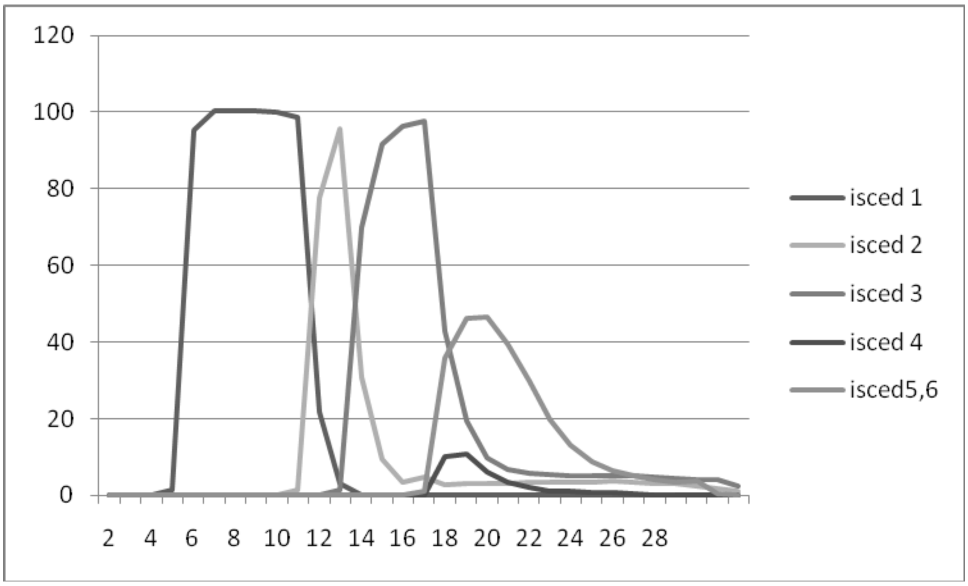
The above Table 4 contains the probability of observing an individual having a level of education 1 to 3 by age group. So we have to choose an age category where the individuals are old enough for the majority of them to have completed education, but young enough to be representative for future generations. We have decided to use the observed probabilities of the age category between 30 and 34 years old.

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 projections for Belgium for each level of education.

6 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 below Figure 1 presents the observed participation rates to age and ISCED-level in Belgium in 2002.

**Figure 1: Observed participation rates to age and ISCED level**




Source: AWG-projected education expenditures, Belgium, Eurostat.

For example, we observe that at any time, 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 46 %, and this participation rate reaches its maximum at 19. So, the average age of education ending at ISCED 5 and 6 is the lowest age (>19) where the participation rate is 0.5*46%=23% or lower. This is at the age of 23.

Table 5 shows the resulting average ages of education ending and given the various levels of ISCED.

**Table 5: Ages of education ending**

| ISCED | 1 | 2 | 3 | 4 | 5/6 |
|---|---|---|---|---|---|
| Modal age of education ending | 12 | 14 | 18 | 21 | 23 |

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

For comparison, the below Table 6 contains the theoretical ending ages to level of education.

**Table 6: Theoretical ending ages for level of education**

| ISCED | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Theoretical age of education ending | 11 | 13 | 18 | n.a. | 21 | 23 |

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

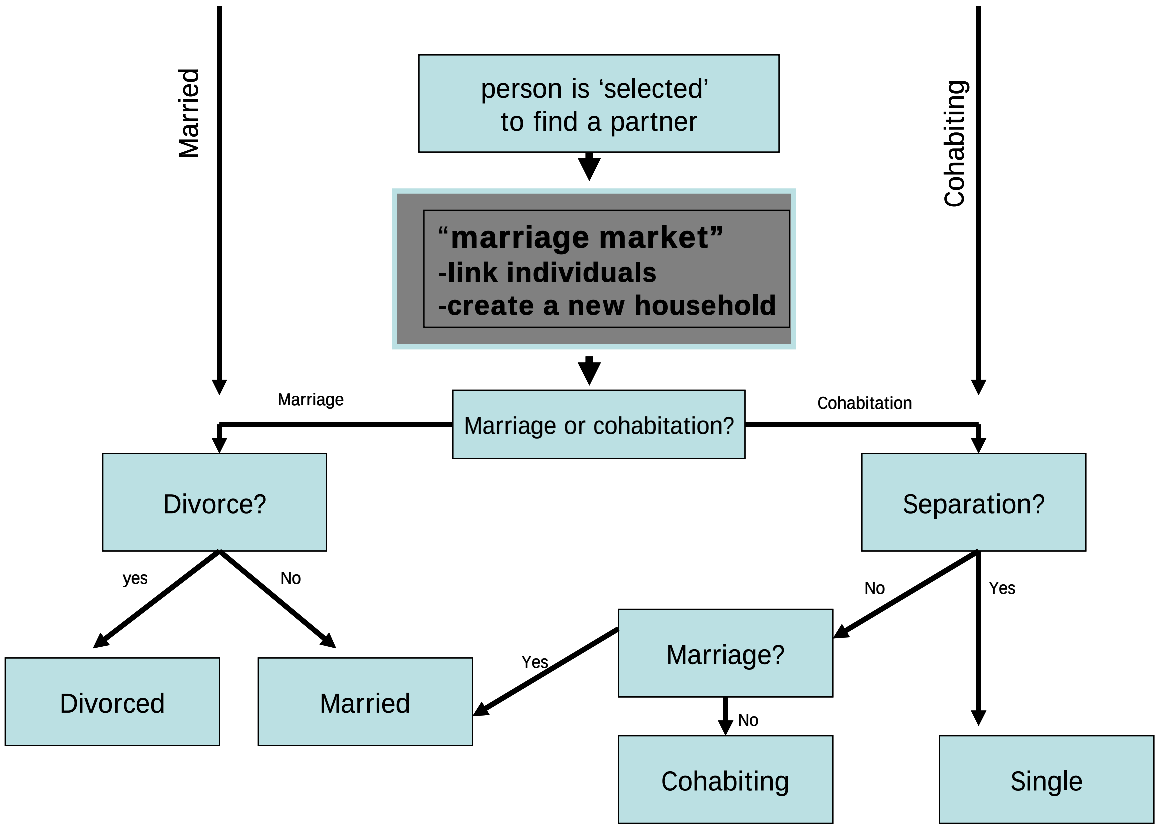
Note that the ending ages in Table 5 are often one year higher than those in Table 6. This may be due to definition differences. After all, the average age of ending a certain level of education in Table 5 is that age where 50% or less of the individuals in that age group that did participate when they 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 5 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 2 describes this module.

**Figure 2: 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 men and women in the population who are eligible for marriage or cohabitation. In the second step and for each of the selected women, a vector is constructed that contains the probabilities that she will become partner with any of the men eligible. These probabilities are based on an estimated marriage market logit regression. The partnership probability is 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 woman in turn, and matches her with a man. 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 woman, 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.

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

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 woman 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 to match. When a woman is to be matched, the man 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 to form 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 the couple is selected for cohabitation, an additional procedure based on a logit regression permits the transition from cohabitation to marriage in later years. 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 one 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 logit models, 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, the model identifies the widowhood state, so if the spouse of a married individual dies, the surviving partner becomes a widow(er). In contrast, cohabitants who split up return to 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).

### 2.3.2. Behavioural equations of the demographic module

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.

First of all, as a general rule pertaining to these estimated models of the demographic module as well as the labour market module, 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 or more 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.

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 the potential partners, 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 their age difference, and dummies based on the combined working states (*inwork1-4*) and education levels (*education1-9*). Table 7 and Table 8 provide details on the two latter variables.

**Table 7: 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 8: Education status of the couple**

| Dummies | Men's education level | Women's education level |
|---|---|---|
| Education1=1 (=0 elsewhere) | high | high |
| Education2=1 (=0 elsewhere) | medium | high |
| Education3=1 (=0 elsewhere) | low | high |
| Education4=1 (=0 elsewhere) | high | medium |
| Education5=1 (=0 elsewhere) | medium | medium |
| Education6=1 (=0 elsewhere) | low | medium |
| Education7=1 (=0 elsewhere) | high | low |
| Education8=1 (=0 elsewhere) | medium | low |
| Education9=1 (=0 elsewhere) | low | low |

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 9: 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 9 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. 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 enters into marriage or cohabitation. This logit was estimated on observed new actual couples (i.e. the same subsample as the above regression) with the dummy dependent variable reflecting whether they live in marriage. The set of explanatory variables remains unchanged. Results are presented in Table 10.

**Table 10: 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.

These results suggest that the probability of being married (rather than being cohabitant) rises only for a couple where neither partner is working, and/or for low educated partners. The other combinations in the working status or in education have no significant role. Also, a negative but marginally decreasing impact of the age difference is observed. 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 11.

**Table 11: 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 significant 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 marginally decreasing. 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 significantly explain marriage failure.

Results are quite similar when we turn to failure in cohabitation. The probability of failure of cohabitation ceteris paribus is higher than that of divorce. 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.

## 2.4. Labour market module

### 2.4.1. Description

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[7]. Note that the behavioural equations describing various states are based on survey data. This means that there is no official clearly defined definition underlying notions as 'unemployment', 'disability' and being 'chronically ill'.

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 MALTESE 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 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.

The transitions modelled for the employees are more complex than those for the self-employed. Employees are assumed to work in the private sector or in the public sector and, in the latter case, to work as a civil servant or as a public-sector employee. 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), to work full time or part time and about the number of hours worked per week. The hourly wage rate for employees is determined by a simple cross-sectional OLS. The logarithm of the hourly wage rate is estimated separately for men and women as a function of several personal and job characteristics, including 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).

Simulated real hourly wage rates increase with productivity over time, through the monetary two-stage alignment process outlined in section 2.2.2, and using the assumptions of the 2009 Study Committee for Ageing summarised in Table 2 as a basis. Finally, total yearly gross income of an employee is then determined by the product of 1) the individual hourly wage rate, 2) the number of months worked, 3) the number of hours worked by week, and 4) the average number of weeks per month (4.33).

If an individual does not work in a given simulation year, a sequence of aligned logits simulate whether he or she is in one of the inactive states: unemployed, disabled, CELS beneficiary, re-

[7] As with the behavioural equations of the demographic module, the behavioural equations of the labour market module have not changed relative to the previous version of the model. The description in this chapter is therefore taken from paragraph 4.2.2. of Dekkers et al., 2009.

tired or in a residual inactivity category which comprises all remaining inactive states. 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, one may be eligible for Conventional Early Retirement' Benefit (CELS). Next, one may be eligible for regular retirement[8]. If neither of these potential states has become effective, the individual enters the state 'other inactive', which basically is a balance entry. All these states are aligned by age and gender on labour market projections of the 2009 Study Committee for Ageing.

### 2.4.2. Behavioural equations of the labour market module

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 whether the individual was already chronically ill during the previous year, or not.

**Table 12: 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 as being chronically ill. Put differently, chronically ill men with a university degree have a higher probability of not being chronically ill the next year. 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. The probability of becoming chronically ill also increases linearly with age. The negative estimator of the variable *married* shows that this probability decreases if the man is married.

[8] 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 13: 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 (Table 13) is in line with those of men.

Given that the individual is chronically ill or not, the next step in the labour market module pertains to the decision of working. This requires some explanation, as this variable is aligned to exogenous 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 proportional groups of the 2009 baseline projections of the Study Committee for Ageing 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 14: 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) | - | - | -0.3428 | 0.2147 |
| 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) or being chronically ill during the previous period has a negative impact on entering or remaining in the labour market[9]. 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 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 15: 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 a 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 pre-

9 This negative impact of having a higher education on labour market participation of men stands in opposition to women and can be explained by men with a higher secondary degree or university degree more often than women opting to stay in education to get a university degree, or respectively a master or doctorate.

vious 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. Various non-working labour market states (unemployment, retirement, disability …) are based on the alignment with data of the 2009 Study Committee for Ageing as well. For the most inactive states (disability, CELS, retirement, other inactive), the transition probabilities are fully alignment-driven. The exception is unemployment, where the actual transition is a combination of alignment and various behavioural equations.

**Table 16: 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 17: 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.

So far, the transitions in and out of work, in and out of unemployment and being chronically ill or not have been discussed. Given that one is in work, one can be an employee or a self-employed worker. In the former case, one can be in the public sector or not, and –again in the former case- one can be a civil servant or not. For all those that are not self-employed workers, annual earnings are the product of various variables, among which the hourly wage rate. All of these behavioural equations are to be discussed now.

If one is in work, a first 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, results in Table 18 and Table 19 depend on whether the individual was an employee, a self-employed or not active in the previous period.

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 an employee or, inversely stated, 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 employee. In the third and last case, the probability of being an employee (given that one has entered the work force) decreases with age.

**Table 18: 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 employee | - | - | -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 and reported in Table 19. For women who were already employee the previous year, the probability of staying an 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 19: 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 employee | - | - | -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 reported in Table 20 and Table 21 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 to do so. Hence, men with a university degree show the highest turnover between the private and public sector. Furthermore, the older a man is and the longer he has been working in the public sector, the higher the probability that he 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 20: 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 21: 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 results are reported in Table 22 and Table 23 below.

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 22: 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 23: 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, and reported in below Table 24 and Table 25. 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 men and women who had no permanent contact in the previous year, the probability of tenure 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 24: 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 25: 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 simulates 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. The results of these steps are reported in below Table 26 and Table 27.

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 26: 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. Whether or not one has a permanent contract does not seem to play a direct role in determining the probability 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 than unmarried women.

**Table 27: 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. The results are presented in Table 28. 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 28: 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 29: 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 has the (log of the) hourly wage rate as a dependent variable. Using a random-effects panel data regression model resulted in very poor simulation results, even though the regression results were by themselves credible. We therefore decided to estimate a simple OLS cross-sectional model on the 2002 dataset.

For men and women that work while not being a civil servant, the main determinants are related to age and the level of education. Those with a lower 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 30: 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 31: 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.

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 is the size of the regressor limited.

**Table 32: 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.

Before closing this section, it has to be reminded that some transitions are not based on behavioural equations but are fully driven by alignment, because we lack the necessary data to estimate the necessary behavioural equations. It is the case for the transitions into disability (becoming eligible to a disability pension), Conventional Early Retirement (CELS) and retirement.

## 2.5. The social security module

The social security module models the main schemes of the Belgian system of social security, including the first pillar retirement scheme, the early retirement scheme, the unemployment scheme and the disability scheme. Besides that, it covers the social assistance system.

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[10].

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 2005.

The pension benefit if one retires at n after a career of n-t years is calculated as

$$\text{Benefit} = (75\% \text{ or } 60\%) \times \sum_{t=1}^{n} \frac{1}{45} \times \left( wage_t \middle| \begin{matrix} ceiling_t \\ mright_n \end{matrix} \right) \frac{price \quad index_n}{price \quad index_t} .$$

The pension benefit is then based on past wages corrected for the development of prices. Each corrected annual past wage count for a forty-fifth of the wage-base. The length of the career needed for a full pension is therefore equal to 45. 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, or married with a partner who has a revenue or social security benefit the 60% is used. If (s)he is married, (s)he can choose the 'family pension benefit' of 75%, but then the 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.

