Working Paper no.: 2016/04

Michaël Boissonneault and Joop de Beer

# The impact of ability to work at older ages on the postponement of retirement

netherlands interdisciplinary demographic institute

The impact of ability to work at older ages on the postponement of retirement

Michaël Boissonneault[1,2] and Joop de Beer[1]

Working Paper no.: 2016/04

NiDi

[1] Netherlands Interdisciplinary Demographic Institute (NIDI/KNAW)/ University of Groningen, The Netherlands
[2] Corresponding author: P.O. Box 11650, 2502 AR The Hague, The Netherlands. Mail: Boissonneault@nidi.nl. Phone: + 31 70 3565239.



October 2016

**Abstract**

In response to population ageing, new policies have been introduced in many European countries to incite workers to retire at older ages. However, a certain proportion of older workers already do not reach the official age at retirement because of poor health. Considering that health worsens with age, we ask to which extent the efficiency of the new policies can be dampened by poor health. We propose a simple population model that captures the interaction between work, retirement and ability to work and which parameters are estimated on basis of information on health and labour force participation contained in the Survey on Health, Ageing and Retirement in Europe (SHARE). Changes in the model's parameters are introduced in order to simulate different levels of health and of ability to work when age at retirement is postponed. The outcome are different sets of age-specific participation rates and the results are presented drawing on Sanderson and Scherbov's characteristics-based approach using participation as a characteristic. A small limiting effect of health on the levels of participation is found when age at retirement is postponed, suggesting that health should not be a hurdle to higher participation at older ages in the context of policy changes pursuing a moderate postponement of retirement.

## Introduction

The fact that Europe is ageing is well documented. In this context, the unsustainability of many economically developed countries' pension schemes has been showed (OECD 2005). A few different solutions have been pursued in order to bring back those schemes to sustainability. One that has received considerable attention is delaying the actual age at retirement in order to increase the number of contributors and decrease the number of recipients (OECD 2013; Scherbov et al. 2014; Vaupel & Loichinger 2006; Zaidi et al. 2013). The long descending trend in the average effective age at retirement seems now to have been reversed in Europe and participation at older ages is now raising (OECD 2011b). Many changes in legislation have recently been introduced or will be introduced in the coming years or decades in order to maintain or accentuate this trend.

It seems to be a consensus that a higher age at retirement is not only necessary but also achievable. Literature that addressed whether the measures taken will have the desired effect mainly put forward the fact that policy has been the main factor explaining variation in the effective age at retirement, either across countries or through time (Blöndal & Scarpetta 1998; Gruber and Wise 1999; Gruber and Wise 2004; OECD 2013). This state of affairs could lead to the conclusion that a postponement of retirement will have the same effect no matter the ages at which it takes place. However, there may exist factors that limit the age until which people can keep on working, and those factors may change with age.

One of those factors is poor health. In each European country, a certain share of people retire early and take up disability benefits because they cannot keep on working until the official age at retirement (OECD 2010). A number of papers compared people's health with respect to their timing to retirement. Sub-populations that retire earlier, *e.g.* after having started receiving government benefits such as early retirement or disability benefits, constantly show worse health than people who retire later and receive regular pension benefits (Alavinia & Burdorf 2008; Bazzoli 1985; Kalwij et al. 2013; Karpansalo et al. 2004; Smith 2013). However, the extent to which poor health may be limiting participation at older age for a given population does not seem to have been addressed.

Admitting that health becomes worse with age and supposing that it is constant through time, a change in policy that incites workers to retire later may not reach its full anticipated effect if one does not take into account that ability to work may be lower for older people. In other words, measures that are expected to make people retire later by a given number years will produce an equivalent postponement in the effective age at retirement only if the other enabling factors—such as health—are also postponed. The gap between the anticipated and the actual average age at retirement will be a function of how those enabling factors change through time and of the size of their impact on the fact of working at older age. Decision makers should be aware of such reality and not overestimate the effect of policies they design.