10 The social security regulation that is described here is based on the regulation of 2009. As the model start to compute benefits from 2003 onwards, benefits allocated between 2003 and 2009 are computed based on the regulation of the year of allocation.

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. If earnings in a certain year are below the minimum right per career year in vigour in the year of retirement $n$ ($mright_n$ in the above equation), then it is uprated to that level. This minimum right per career year is intended to uprate the pension benefit of those with a long career but which had low earnings. Finally, the pension benefit is subject to a minimum pension[11].

The 2006 Solidarity Pact between generations has introduced, among other things, a new regulation called the pension bonus. This bonus is allocated to wage-earners who retire from the age of 62. The pension bonus is equal to €2.00 per extra day of work from the age of 62. It represents an additional yearly amount of €624 for someone who retires at 63, €1248 for someone who retires at 64 and €1872 for someone who retires at 65 years old.

Surviving pensions are also computed for spouses of deceased wage-earners or pensioners. It can be obtained from the age of 45 or 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 retired or not. In the first case, the widow(er) receives 80% of the deceased' retirement benefits at the household rate. This is equivalent to the full retirement benefit at the single rate, since 80% of 75% equals 60%. When the deceased spouse was however not in retirement at the moment of decease, a theoretical retirement benefit is computed as if the deceased retired at the date of his decease. The complete career that is considered into the benefit formula is then adjusted to take into account of the premature character of the decease.

There exists also a minimum widow(er) benefit that is allocated - proportionally to the career ratio - when the length of the career of the deceased exceeds two thirds of a complete career. Finally, the combination of a widow(er) benefit with a legal retirement benefit is allowed up to a ceiling equal to 110% of the widow(er) benefit given a complete career.

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 60 on if a career condition is fulfilled[12]. Unlike the retirement benefit, the

11 In practice, the pension benefit that one receives in the extreme case that earnings in all years of the career were uprated to the minimum right, still is a little lower than the minimum pension, so that it again is uprated to this minimum.

12 The career length requirement is 30 years for men (35 years in 2012) and 26 years for women (increasing from 2008 with 2 years every 4 years until 35 years). Early retirement from the age of 58 is possible for some kinds of works (heavy jobs, night work …) but these particular regulations are not considered in this paper.

CELS benefit does not depend on the number of working years. Furthermore, when one enters the CELS, one formally does not retire. The career length, on which the future old-age pension will be based when one will reach the mandatory retirement age, therefore continues to increase. The wage which is taken into account for that period is the corrected wage earned during the last year worked.

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 very few disability benefit recipients of 50 years and older re-enter the labour market. For this reason, MIDAS treats disability after the age of 50 as an absorbing state until retirement. The disability benefit is equal to 40% of the last wage when the individual is a cohabitant, and 53% of the last wage when the individual is a single person, or 65% of the last wage for beneficiaries that are the head of household. This amount is subject to a minimum and maximum.

The unemployment scheme is, as the disability scheme, a pathway into retirement. Unemployment is also considered as an absorbing state after 50 years of age. The unemployment benefit depends on the last wage, the individual' status (single, head of household, with/without children…) and the duration of unemployment. An additional benefit is allocated to old-age unemployed.

Civil servants are subject to a first-pillar pension system that is separate to that of the private sector. Public sector pensions are considered deferred incomes rather than old-age insurance. Public pensions therefore are paid out of the general federal budget and financed through taxes. Benefits are essentially individualized, that is, there are no difference between a "household" benefit and a "single" benefit.

Indexation rules of public sector pensions differ from those that prevail for wage-earners' pensions. Private sector pension benefits are indexed to CPI, with additional discretionary increases. In addition to indexation to the CPI, public pensions are indexed to average wages[13], excluding wage drift. Retired civil servants therefore share in the benefits of productivity increases.

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,

[13] The perequation is based on the wages in the public sector. However, MIDAS does not make a difference between wages in the public and private sector so public pensions are indexed to the development of overall wages.

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 is in general equal to 60 but can vary from 55 for some teachers to 30 for university professors and magistrates. The n/N ratio is capped to 75%.

As for wage-earners, MIDAS also covers civil servants survivors' pension benefits. If the deceased person had worked as a civil servant for at least five years, and if the surviving married spouse is at least 45 years of age, then the survivors' 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, $D$ 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.

Unlike the civil servants and wage-earners' pension schemes, MIDAS does not replicate the exact rules and regulations of the self employed retirement benefits and surviving benefits. This is because we lack credible data concerning the career and past revenues of the self-employed, so it is not possible to compute their benefits. The model therefore assigns 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 pensioners actually receive a minimum pension (Scholtus 2008), the consequences of this simplification might be limited. Nevertheless, it is a point of attention in the future development of MIDAS.

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. Barring a so-called "reduction coefficient", the pension systems of employees and self-employed are quite similar. The "reduction coefficient" is equal to the ratio between the (lower) contribution rate of self-employed and the contribution rate of wage-earners. Its 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. Finally and contrary to wage-earners, the self-employed are subjected to a malus system; a progressive actuarial discount factor which reduces retirement benefits in case of early retirement between 60 and 65 years old, except in case of a complete career or a career of 43 years.

The pension bonus that is allocated to self-employed retirees is also taken into account here. The computation formula is exactly the same as the one for wage-earners. The bonus has a relative large effect on self-employed pensions since their lower average pensions.

Finally, there exists a guaranteed minimum income for all old age individuals. This means tested benefit is available from the age of 65, and has recently been increased.

The Belgian social security system has a system of social assistance as a “last resort” or residual benefit. Claimants must have exhausted their entitlements to any other benefits and (still) not possess adequate means of support. The social assistance benefit is means-tested, and, for those who are not retired and therefore potentially could earn their own income, conditional upon pursuing integration into the labour market, for example by actively looking for a job, or by receiving schooling or training.

Summarizing, the social security module of MIDAS simulates first-pillar old-age pension benefits for private sector employees, civil servants and self-employed, as well as the guaranteed minimum for the elderly. Furthermore, it simulates the Conventional Early Retirements (CELS) benefit, the widow(er)s’ pension benefit, the disability pension benefit, unemployment benefit and, finally, social assistance benefit.

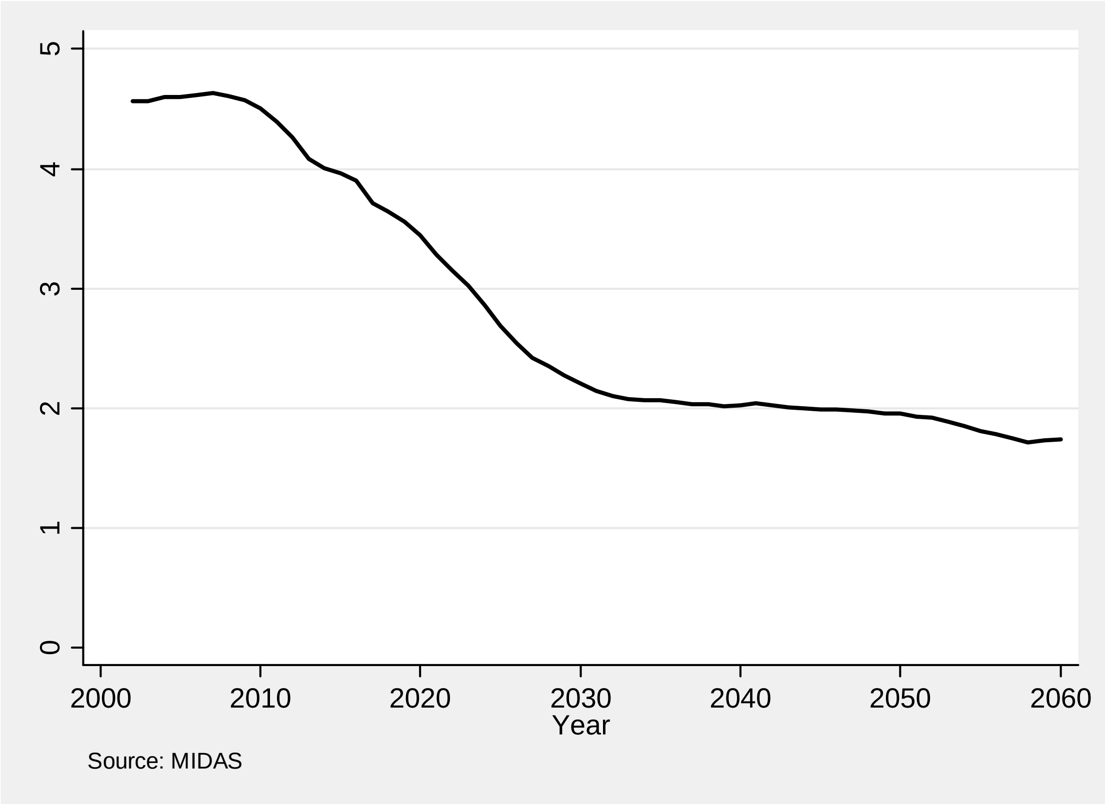
# 3. The Simulation Results

## 3.1. Demographics

Simulation results of MIDAS' demographic module are aligned to the most recent Belgian demographic projections of 2008 realized by the Federal Planning Bureau and the DGSIE (Federal Planning Bureau et al., 2008). More specifically, survival probabilities and fertility rates compose the core of the demographic alignment procedure. The key indicators of these projections are presented in Table 2 on page 13.

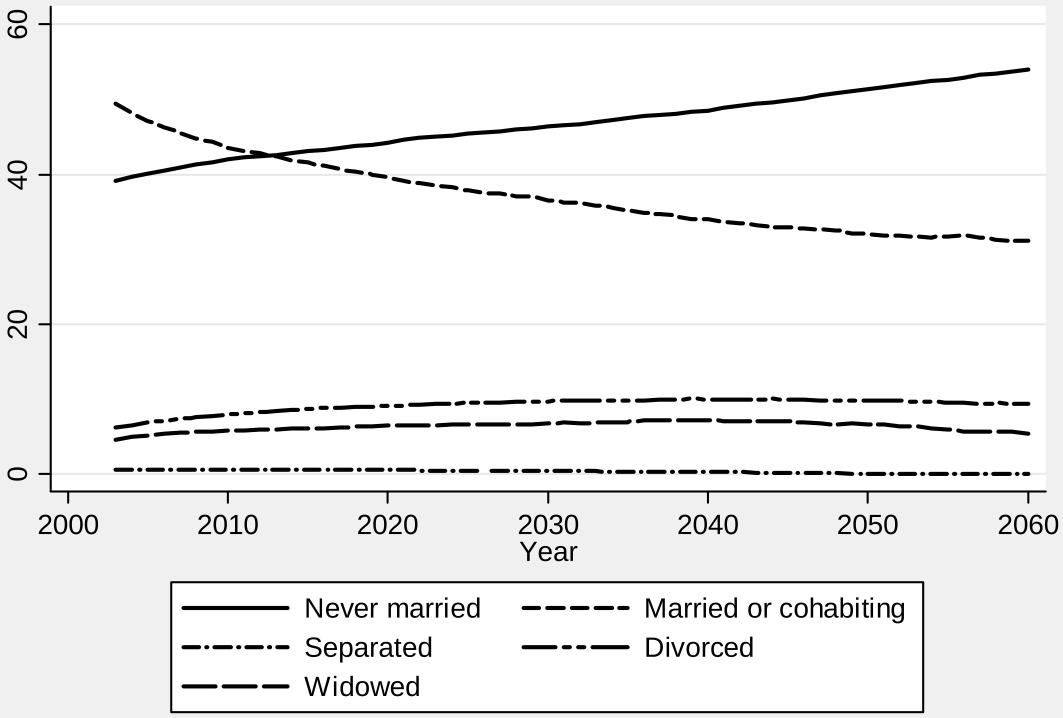
The indicator presented in Figure 3 is the inverse of the demographic dependency ratio generated by MIDAS: the population aged between 16 and 64 on the population of 65 and older. It sums up demographic pressure that the pension system will face in following decades. While before 2010 there is more than four active individuals for one retired (or more precisely four individuals in the age range of active people for one individual in the age range of retired people), the dependency rate sharply decreases between 2010 and 2030 to reach two active individuals for one retired. This is caused by large baby-boom cohorts going into retirement. The second period that can be highlighted for this indicator is the one between 2030 and 2050. On that period, the dependency ratio stays more or less constant: there is no more demographic shock. Finally, between 2050 and 2060, the dependency ratio decreases somewhat again. It is the result of a second and smaller demographic shock that enters into action on that period. This shock is actually the result of the first one, namely the baby boom shock. Indeed, the early 2050's see a larger cohort of individuals entering into retirement: they are the children of the first baby boomers. As MIDAS works with a close population – immigration is not modelled – this second wave effect is probably more important than it would be in case of migration was taken into account. Hence the fact that the current version of MIDAS does not take into account immigration means we to a certain degree overestimate demographic ageing.

**Figure 3: Inverse dependency ratio**




Next, we consider the simulation results of the marriage market. Figure 4 shows these results, taking married and cohabiting individuals together.

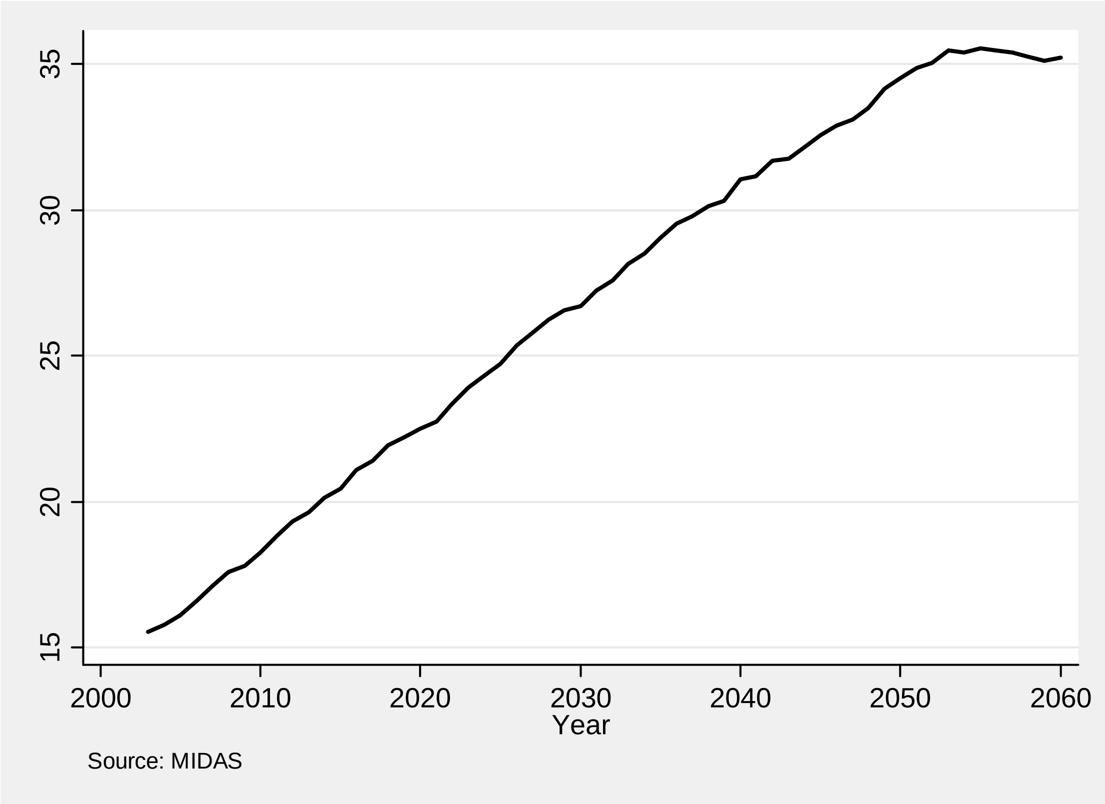
**Figure 4: Proportional size of marital status, in percent**




Source: MIDAS

Figure 4 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 not just with anybody, but with a partner. Somebody who lives with his or her parents is therefore not cohabiting but single. The proportionally large number of singles is caused by children that actually live with their parents. The proportional size of the other categories (widowed, separated, divorced) clearly are much smaller. Over the simulation period, 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 continuously at the expense of the proportion of married individuals. This is shown in Figure 5.

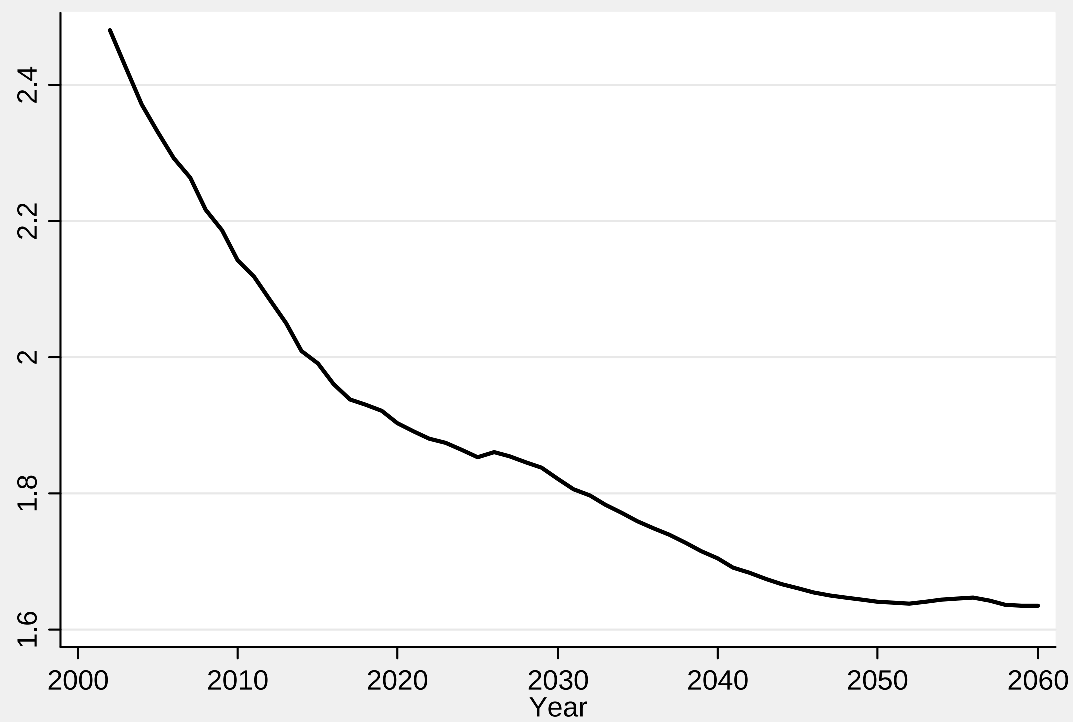
**Figure 5: Proportional size of cohabiting individuals within the group of those living together, in percent**




Now why does the proportion of married or cohabiting individuals decrease over time in Figure 4 above? The answer lies in Figure 5, showing the increasing popularity of cohabitation. Indeed, the discussion of Table 11 on page 22 concluded that, ceteris paribus, the probability of separation is often higher for cohabiting partners than the probability of divorce is for married partners. 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. Furthermore, when they do split up, proportionally more people return to the status of being single. The proportion of singles hence increases.

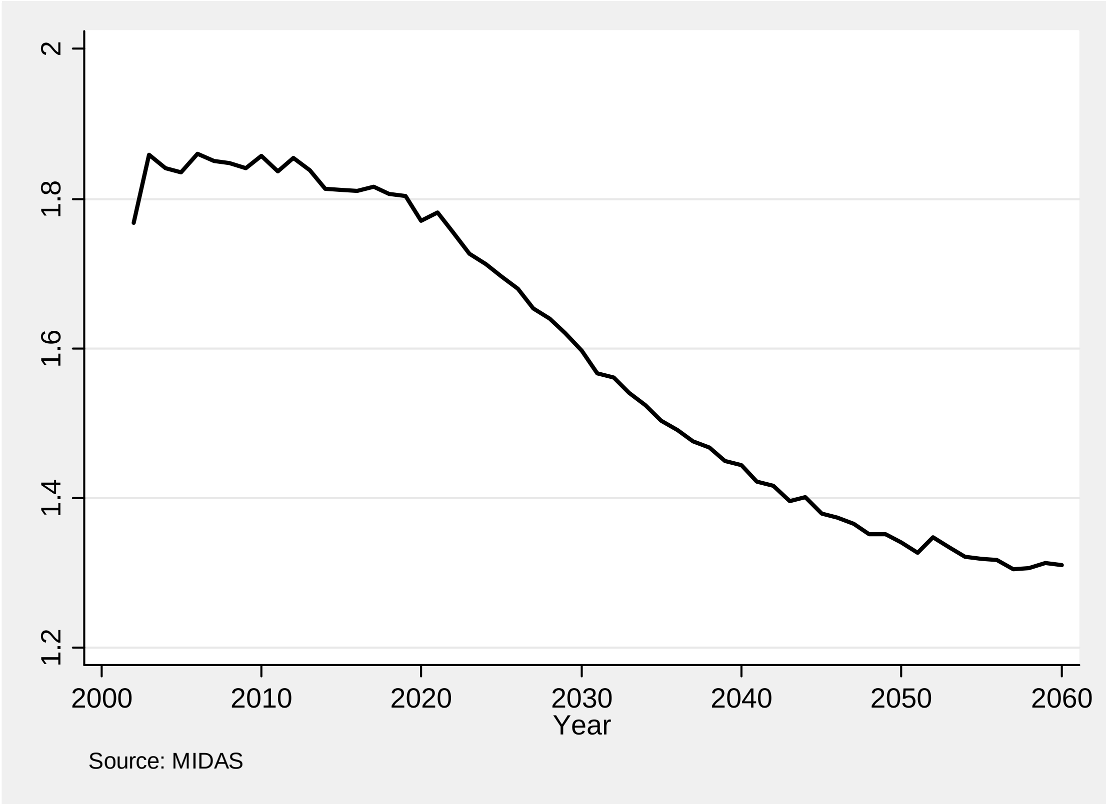
This can also be observed through Figure 6 plotting the average number of individuals in households. This is continuously decreasing over time. As explained above, the increasing number of cohabitations, that leads more often than with marriage to a separation, creates an increasing number of single households. The second effect that explains the decline of the households' size is directly related to the modelling of households' creation. As described in section 2.3.1.d on page 17, the model includes a procedure of households' creation that allows avoiding, for example, that children stay in their parents' household during their entire life. But a consequence of this procedure is that the elderly by definition form households separate from their children. Put differently, the model does not allow for multigenerational households, other than those observed in the starting dataset. Figure 7 shows the same indicator as Figure 6, but 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. These developments are far from trivial, since many indicators of (pension) adequacy are based on equivalent household income. It will be argued below that the composition of households has an important impact on poverty and inequality measures.

**Figure 6: Average number of individuals in households**



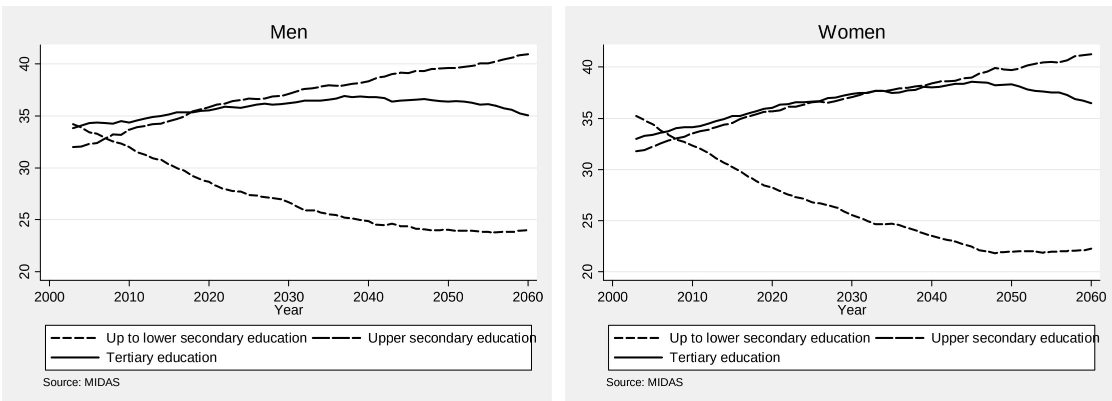

Source: MIDAS

**Figure 7: Average number of individuals in households where at least one individual is retired**




Next, Figure 8 shows the development of the proportional educational categories.

**Figure 8: Proportional educational attainment, in percent**




The three levels of education are described in Table 3 on page 15. 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 (at most lower secondary education) decreases. The average level of education is simulated to increase stronger for women than for men, since the proportion of men with the highest levels of education (first stage of tertiary education or more) stabilizes, while the proportion of men with an intermediate level of education (between upper secondary level and post-secondary, non-tertiary education) continues to increase.

### 3.2. Labour market

Figure 9 shows the evolution of employment rates by gender of individuals aged between 16 and 64. These rates are fully aligned to the projections and assumptions of the MALTESE model, (FPB, 2009, High Council of Finances, 2009). First of all, we notice the important impact of the current economic crisis on employment in the short run. The long-term trend is driven by the 2009 Study Committee for Ageing assumptions, being a recovery of employment rates from the mid- or late 2010s until the early 2030s, which is stronger for women. This recovery is followed by a stabilisation.

**Figure 9: Employment rates of the population aged between 16 and 65 by gender, in percent**

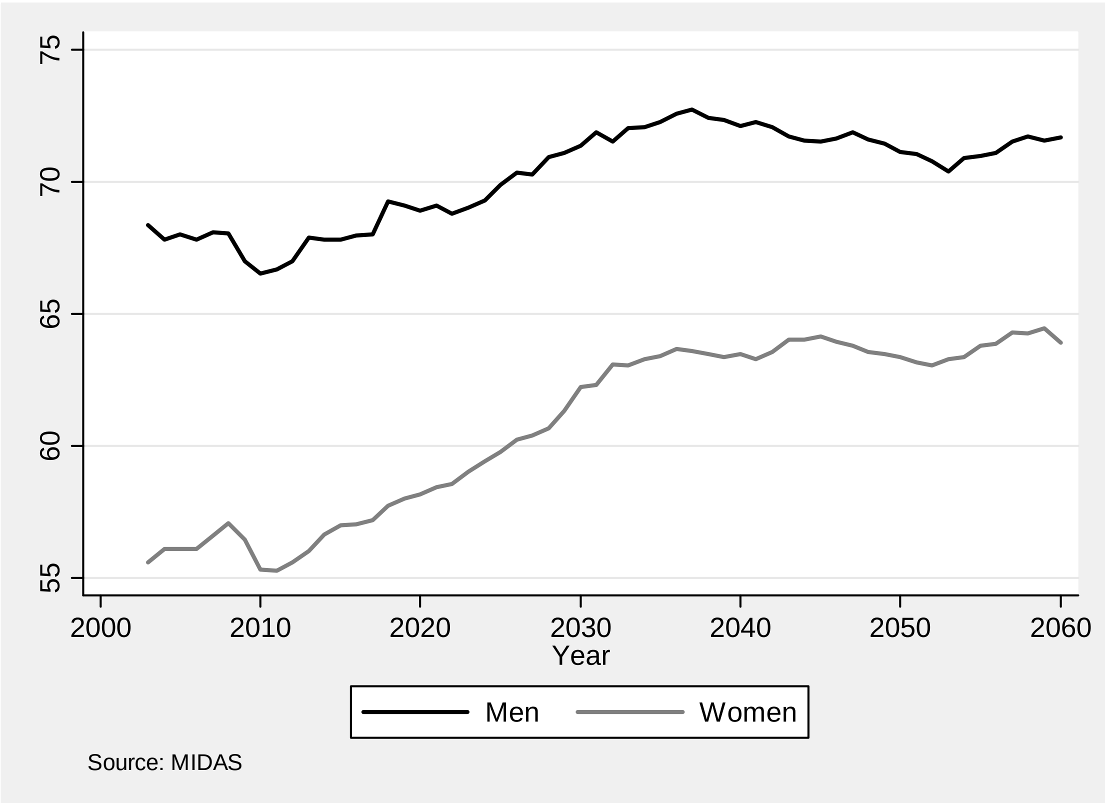
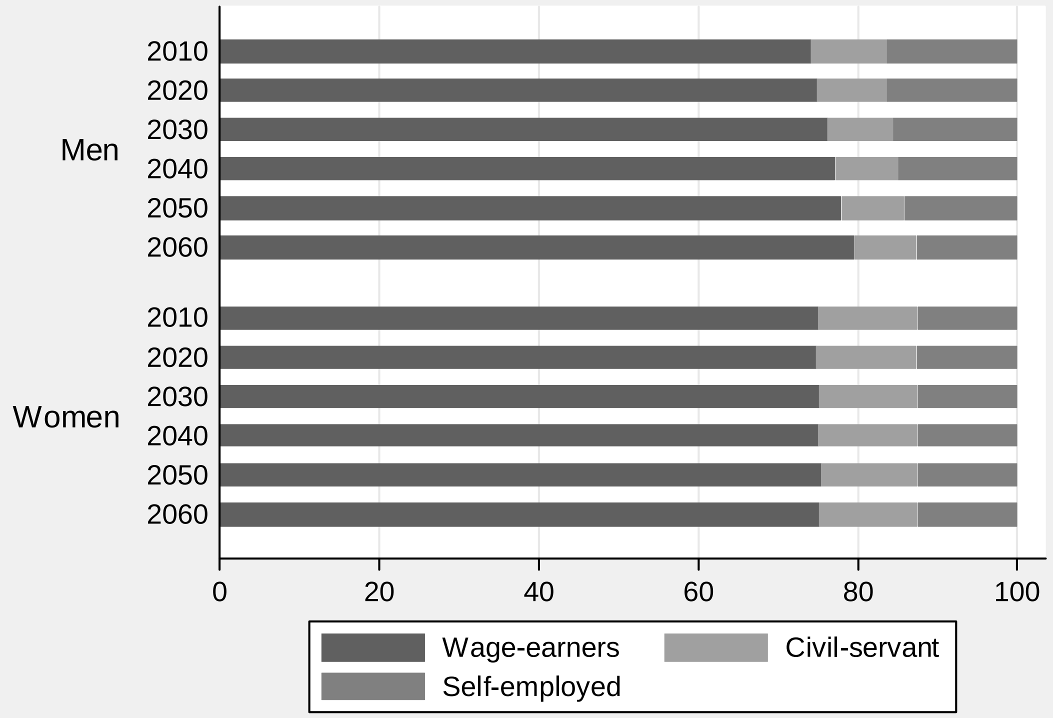



Figure 10 presents the evolution of the working status of active individuals. It appears that working status projections of the 2009 Study Committee for Ageing assume a decrease of the proportion of male self-employed and male civil servants while female working status distribution is assumed to remain roughly constant over time.