The aim of this paper is to quantify the extent to which health—and by extension, ability to work—is likely to limit participation at older ages under different scenarios when age at retirement is postponed. This is done on the basis of a simple population model that assumes three states of health from which we derive two states of ability to work (able and not able to work) and two states inside of the population that is able to work (active and non-active). Rates of participation as well as rates of ability to work are computed under different assumptions about health and ability to work when age at retirement is postponed. The results are presented drawing on the approach presented by Sanderson & Scherbov (2013) where labour market participation is used as characteristic to compare ageing through time.

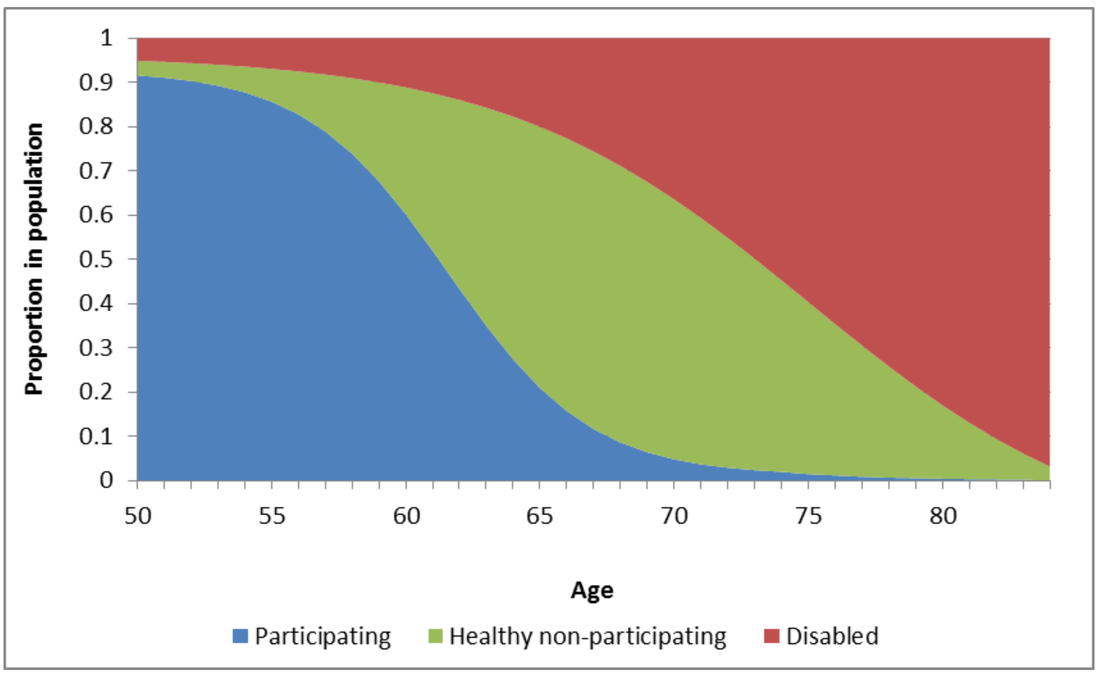
## A model for estimating labour force participation considering ability to work

The decision of retiring is complex to model, as there exist a variety of factors influencing people's behaviour pertaining to work and retirement in their life course. In the present paper, we concentrate exclusively on the interplay between health, work and retirement. For simplicity, we will consider throughout this paper that the only two factors influencing people in their decision to continue working or to retire are poor-health and any other non-health related reason. Furthermore, we will disregard the age-specific variation in participation that can be induced when younger cohorts grow older. The analysis consider people aged 50 years and older only, as we assume that changes in people's behaviour concerning retirement will only affect people of those ages.

Labour participation at age 50 and older is characterised by a near-universal transition from the state active to the state non-active, or retired. While most of those transitions are not related to health problems, there is a share of people who make this transition on grounds of poor health. Those transitions occur at a younger age when compared to the non-health-related transitions because they concern people who stopped working before being eligible to regular pension benefits.

People who work are per definition able to work. Among people who do not work, we assume that some do not because their health does not allow them to work anymore and that others do not because of other reasons (they decided or were forced to retire but their health could have allowed them to keep on working). Throughout this paper, we will use the term *ability to work* when quantifying the flow of people who transit from the state able to work to the state not able to work; in parallel, we will use the term *propensity to work* when quantifying the flow of people who are able to work but who still transit from the state active to non-active. Each retired person will correspond to either the state not able to work or non-active.