**Figure 10: Working status distribution by gender, in percent**




Source: MIDAS

As explained in section 2.4, the total yearly gross income of an employee is determined by the number of months worked, the number of hours worked and the individual hourly wage rate. The obtained average number of months worked of employees stays fairly stable all over the simulation period, as well for men (around 11.1) and women (fluctuating between 10.7 and 10.9). The simulated average number of hours worked per week of employees stays also quite constant. It stays between 40 and 41 for men while, for women, it slightly decreases from 34 in the early 2000 to about 33 in 2060. The simulated hourly wage rate is therefore the main component influencing the annual income of employees. In other words, the average annual gross wage presented in Figure 11 below is essentially driven by the hourly wage rate that is, as described in the previous chapter, aligned on the productivity growth rate assumed in the 2009 report of the Study Committee for Ageing.

Via the alignment of annual earnings on productivity growth rates, Figure 11 shows a considerable negative impact of the 2008-2009 recession. In the longer run, it shows that the productivity growth of men and women evolve at the same pace. This is due to the monetary alignment that is applied separately for men and women (see section 2.2.2).

**Figure 11: Average gross annual wage, prices of 2002, in euro**

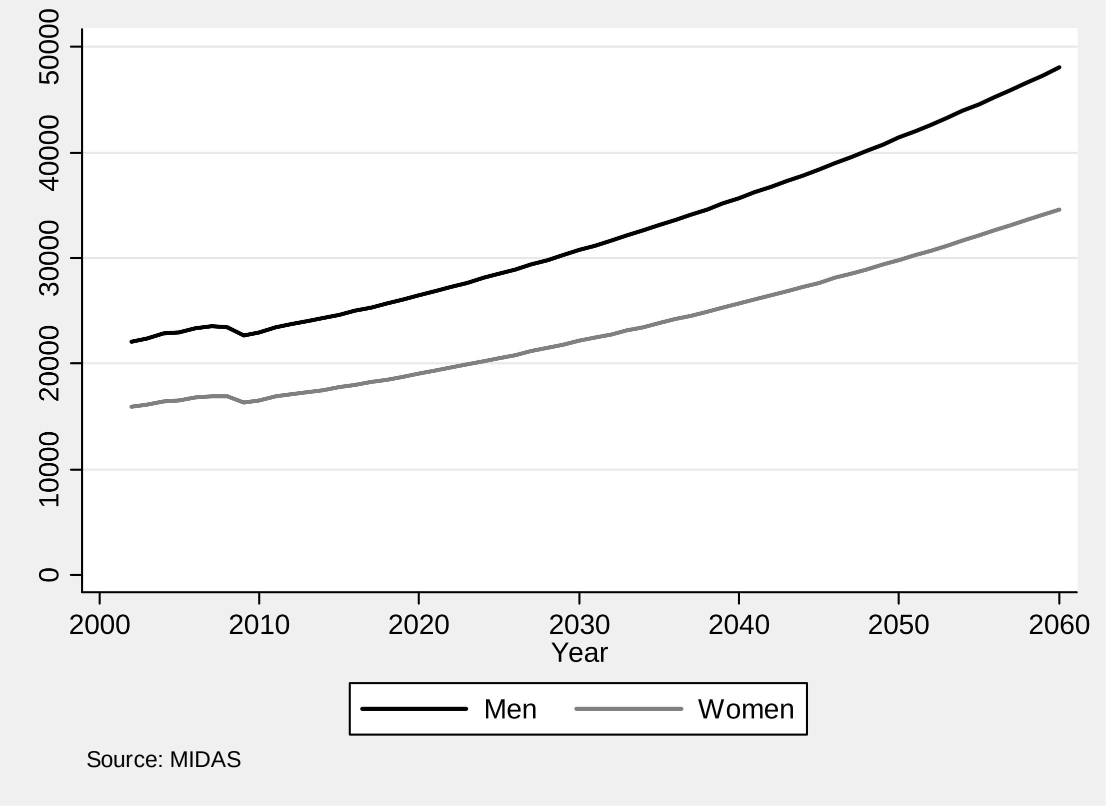
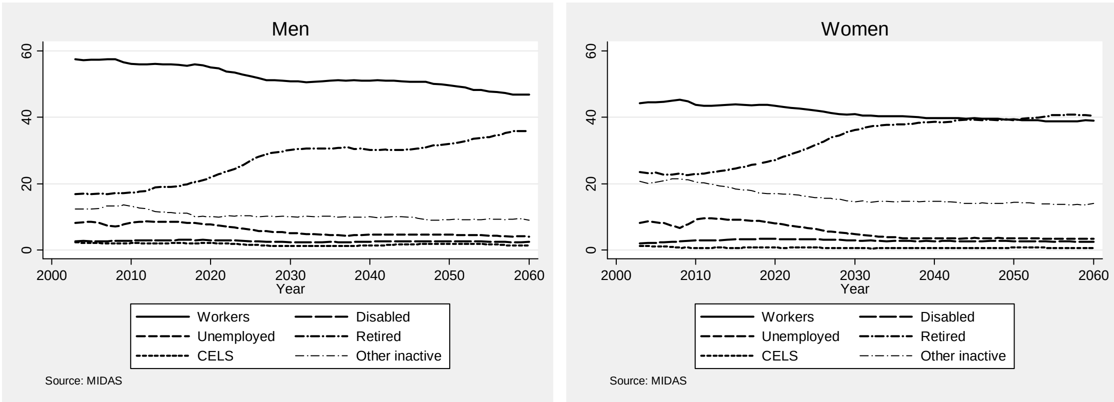



Figure 12 presents the proportional sizes of various labour market states for men and women of 16 and older. For both men and women, the proportion of people being in work is by far the largest, at least in the first decades. The proportion of working men shows a continuous decrease over the simulation period. The financial crisis will cause the unemployment rate to increase quite considerably in the medium run; this increase will continue until the end of the 2010s, after which unemployment will again decrease. These developments come with a considerable increase of the proportion of retired men, especially until the early 2030s and between 2050 and 2060. It seems obvious that this development is the result of demographic ageing (expressed by the development of the dependency ratio in Figure 3 on page 42) that causes the proportion of elderly to increase.

For women, the general tendency is the same as for men, in that the proportion of working and unemployed women decreases, after a marked short run increase in the proportion of unemployed women, again the result of the financial crisis. However, the proportion of women in work decreases considerably less than that of men. The proportion of retired women is more driven by ageing processes than labour market processes, so this proportion is comparable to that of men. For women, the proportion of retirees is therefore high compared to the proportion of workers. From about 2040 on, the proportional sizes of working and retired women are more or less the same, and as the dependency ratio decreases further after 2050, a small majority of women will be in retirement in the last decade of the simulation period.

Finally, besides students, housekeeping women and women staying at home for child care are reflected in the large 'other inactive' state among women. Mainly dejuvenation before 2030 causes the size of the category of 'other inactive' to decrease over time

**Figure 12: Labour market status of individuals of 16 and older, in percent**



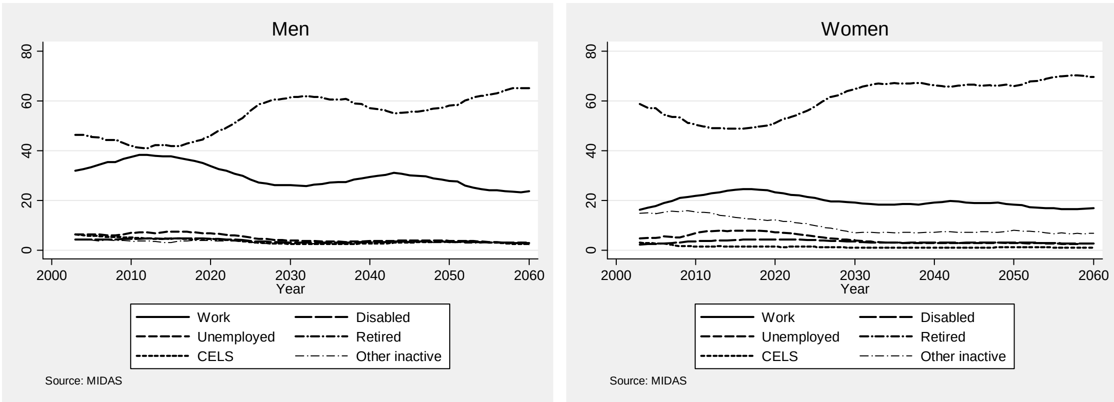

The point of focus of the research project is the adequacy of social security, and specifically pensions. It is therefore relevant to discuss the proportional sizes of the states of men and women of 50 years and older. These are presented in the below Figure 13.

Obviously, the proportional size of retirees now exceeds that of the working population, and also the size of the 'other inactive' state now becomes considerably smaller and comparable to the other inactive states. Indeed, men and women of 50 and older are less often in school or in full-time child care.

Even though the state of being a CELS beneficiary, disabled, or unemployed increase in proportional size, they remain less important, compared to retirement, being in work, but not compared to the 'other inactive' state. Furthermore, the proportional size of the unemployment state now decreases to a level comparable to that of disability and CELS, especially for men. This shows that the majority of unemployed is younger than 50.

An interesting pattern is revealed by comparing the development of the proportions of workers between men and women. Where the employment rate of all men (Figure 12) starts of a slow but steady decrease until the early 2010s, this is not so when one considers men of 50 years and older. Here we see a first increase until the mid-2010s, followed by a considerable decrease until about 2030. A second decrease in the proportion of workers starts mid-2040s by a further decrease of the dependency ratio and by that an increase in the proportion of pensioners. By women, the proportion of working individuals increases as well until the late 2010s, and this increase is more important than that of men, seeing the lower starting level of the proportional size of this category. Since this increase continues until the late-2010s, it goes on longer than with men, and the proportion of women in work thereafter remains on a higher level than initially. So the decrease of the proportional size of working women shown in Figure 12 for the period after 2010 results from women younger than 50 years old.

**Figure 13: Labour market status of individuals of 50 and older, in percent**




## 3.3. Retirement

### 3.3.1. Retirees and pensions

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, employees or self-employed

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[14], 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 33 shows the two problems and some 'cope strategies'.

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

**Table 33: 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 |

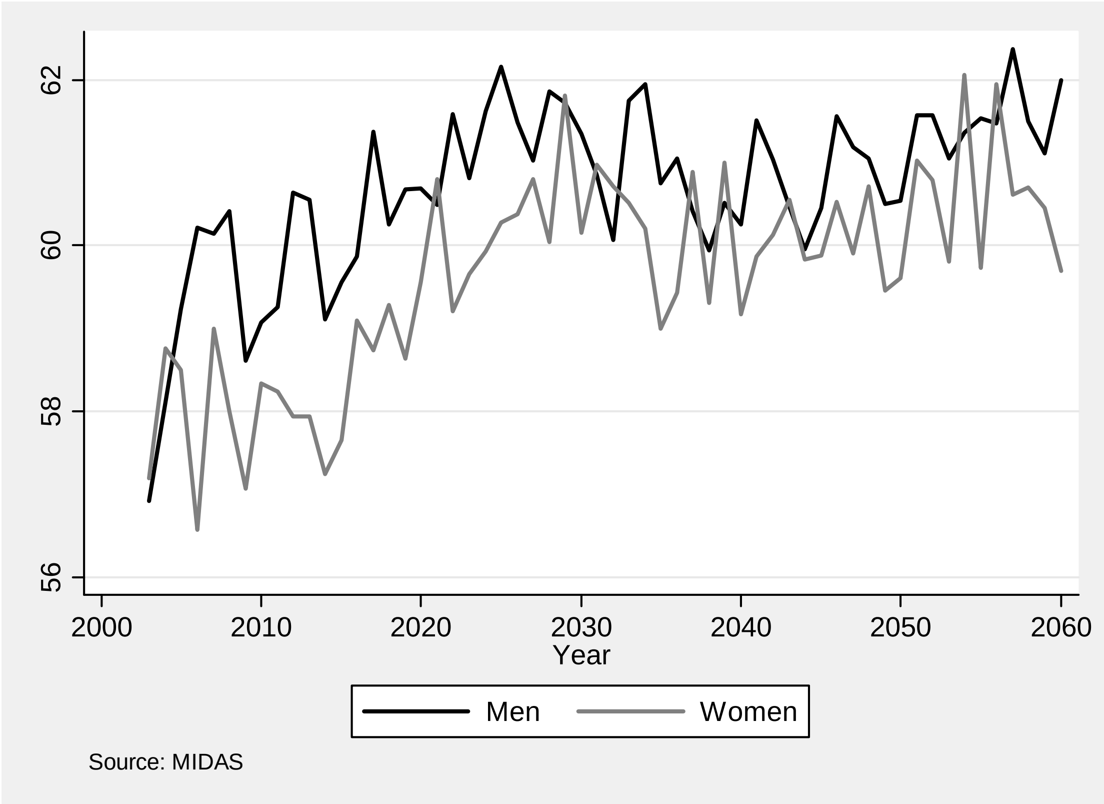
The first problem of too high pension benefits in the starting dataset can be dealt with by explicitly separating those who entered retirement before and after 2002. This is strategy 1.1. The pension incomes of the first group suffer from the aforementioned problem, whereas the incomes of the second 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). 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 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.

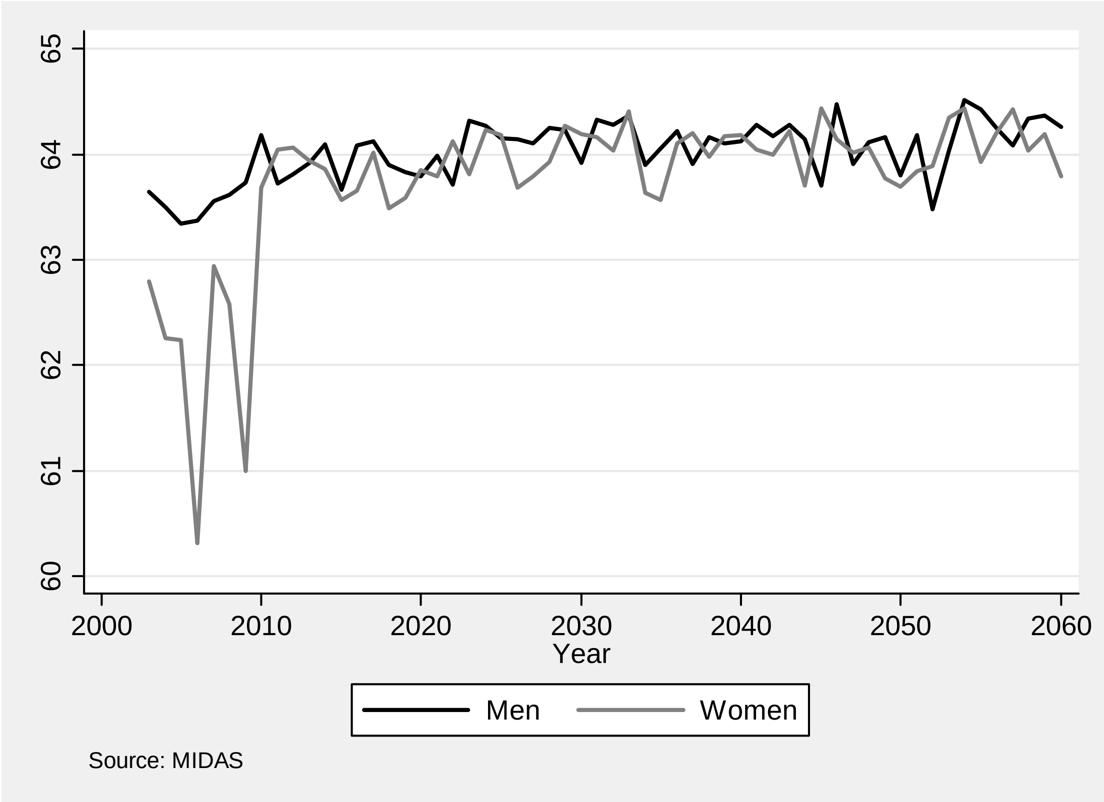
Figure 14 presents the average age of withdrawal from the labour market for men and women. This is driven by the alignment procedure that controls the work force participation. The average age of labour force withdrawal is increasing until around 2025 for men and women. It starts around 57 for men and 56 for women to reach respectively almost 62 and 61. After 2025 the trend of the average age of labour market withdrawal for men and women decreases to roughly 60 in the mid-2040s, and then starts a moderate increase until the end of the simulation period.

**Figure 14: 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 15 presents the average age of retirement. Trends for men and women follow the same evolution from 2010 onwards. They increase until 2030 and decrease slightly afterwards. The large increase in the women's age of retirement is due to the transitory regime that increases the legal retirement age of women to the age of 65 in 2009.

**Figure 15: Average age of retirement**




As expected, the average age of retirement is higher than the average age of withdrawal. However, apart from that, changes in the latter are considerably smaller than the developments in the former. This suggests that the non-working labour market states such as CELS, disability and unemployment, remain the most important pathways towards retirement. The increasing ages of withdrawal suggest that people withdraw later, but that the majority of older workers continues to enter into retirement via another scheme.

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 16 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 17 in 1960 to reach 22 in 2000. Trends can be described as that the average age increases from 17 to 20 between 1960 and 1980. It increases again of two years 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 16: Average age of labour market entry**


Source: MIDAS

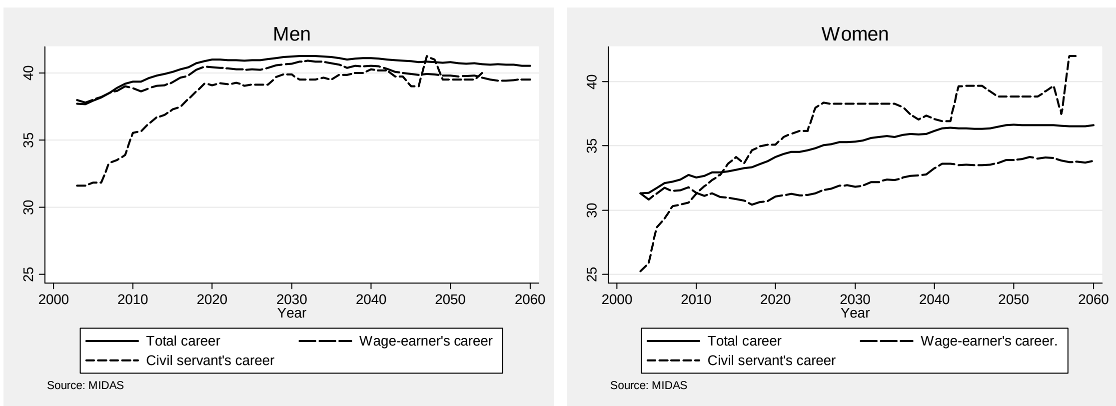
The level of labour market entrance may seem somewhat high at first instance. The compulsory age at which one had to be in education was 15 years in 1960 and many went to work at that age. During the 1970s, this age was increased to 16 and finally it became 18. One might think that the age of entry is overestimated. There are however three reasons why this may not be so. First of all does the model not take into account those that leave education early without the appropriate diploma. Secondly does the model not make a difference between full-time and part-time education, and groups all of them under being ‘in education’. And a third reason hinges on the fact that the results shown in Figure 16 pertain not to all individuals but only those that retire after 2002. This introduces a selection bias relative to the population as a whole (and therefore the mandatory education ages). This selection bias is stronger with an earlier year of entry. So those that entered the labour market early and retired in 2002 or later, retire at a comparably old age. The model simulates that those with a higher level of education (white collar workers) who less do physical labour, retire later than those who have a doing manual labour[15]. This implies a selection effect where those that entered the labour market at an early age have a higher probability of being retired before 2002 than those who entered the labour market at a later age.

[15] This is not a direct effect of education described in Table 14 and Table 15 but an indirect effect via the better health status (Table 12 and Table 13) on labour market participation.

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 17 presents the average career length for all retired with a "pure" career, meaning people who retire during the simulation period, i.e. after 2002. For both men and women, the average length of the career of the wage earners (either in the private or public sector) is by far the largest group, and this average increases respectively by two and three years. For men, it increases from 38 in 2003 to 41 years in 2030 and decreases slightly during the last three decades. For women, except the slight decline on a couple of years after 2010, the average career length increases constantly from 31 to 34 years. The average length of the career of civil servants increases much more than those of wage-earners. This is partly due to the way the work force participation of civil servants has been modelled. While there exist different possibilities to withdraw from the public sector labour market before the legal age of retirement through particular programs (especially for special categories like teachers or military), MIDAS 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, and this results in an overestimation of the civil servants' career length.

Finally, note that the model produces more and more 'mixed careers', i.e. the proportion of individuals who at least once in their career have made a switch between being an employee (either in the private or public sector) and being a civil servant increases over time. Inversely stated, the proportion and number of individuals retiring with a 'pure' career decreases over time. The numbers underlying Figure 17 therefore become increasingly smaller. The extreme case is shown in the left pane of Figure 17: there are no more male civil servants with pure careers after 2055.

**Figure 17: Career length – All retirees with "pure" career**




Next we turn to the simulated levels of retirement benefits. Following the discussion pertaining to Table 33, 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 'pure' wage-earners (those who have worked only as wage-earners) that retired after 2002.

Figure 18 includes simulated gross retirement benefits for retired civil servants with a 'pure' career, together with the simulated gross earnings of active civil servants. The evolution of average benefits is erratic due to the low number of observations it is based on. Furthermore, as it was already the case in Figure 17, we see here that, from around 2055 on, there are no more retired civil servants with a 'pure' career. Furthermore, only pensioners retired after 2002 are taken into account in this figure. Retirement benefits of women increase more or less at the same pace over the whole simulation period. This evolution is, in large part, explained by the increased career length of especially women civil servants The trend of men's retirement benefits is comparable to that of women until the mid-2040's, but then starts to slack as the length of career of male civil servants decreases slightly while the career length of female civil servants continues to increase.

Note that, especially for male civil servants until the mid 2040's, the pension benefit is very close to earnings. To understand this, one should realize that earnings and pension benefits observed or simulated in any given year pertain to different cohorts. So an increase of the length of career of retired civil servants will result in a higher pension benefit. It will however not change the earnings of the active civil servants. Hence pensions will increase relative to earnings in any given year. Furthermore, there is a large cohort of civil servants that are close to retirement. As the members of this cohort gradually enter into retirement, the average age of both active and retired civil servants decreases. The average earnings of the former hence decrease, whereas the average pension benefit of the latter increases: consequently, pensions increase relative to wages.

**Figure 18: Gross earnings and simulated retirement benefits for civil servants with pure career, retired after 2002, prices of 2002, in euro**

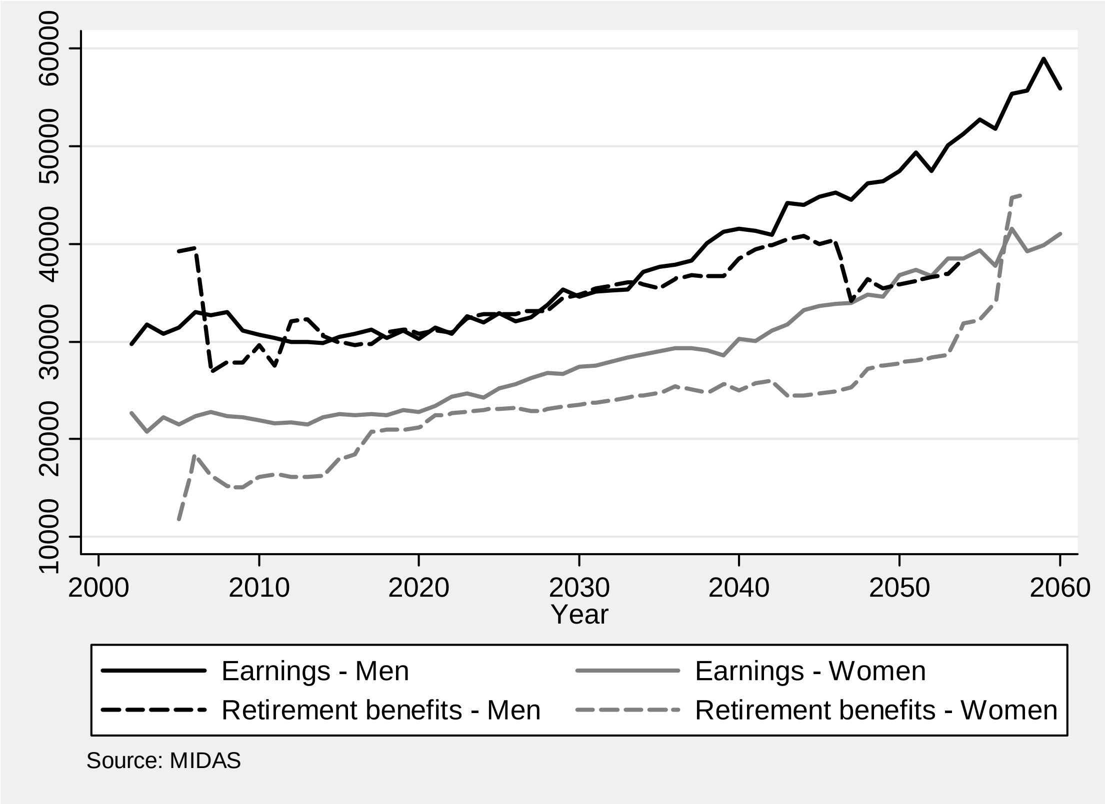
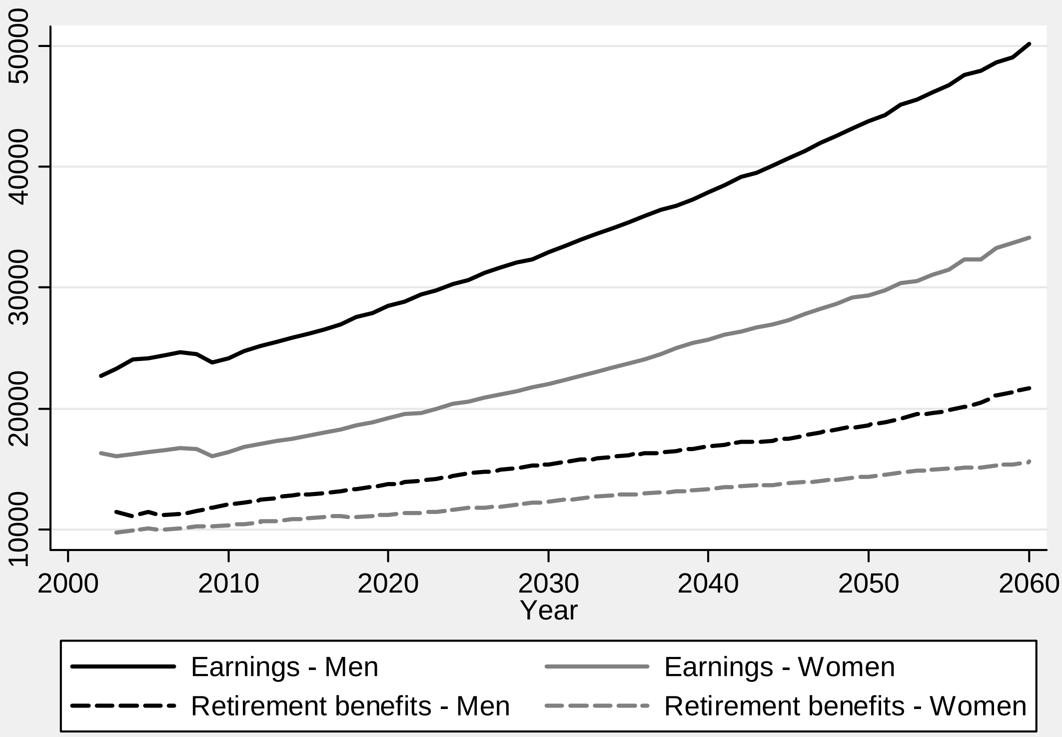



Figure 19 presents gross earnings and retirement benefits of wage-earners that were wage-earners throughout their entire career. Retirement benefits for men and women show a limited growth pattern during the whole simulation period. We see two reasons that explain why retirement benefits do not increase 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. The second 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 20 below.

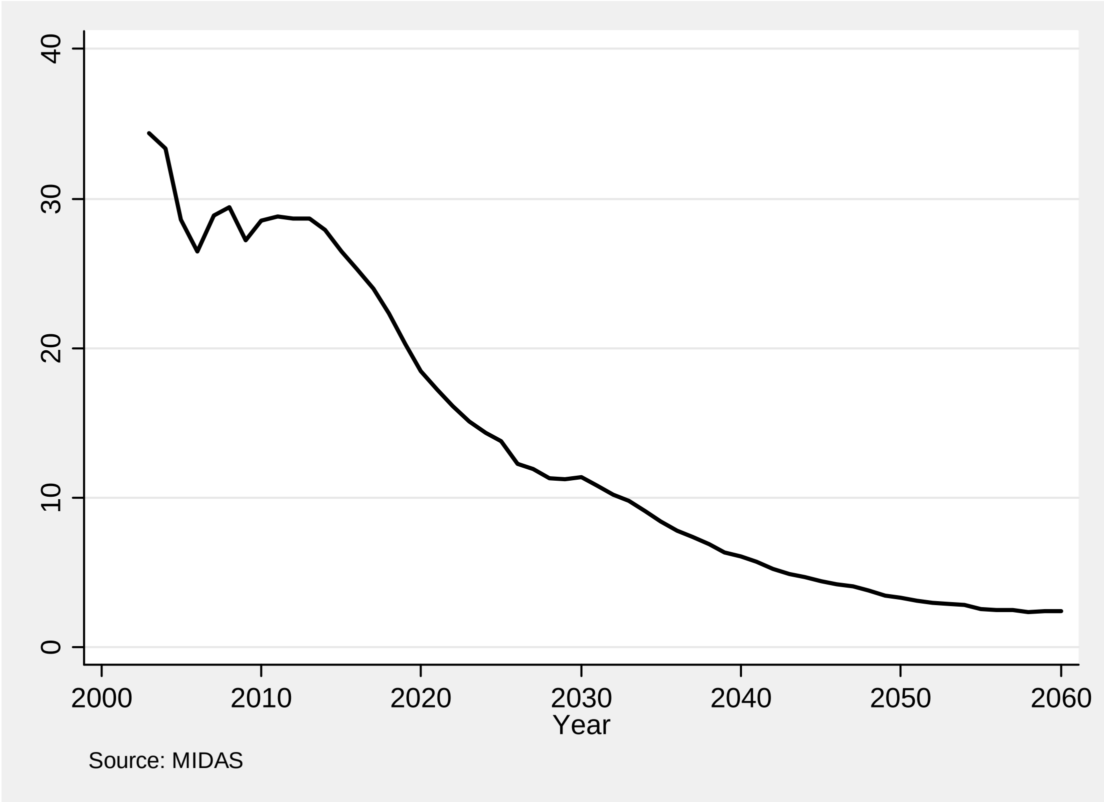
**Figure 19: Gross earnings and simulated retirement benefits for wage earners with pure career, retired after 2002, prices of 2002, in euro**




Source: MIDAS

As explained in section 2.5, 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 20 shows how evolves the proportion of wage-earners households benefiting from the "household rate": It decreases from 35% in 2003 to less than 5% in 2060. This is explained by two main factors. The first one is the household structure of retirees that is described by Figure 7 on page 46. We see that the household size decreases. 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 20: Proportion of households benefiting from the "household rate" pension, in percent**




### 3.3.2. Adequacy of social security in Belgium.

The Open Method of Coordination (OMC) on pensions, which was launched by the Laeken European Council in December 2001 and was developed, further thereafter[16], defines the adequacy of pensions as the capacity of pension systems to meet their social objectives. To this end, they should: (1) ensure that older people are not placed at risk of poverty, (2) provide pension entitlements enabling them to maintain, to a reasonable degree, their living standard after retirement and (3) promote solidarity between and within generations. The first two points of this definition are not specific to pensions, and can therefore be extended to include other social security benefits, as well as social assistance.

In this section we analyse the adequacy of pensions, and social benefits in general by considering the effect of pension income on the living standard of recipients and on inequality and poverty. The results are based on the MIDAS-model which is consistent with the socio-economic projections and macro-economic and social policy assumptions of the baseline scenario determined by the Study committee for ageing in its latest yearly report (2009), and discussed in section 2.2.3.c on page11. We will start here by considering the replacement rate of pensions only. Next, the redistributive impact of all social security benefits considered, as well as their impact on the

[16] See e.g. the new framework for the social protection and social inclusion process, adopted by the European Council in March 2006 (see http://ec.europa.eu/employment_social/spsi/common_objectives_en.htm).

risk of poverty of their recipients. To recapitulate, the social security module of MIDAS simulates first-pillar old-age pension benefits for private sector employees, civil servants and self-employed, as well as the guaranteed minimum for the elderly. Furthermore, it simulates the Conventional Early Retirements (CELS) benefit, the widow(er)s' pension benefit, the disability pension benefit, unemployment benefit and, finally, social assistance benefits.

### a. Replacement rate

The replacement rate represents the income transition when an individual changes from working status to retirement status. Here, it is calculated as the ratio between the income from the (first pillar) pension in the year one becomes a pensioner and the earnings of the last working year. Hence, the replacement rate only reflects the income fall of those moving from having a job into retirement; new retirees coming from unemployment, disability, CELS or inactivity are excluded. Also, the nominator does not include benefits from the CELS, nor unemployment, disability or social assistance. Since the purpose of the replacement rate is to show the adequacy of the system of pensions, and not the regulations of social protection outside the pension system, the benefits from the system of guaranteed minimum income for the elderly are excluded as well. Figure 21 shows the averages of the individual replacement rates for the retired wage-earners and civil servants by year and sex. The individual replacement rates for self-employed people are not included in these averages since they are approached by the minimum pension scheme.

Note that the development of the replacement rate is somewhat erratic, due to a relatively low number of people actually making the transition from working into retirement in the sample. Therefore, and to clarify their development, a Hodrick Prescott filter ($\lambda$=1600) has been used to separate a trend for men and women. These trends are added to the figure.

**Figure 21: Gross replacement rate, in percent**

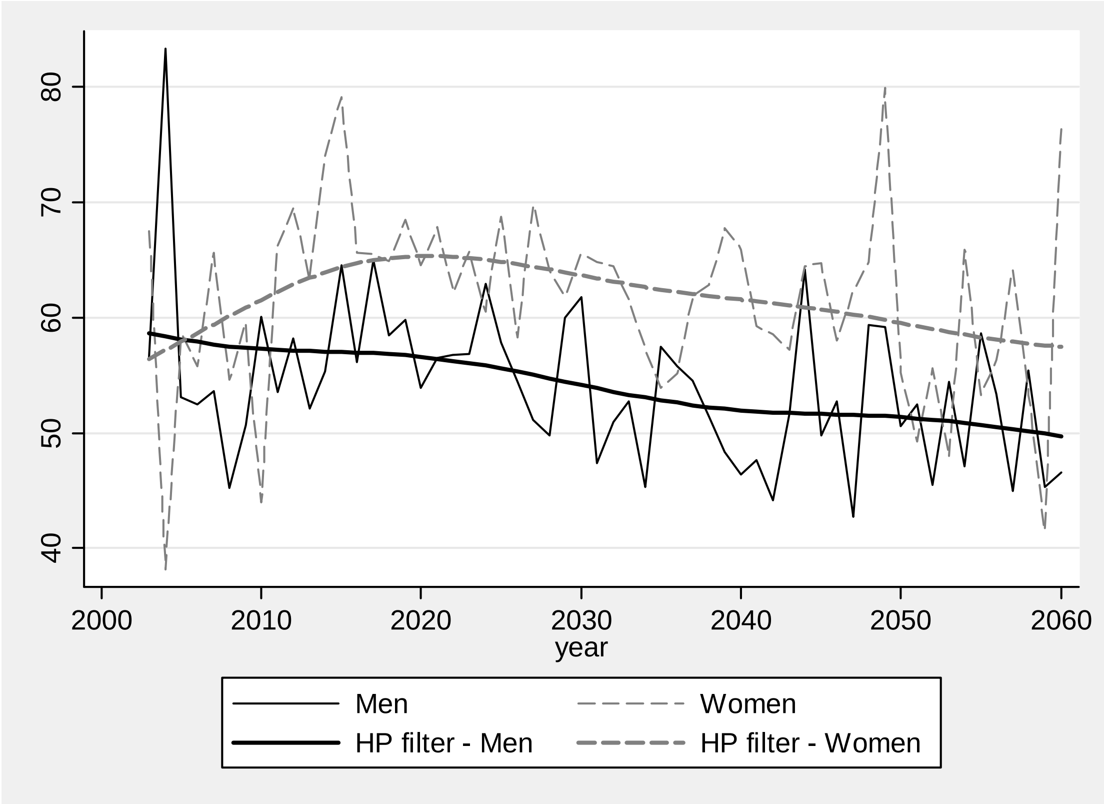



Figure 21 shows that women have a higher (gross) replacement rate than men's over the whole simulation period[17]. This result shows the redistributive effect of the pension system. The minima (minimum pension, minimum pension right per year of work, old age guaranteed minimum income) and the wage ceiling both contribute to lessening the link between social contributions and pension benefits and to making the distribution of pension income more egalitarian.

On the first 20 simulation years, the replacement rate of women increases consequently while the replacement rate of men slightly decreases. The women's trend on that period is a result of the increase of the length of women career, combined with the re-value of the minimum pension benefit. Men benefit less from these minima but are more subjected to wage ceilings: This may explained the moderate decrease of their replacement rate.

The period between about 2020 up to about 2060 shows a parallel decreasing development of the replacement rate of men and women, where the average replacement rate of women is about 8% above that of men. This parallel evolution comes from the double effect of the increasing employment rate of women. The first effect is a direct effect: as the earnings and employ-

[17] It is the case for the whole simulation period except for the first couple of years. Indeed, due to some "outliers" in the first years, the women's trend starts lower than the men's trend. Because of the low number of observations at the very beginning of the simulation, trends before 2010 are not considered to be significant.

ment history of women increases, they benefit less from minima. In addition to that, because of the reduced growth rate of pension minima compared to the growth rate of earnings, as time goes by, less often pensions fall below the minimum and need to be uprated. Their pensions are therefore more directly related to their earnings and, as a consequence, their replacement rate decrease. The second and indirect impact is the following: as participation rate of women increase, they more and more apply for their own individual pension benefit. The proportion of men claiming a household pension benefit for themselves and their spouses, hence decreases, and so does the average replacement rate of men. Furthermore, with an increasing wage comes an increasing limiting impact of the wage ceiling on the pension benefit of men entering into retirement. This impact is less important for women because their lower wages are less often confronted with the wage ceiling.

### b. Inequality: The Gini index

**Figure 22: Gini index by status**

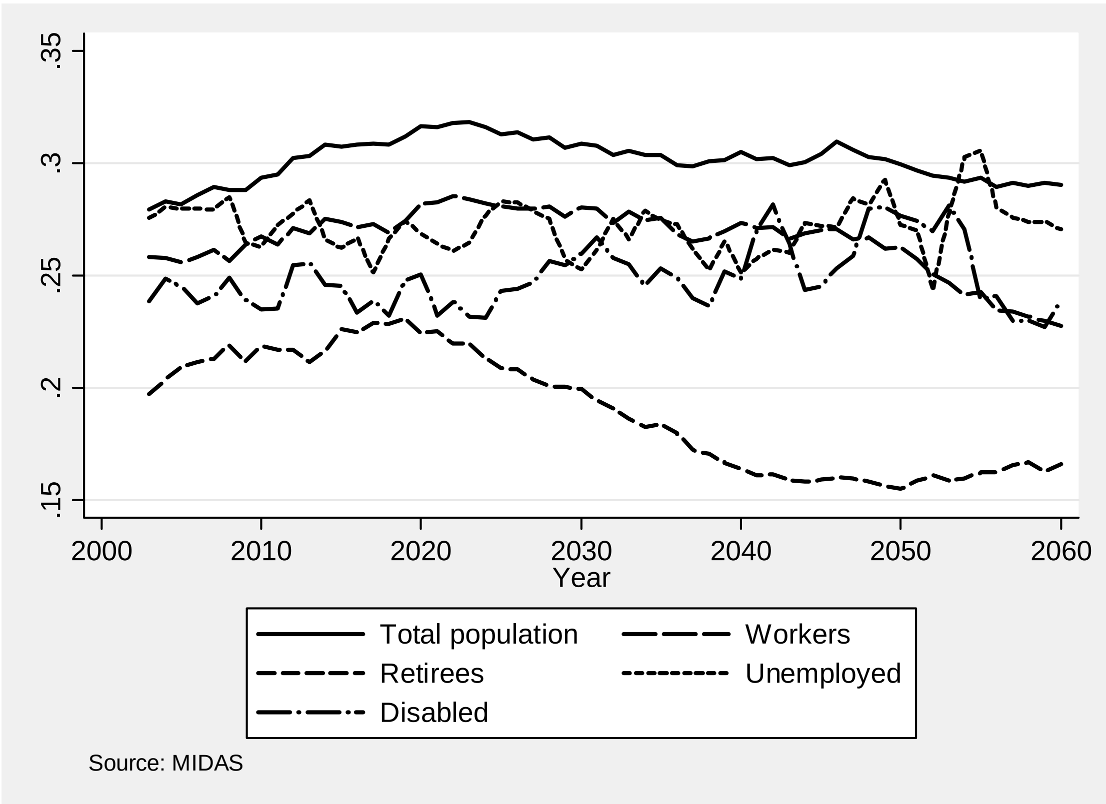



Figure 22 shows the evolution of the Gini index[18] for various categories of individuals, including pensioners and the working population. Note that where Figure 21 is based on individual

[18] The Gini index is a measure of the inequality of income distribution. Its value varies between 0 and 1, which enables comparisons of income inequality between populations of different sizes. Value 0 points to a complete equality of income: everybody has the same income. Conversely, value 1 refers to complete inequality: one single individual concentrates all income.

income, these Gini indices in Figure 22 are based on the equivalent household income of an individual. Household income is therefore divided by the equivalent household size in order to reflect differences in household size and composition. The equivalent size of the household income is based on the so-called "modified OECD" equivalence scale. This equivalence scale gives a weight of 1 to the first adult, 0.5 to any other household member aged 14 and over and 0.3 to each child (younger than 14). The resulting equivalent household income is then assigned to each member of the household. A consequence of using equivalent household income is that the Gini by activity status can be made up of incomes from different sources. A household comprised of a pensioner and a working person will have an equivalent household income made up of both work income and pension income. As we will see later, income distribution of pensioners will not only depend on retirement income but also on the composition of the household and their income structure.

Before discussing this figure, note that individuals in this Figure 22 are split up according to their activity status and not the source of their income. This is relevant because the Gini is based on household income. Hence, a working individual can 'receive' earnings as well as a pension benefit if at least one of the members in his or her household is retired. In a previous application of MIDAS (Dekkers et al., 2009), the discerning factor was the source of income. Hence, the inequality of individuals receiving only earnings was compared to those receiving only pensions, and this implied that individuals from 'mixed' households were excluded. This was possible since the previous version of the model was limited to simulating earnings and pensions. Other incomes were 'unknown' and the impact of the exclusion was therefore limited. In this version of the model, however, this is no longer the case. Now unemployment benefits, disability benefits, and social assistance benefits are simulated as well. As a consequence, the proportion of 'mixed' households, in terms of the incomes they receive, proportionally increases. Choosing to discern individuals not on the basis of the composition of their household income but on their own status seems the sensible thing to do. In this case, a given level of difference between the income inequality of, say, workers and pensioners is the combined result of a different 'pure' redistributive effect (i.e. of the system generating the income) itself, and of the overlap between the sources of income (the probability that a household that receives earnings, also receives a pension benefit).

We start the discussion of the above Figure 22 by considering the evolution of the distribution of pensioners' income. This evolution can be divided into three stages, from now until about 2020, from 2020 until mid 2040's and thereafter. In the first stage, inequality among pensioners increases from 0.20 to 0.23. It then decreases progressively in the second stage until around 0.16 to increase again slightly on the last 15 years to reach 0.17.

In order to analyse this evolution, those inequalities of pensioners' income have been split up to its source. We discern pension income, income from work earnings and income from benefits other than pensions (unemployment, disability and minimum "social integration" income benefit). Lerman and Yitzhaki (1985) show that the Gini (G) of the household income compounds of three elements:

(i) the share of each income category k in total income ($S_k$);

(ii) the Gini of each income source k (1,2,3) ($G_k$);

(iii) the correlation of each income source k with the distribution of total income ($R_k$).

So, $G = \sum_k S_k G_k R_k$

The proportion of income source k in the total income inequality ($P_k$) is then calculated as:

$P_k = (S_k G_k R_k)/G$ ; and the sum of these proportions in inequality equals 1.

As we can see in Table 34, the share of other social benefits than pensions in the overall income of pensioners, and its inequality, is limited and relatively stable over the period. Therefore we can suppose that this source of income has no influence on the income inequality between pensioners. So, in what follows, the focus of the discussion shifts to pension benefits and income from work.

**Table 34: Contributions of different income components k to income inequality among pensioners**

| | $S_k$ | $G_k$ | $R_k$ | $P_k$ |
|---|---|---|---|---|
| Year: 2003 | | | | |
| Pension benefits | 0.8480 | 0.2546 | 0.6049 | 0.6623 |
| Income from work | 0.1282 | 0.8953 | 0.6177 | 0.3594 |
| Other income | 0.0238 | 0.9348 | -0.1920 | -0.0217 |
| Total income | | 0.1972 | | |
| Year: 2010 | | | | |
| Pension benefits | 0.8153 | 0.2657 | 0.6052 | 0.6006 |
| Income from work | 0.1621 | 0.8714 | 0.6419 | 0.4154 |
| Other income | 0.0225 | 0.9401 | -0.1643 | -0.0159 |
| Total income | | 0.2183 | | |
| Year: 2020 | | | | |
| Pension benefits | 0.8331 | 0.2616 | 0.6686 | 0.6489 |
| Income from work | 0.1459 | 0.8848 | 0.6447 | 0.3706 |
| Other income | 0.0210 | 0.9413 | -0.2216 | -0.0195 |
| Total income | | 0.2245 | | |
| Year: 2030 | | | | |
| Pension benefits | 0.8900 | 0.2229 | 0.7141 | 0.7089 |
| Income from work | 0.0935 | 0.9301 | 0.6874 | 0.2991 |
| Other income | 0.0165 | 0.9551 | -0.1014 | -0.0080 |
| Total income | | 0.1998 | | |
| Year: 2040 | | | | |
| Pension benefits | 0.9541 | 0.1891 | 0.8603 | 0.9434 |
| Income from work | 0.0351 | 0.9696 | 0.3147 | 0.0652 |
| Other income | 0.0107 | 0.9719 | -0.1354 | -0.0086 |
| Total income | | 0.1646 | | |

| | $S_k$ | $G_k$ | $R_k$ | $P_k$ |
|---|---|---|---|---|
| Year: 2050 | | | | |
| Pension benefits | 0.9608 | 0.1805 | 0.8518 | 0.9504 |
| Income from work | 0.0332 | 0.9735 | 0.3277 | 0.0681 |
| Other income | 0.0060 | 0.9854 | -0.4874 | -0.0186 |
| Total income | | 0.1555 | | |
| Year: 2060 | | | | |
| Pension benefits | 0.9547 | 0.1862 | 0.8010 | 0.8540 |
| Income from work | 0.0406 | 0.9735 | 0.6877 | 0.1631 |
| Other income | 0.0047 | 0.9874 | -0.6194 | -0.0171 |
| Total income | | 0.1668 | | |

The rise in inequality among pensioners over the first two decades in Figure 22 can be explained by the fact that the proportion of work income rises slightly at the expense of pension income ($S_k$) and by the stronger correlation of income from work with total inequality ($R_k$). This change in the structure of income is due to the rising participation rate of women in the labour market. It so appears that over this period, on the one hand, more and more retired men have a spouse who is still working, and, on the other hand, as an increasing number of women get a pension of their own, it happens more and more that in the households that are entitled to a pension benefit, the man is still working. As earnings are much less evenly spread than pension income ($G_k$); an increase of the proportion of earnings in the income of pensioners causes the overall inequality (G) of pensioners to increase.

From about 2020 until the mid 2040's, there is a distinct declining trend of inequality among pensioners. Three factors can explain this development. Firstly, women's growing participation rate in the labour market and the lengthening of their career both result in increased eligibility to a pension benefit. Secondly, the alleged decrease in the number of marriages and cohabitations causes the proportion of pensioner's households only comprised of a single person to rise. As a result, fewer and fewer pensioners get work earnings as part of the household's overall income. Moreover, because of the rising average age of pensioners, they are less likely to have a partner who is still working. This results in a very clear decrease in the relative part of work earnings in their overall income in Table 34 and a parallel increase in the relative part of pension income ($S_k$).

A third explanatory factor of the decreasing inequalities among pensioners has to do with the decreasing inequality linked to pension income ($G_k$). For this, there are again various reasons.

First of all, Table 2 shows that the link with the development of wages is especially strong for the minima: 1% per year for the minimum pension and 1.25% for the minimum right per working year. The welfare adjustment of employees' and self-employments pensions is only 0.5%. The minimum pensions therefore increase faster than the average pension, which reduces inequality of pensions.

Secondly, the decoupling between wage growth and the setting of ceilings lies at the base of this more egalitarian distribution of pension income. This growing discrepancy between wages and wage ceilings implies an ever stronger capping of pension levels.

The third and possibly most fundamental reason for this decreasing inequality of pension benefits is that the assumptions of the 2009 Study Committee for Ageing pertaining to productivity growth and social hypothesis outlined in Table 2, imply a stronger welfare adjustment of benefits in the future than in the past. In the long run, productivity increases by 1.5% per year, and the welfare adjustment for pensions is 0.5%. The difference between the two, i.e. the lag of benefits to wages, is thus 1%. Fasquelle et al. (2008: 2) show that this lag was on average 1.8 percent between 1956 and 2002. Hence, the hypothesis underlying MIDAS imply a reinforcement of the future link between wages and pension benefits. Therefore inequality decreases in the long run. See Dekkers (2010) for a more elaborate discussion of this point. Between the mid 2040's and 2060, inequality among retirees again increases somewhat. This is because a relatively large cohort enters into retirement what is reflected by the dependency ratio in Figure 3 on page 42. The younger pensioners are, the higher the probability that they live in the same household as an active partner. Or, the younger pensioners are, the more important earnings are as a fraction of their household income, and hence the higher their inequality of total household income will be. Hence, the inflow of a large cohort of young pensioners causes the share of pensions in total income of pensioners to decrease at the expense of earnings (see Table 34). Hence, as was the case in the first decade of the simulation period, inequality increases.

Income inequality among those unemployed and disabled are also included in the above Figure 22. These categories are not the point of focus here, so their discussion will remain brief. The development of inequality of income over time is more discontinuous for these categories, which is due to the lower number of individuals in these categories. Nevertheless trends let appear that the level of inequality of disabled is always slightly lower than the level of inequality of unemployed. Indeed, disability benefits are always more generous than unemployment benefits.

Figure 23 specifies the redistributive impact of pensions according to gender. To limit the number of lines, the inequality of male and female unemployed and disabled are not included in this figure. Note that the difference of level between men and women is diminished by the fact that we use equivalent household income. Hence, any difference in inequality results from single men and women.

**Figure 23: Gini index by status and gender**


As for the global Gini, we can divide the analysis into three periods: before 2020, between 2020 and the mid 2040's and after the mid 2040's. In the beginning of the period (2003-2010), we see that inequality of pensions is higher for women than for men, but that inequality increases for male pensioners, so that the levels converge around 2015. The higher inequality among women pensioners in the starting period is a reflection of their heterogeneous careers. Women more often than men work part time or not the full year and this heterogeneity reflects itself in the higher earnings inequality of women relative to men. Once women retire, this inequality is toned down considerably by the redistributive elements of the Belgian pension system, but a residual difference remains.

Until about 2020, the inequality among male pensioners increases towards that of women. It seems contradictory, but this development is the result of the increasing labour market participation of women. Of a married couple, the man typically is a few years older than the woman. An increasing labour market participation of women therefore increases the importance of earnings in the income of male pensioners, and the inequality of their income therefore increases. This effect obviously does not play for women pensioners.

Between 2020 and the mid 2040's the Gini indexes of retired men and women have the same decreasing evolution, which can be explained by the three factors from the global analysis of the Gini, as explained previously.

And finally, between the mid 2040's and 2060, the Gini indexes of retired men and women start again to increase slightly with a more marked evolution for men. Here again, the typical positive age difference between men and women in couples explains this. Indeed, among new retirees from the large cohort entering into retirement, we can imagine that men enter retirement some years before their spouse and are therefore, more often than women, in a couple with positive work earnings.

### c. Relative income poverty

The financial dimension (income) of poverty is usually approximated by indicators based on poverty thresholds. The simplest and most well-known of these is the "risk of poverty" indicator p/N where N is the size of the population, and p is the number of individuals whose equivalent household income is on or below an exogenous threshold level, usually 60% of median equivalent income. This "risk of poverty" indicator will be discussed in the following paragraphs.

Before turning to the simulation results on poverty risks in detail, a problem pertaining to the simulation of disposable income should be discussed. The most recent official statistics on the observed adequacy of pensions pertain to the year 2006 and are derived from the observed distribution of disposable income in the EU-SILC survey of 2007. A comparison between these official EU-SILC statistics and the simulation results of MIDAS suffers from an underestimation in the latter compared to the former. This underestimation is due to various reasons. First of all, both the EU-SILC and the PSBH (the dataset that underlies the current version of MIDAS) are rather small panel surveys. Differences between the mean or median disposable incomes can therefore partially be the result of selective attrition or sampling variation.

A second and more fundamental reason for the observed difference however is that disposable income as measured by the EU-SILC takes into account revenues that are not available in the PSBH and not simulated by the MIDAS-model. This includes returns on investments, rental incomes, dividends, as well as benefits and capitals received from the second and third pillars of the Belgian pension system.

There are two possible consequences for the underestimation of disposable income. A first consequence pertains to the poverty line. This poverty line is set equal to 60% of the median equivalent disposable household income. The first two lines of the below table shows the EU-SILC poverty line (High Council of Finances, various years) and the MIDAS poverty line, both expressed in euro per year.

The last line is the difference between the two poverty lines. The most recent official poverty line in Belgium pertains to the year 2006. It is derived from the EU-SILC survey of 2007 and equals 878€ per month or 10540€ per year (High Council of Finances, 2009, 49). The poverty line simulated by MIDAS for the same year is 9573€ per year or 798€ per month. Hence the poverty line simulated by MIDAS underestimates the official poverty line by 967€ per year or 80€ per month. In 2005, the ‘mismatch’ is the highest, and equals 1034€ per year or 86€ per month. These differences do not seem very important, and it is therefore unlikely that the ‘mismatch’ will influence the simulation results.

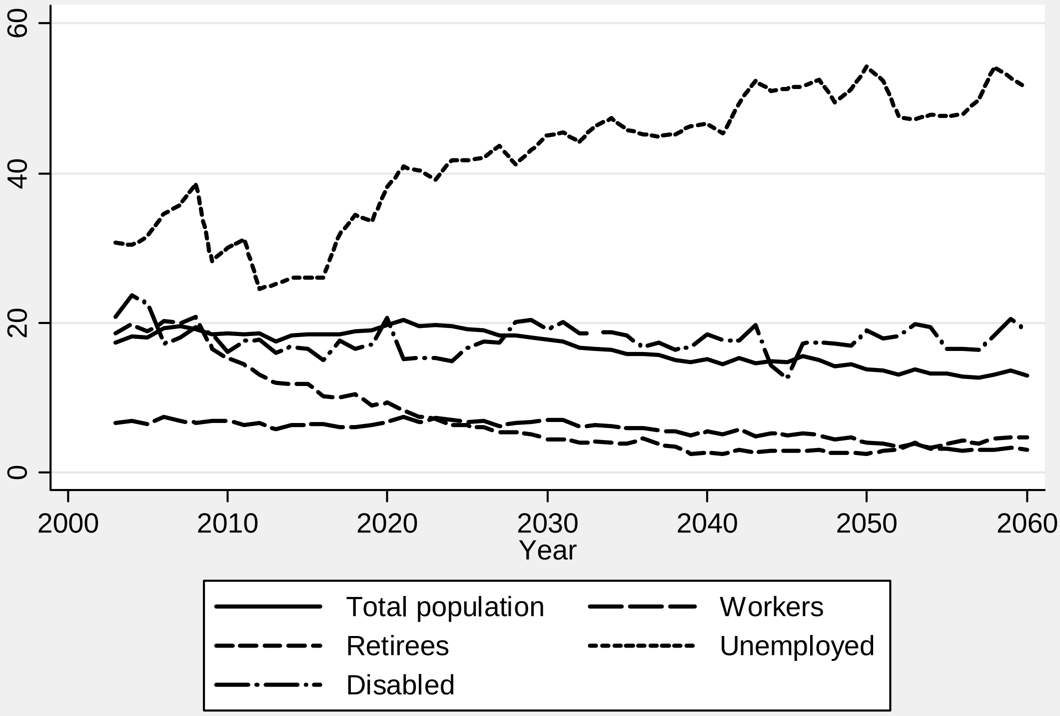
| | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| EU_silc | 9324 | 9942 | 10316 | 10540 |
| MIDAS | 8727 | 9085 | 9282 | 9573 |
| Difference | 597 | 857 | 1034 | 967 |

The second consequence for the underestimation of disposable income pertains to the simulation of the means test. The fact that MIDAS does not simulate all sources of income or capital means that those simulated lump-sum benefits that are subject to a means test are simulated too high. The most important examples are social assistance benefit like –again– the Guaranteed Minimum Income for the Elderly. An additional problem for the simulation of the latter is that MIDAS does not simulate home ownership or the value of the dwelling. The disposable income of those having earnings or social security income below the minimum is therefore underestimated, and the lump-sum benefit after the means test is thus overestimated.

The conclusion of this is that, even though the impact of the ‘mismatch’ in disposable income on the poverty line is limited, it may overestimate the impact of the means-test in the simulation of lump-sum benefits.

Figure 24 shows the risk of poverty rate by status. The concept of income used here is the same as in the preceding figures, i.e. the equivalent household income. As explained earlier on in this chapter, the risk of poverty rate is the proportion of individuals who are under the poverty threshold.

**Figure 24: Risk of poverty rate by status, in percent**




Source: MIDAS

The risk of poverty rate among pensioners gradually declines between 2006 and approximately 2040, stays relatively stable over the next decade and increase slightly between 2050 and 2060. In 2007, the risk of poverty is lower for pensioners than for than the whole population, while around 2025, the poverty risk of pensioners even falls below that of those being at work.

Two factors can explain the fact that the poverty risk among pensioners decreases until 2040. The first factor is the whole of the recent measures that have been taken in order to raise pension minima at the end of 2006, mainly the nearly 14 % rise of the "guaranteed income for the elderly" (GRAPA/IGO) (see Table 1 on page 4). The means-tested character of this benefit allows it to have an important impact on poverty measures. Furthermore, because of this large re-value, the impact of this benefit is felt during the whole simulation period. On the other side, the re-value of 17% of the minimum right per working year in the same year has no significant impact on poverty measures. Indeed, those who benefit from that measure were already above the poverty line before this re-value.

The second factor that explains the declining risk of poverty for pensioners during the first four decades is the increased participation of women in the labour market. This increases the share of earnings in the income of especially male pensioners, thereby decreasing their risk of poverty. The most important impact of this increasing labour market participation of women is however on their own future pensions. As women tend to have longer careers, this enables them to get higher pensions. Hence, as will be shown in Figure 25 below, the reduction of the poverty risk among pensioners is, to a great extent, the result of the increasing level of women's pensions.

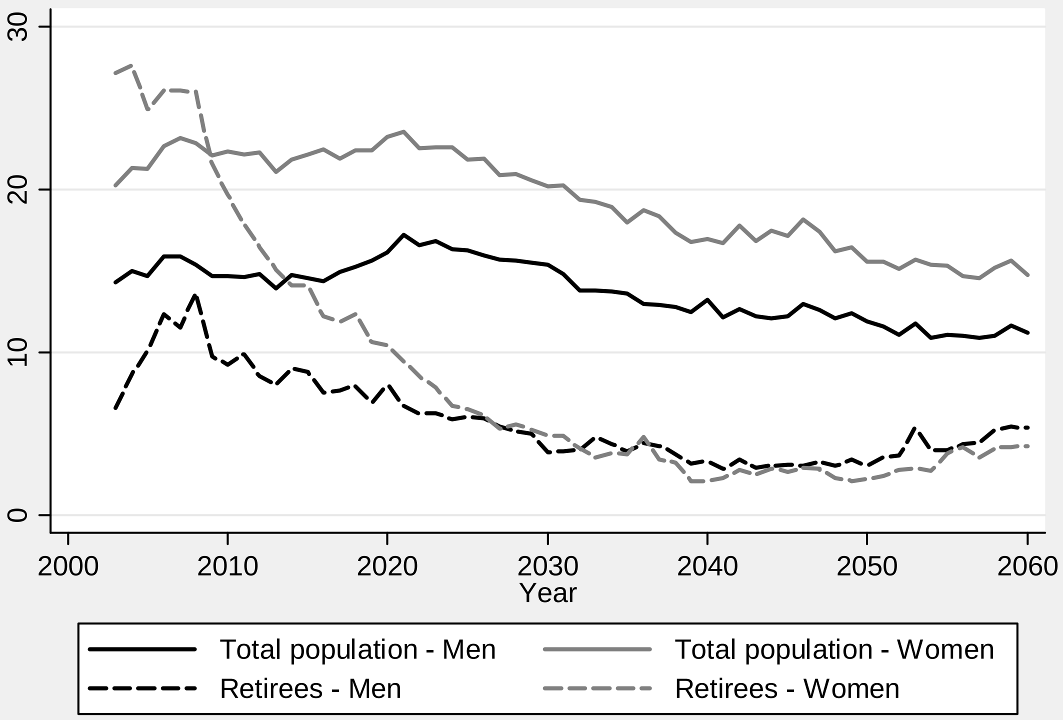
The period between 2040 and 2050 is marked by a stabilisation, at a relatively low level, of the poverty risk of pensioners. By then, the effect of the two factors mentioned above has faded away. The only factor still in action is the decoupling between pension growth and wage growth, and, in particular, its impact on the evolution of the poverty threshold. As this decoupling is relatively limited, the growth of the average pension is close to the rise of the poverty threshold. The adjustments to living standards, especially those that affect pension minima, are relatively generous when compared to wage growth, all the more so as among the two mechanisms aimed at ensuring pension minima, that of the minimum right per year of work (to which a higher growth is applied), will in the long run supplant the mechanism of the minimum pension. Considering their respective starting levels and growth rates (1 % for the minimum pension and 1.25 % for the minimum right per year of work), the minimum guaranteed pension will soon no longer be relevant, which means that the minimum right per year of work will be the only mechanism that will ensure that pensioners are entitled to a minimum allowance. As this minimum allowance grows according to a decoupling of a mere 0.25 p.p. compared to wage growth, it is no wonder that we should see a stabilisation of the poverty risk for pensioners. Finally, during this period, one sees an increase of the relative part of pensions in the overall income – the median of which is used as a basis to calculate the poverty threshold. This also explains why the poverty threshold does not really grow faster than pensions.

Finally, from 2050 to the end of the simulation period, the poverty risk of pensioners increases somewhat. The main effect in action here is the decoupling between the adjustment growth rate of minima and the wage growth rate. As specified here above, the main mechanism aimed at ensuring pension minima, the minimum right per year of work, is decoupled from the wage growth from only 0.25%. Because of this low decoupling level and the high re-value of this minima in 2006, we have then to wait until the last decade of the simulation period to see the impact of this decoupling on the poverty level of pensioners. We see clearly on that period that less and less women benefit from this minimum.

Figure 24 also enables us to analyse the evolution of the poverty risk for the unemployed and disabled workers. These two categories are exposed to very different poverty risks. While the poverty risk of disabled stay constant over the whole simulation period, the poverty risk of unemployed increase constantly to reach 50% in 2060. This difference is almost uniquely explained by the difference into the benefit generosity. Indeed, due to the relative nature of the poverty measure applied in this paper, if the equivalent income of one category lags behind that of the population as a whole, its poverty risk increases. It therefore appears that, in future years, the category of unemployed will face the highest poverty risks.

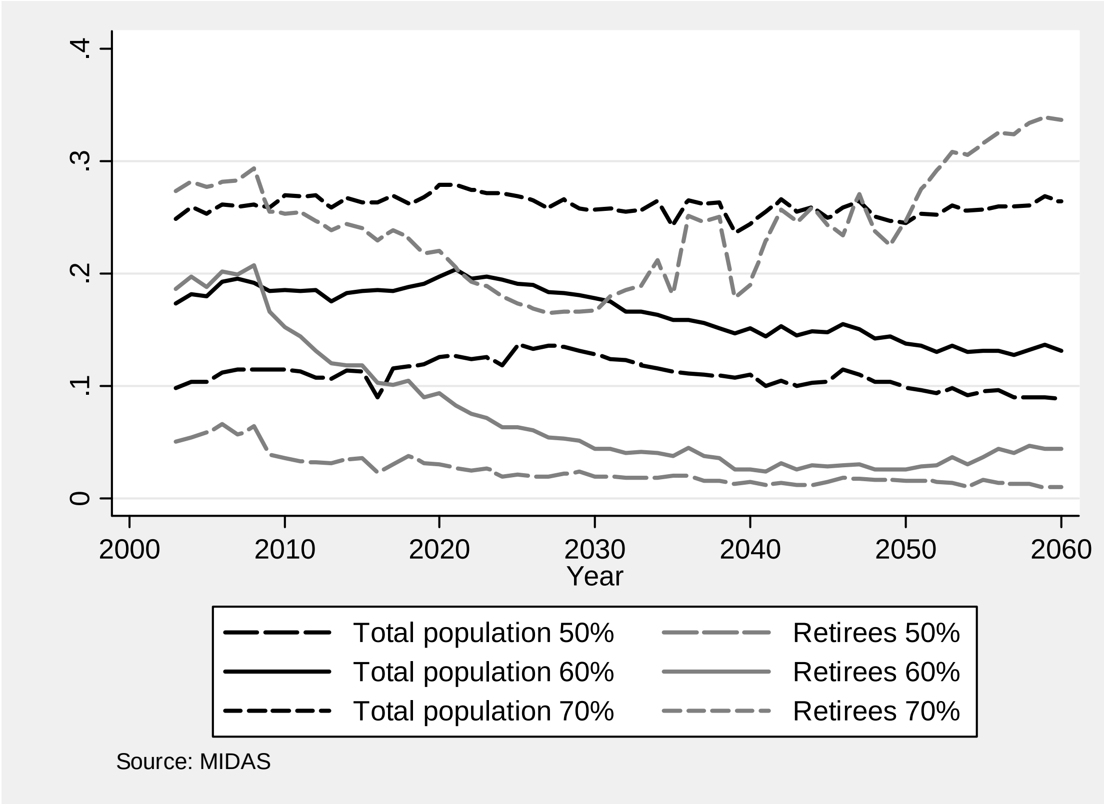
A break-up by gender in Figure 25 shows that the decrease in global poverty rate of pensioners until around 2040 is largely the result of the fall of poverty among female pensioners, for the reasons explained above. In the beginning of the period, we even see an increase in poverty among male pensioners. This can be explained by household composition. As seen in Figure 20, a relatively large proportion of men have a pension calculated at the « family rate » since their wives have no income. To calculate the equivalent household income, their pension will be divided by the equivalence scale, which is 1.5 for a couple. But the « legal » equivalence scale of the pension at family rate equals 1.25 (the difference between the pension at family rate for a couple (at 75%) and for an individual (at 60%)). So this will induce a relative low equivalent household income for the male pensioner. Moreover, given an average age difference of three years between partners in a couple, it is possible that a man's spouse will not meet the age condition which opens the right for the guaranteed income for elderly persons (assistance scheme). Note that these households are not included in the female pensioners since those women do not have the status of pensioner but they are considered as 'other inactive'. The large rise of the guaranteed income in December 2006 and the increasing participation rate of women (and, with it, the substitution of one pension at the family rate by two pensions at the individual rate) will induce a reduction of the risk of poverty rates for male pensioners.

**Figure 25: Risk of poverty rate by status and gender, in percent**




Source: MIDAS

**Figure 26: Risk of poverty rate by status and poverty line, in percent**




In the above figures 24 and 25, the poverty line was by convention set equal to 60% of the median equivalent income. Figure 26 shows how the poverty risks of pensioners and the total population changes when the poverty line equals 50 and 70% of median equivalent income. In the discussion of this figure, we describe the poverty risk pertaining to a poverty rate of x% of median equivalent income as “poverty risk at x%”.

Note that these reflect a different severety of poverty. The lower the poverty line, the more precarious the situation pertaining to the risk of poverty. For the population as a whole, there is no remarkable difference in development of the poverty risk. The converging decrease of poverty risks at 50% and 60%, and a proportional increasing poverty risk at 70% obviously are a reflection of the developments among the pensioners.

Looking at pensioners, the poverty risk at 50%, which is the risk pertaining to the most severe lack of income, is at the starting point much lower that the risk at 60%. An important explanation for this is that the Old-Age Guaranteed Minimum Income is above the 50% poverty line but below the 60% poverty line. The strong increase of this minimum in December 2006 brings its maximum amount above the 60% poverty line which explains the large effect of this measure on poverty measured with a poverty line of 60% of median income compared with the 50% poverty line. Moreover, this suggests a selection effect where mainly women (see Figure 25) that were in households that have an equivalent income between 50 and 60% of the median see their household income increase above the latter level. Especially the increased labour market participation of women, benefits mainly individuals living in households with incomes just below the 60% poverty line. As from 2030 both lines become very close. This conclusion is reinforced when we compare the developments of poverty risks at 60 and 70%. Until the second half of the 2020s, the risk of poverty at 70% decreases at a comparable speed as the risk of poverty at 60%. As the poverty risk at 70% is unlikely to be affected by the increase of the GMI, the reason for this decreasing development is the increasing labour market participation of women. From the early 2030s on, however, the poverty risks at 70 and 60% diverge since the poverty risk at 70% starts a steep long-term climb, ending up higher than 30% in 2060. This development shows that the social hypothesis used for the welfare adjustment of pensions bring the equivalent income of households higher than the 60% poverty line, but not beyond the 70% poverty line.

# 4. Conclusions

Microsimulation models in recent years have gained popularity in the assessment of social security systems in terms of the adequacy they provide, and specifically pension policy. This working paper describes the second version of MIDAS (an acronym for 'Microsimulation for the Development of Adequacy and Sustainability'). Contrary to the first version of the model, this second version is intended for use in the Belgian context. The model aligns to the baseline projections and assumptions of the 2009 Study Committee for Ageing. The simulation results of this version of MIDAS therefore describe the consequences of the 2009 budgetary projections and assumptions on the projected adequacy of pensions in Belgium.

Given recent policy measures and the latest projections of the budgetary impact of ageing in Belgium, what is the projected development of poverty and redistribution among the elderly in Belgium between 2002 and 2060? This is the central question of the working paper.

Increasing labour market participation of women and policy measures on the pension minima (mainly the nearly 14% rise of the "guaranteed income for the elderly" in 2006) are key elements in explaining the development of pension adequacy.

The paper first discusses the development of the replacement rate. The average replacement rate of women starts off very close to that of men. On the first 20 simulation years, the replacement rate of women increases consequently while the replacement rate of men slightly decreases. The women's trend on that period is a result of the increasing length of their career, and the strong re-value of the minimum pension benefit from 2007 on. The period between about 2020 up to 2060 shows a parallel decreasing development of the replacement rate of men and women, where the average replacement rate of women is about 8% above that of men.

In the first stage, until the late 2020s, inequality among pensioners increases. This is because the increased labour market participation of women causes earnings to become more important as a source of income of pensioners. Hence their income inequality goes up. In the second stage, until around 2020 and the mid 2040's, income inequality among pensioners decreases. This among other things is the result of the increasing proportion of single pensioner's households and ageing among the elderly. This causes the impact of earnings to decrease again. And finally, on the last stage, between the mid 2040's and 2060, inequality among retirees increases again somewhat due to the relatively large cohort entering into retirement: The introduction of a large number of young individuals into the pool of retirees will have the effect of increasing the proportion of retirees sharing their lives with an active partner and therefore causes the share of pensions in total income of pensioners to decrease at the expense of earnings.

Probably the most appealing indicator of pension adequacy is the poverty risk indicator of retirees. This indicator is expected, first, to decrease the next 40 years, secondly, to stabilise under the level of the working population poverty between 2040 and 2050 and finally, to increase slightly over the last decade. The evolution during the first two periods is a result of the increasing length of career of women relative to that of men, and a strong increase of the guaranteed minimum for the elderly from 2007 on. The evolution during the last decade is due to the decoupling between the adjustment growth rate of minima and the wage growth rate that, finally, after 50 years, have an impact on the poverty level of pensioners. This second version of MIDAS also enables us to analyse the evolution of the poverty risk for the unemployed and disabled workers. Already more exposed to poverty than the average population, including the elderly, the poverty risk of the unemployed keeps rising over the whole simulation period.

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