**Figure 1: Assessing the share of work-related disability**




Ability to work can be seen as the level participation will reach when everybody who is able to work actually does so. It captures the balance between one's resources in health and the burden put on it by one's work, and its level diminishes through years of age as people have poorer health.

Propensity to work, on the other hand, can be seen as the level labour participation reaches when everybody is able to work. It predicts the proportion of people that is actually working among the one that is able to work. We assume this notion to capture the pull as well as the push factors between the decision of retiring or of staying on the labour market; as a result, propensity to work has values that become rapidly smaller at ages where retirement becomes more (financially) attractive, or at ages where the pressure to retire becomes greater.

In the present model, the level of participation for a given population at time *t* will be a function of the two above-mentioned variables.

$$L_{x,h} = A_{x,h} P_{x,h} \tag{1}$$

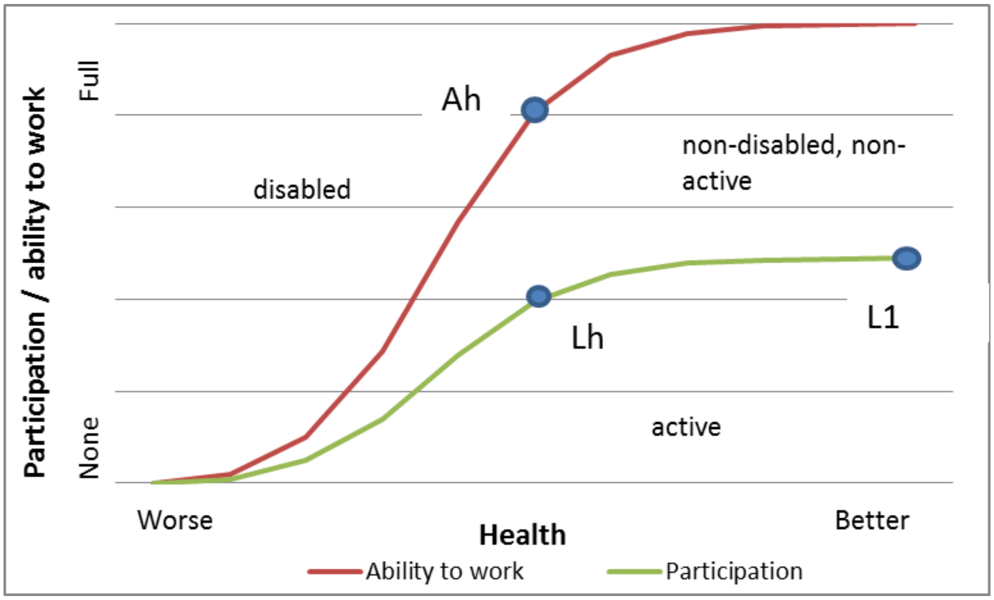
where $L_{x,h}$ is labour force participation of a person at age *x* with health *h*, *A* is ability to work and *P* is propensity to work.

We assume *A* and *P* to be independent from each other; changes in one parameter can occur without that the other one is affected. In the upcoming analysis, we will assess how changes in those two parameters can bring about changes in total participation. Those changes are respectively supposed to represent: 1) changes in ability to work as a result of better health and/or better working conditions; 2) and changes in legislation around retirement. Before we present the results, we illustrate how these parameters are estimated.

**Estimating the Parameters**

We assume a population aged 50 years and older representative of the western European reality with unknown values for *A* and *P*. For this population, we have information on health as well as on the rates of labour participation that are specific to each level of health for each year of age (*i.e.* age- and health-specific participation rates). The level of propensity to work at age *x* is the level of participation free of work-related disability. We assume people with the highest level of health to be all able to work. Hence, propensity to work equals the participation rate that is associated to the group with the highest level of health: $P_x = L_{x,1}$ ; where $L_{x,1}$ indicates the group of health containing only people who are able to work.

**Figure 2: Estimation of ability to work based on health specific participation rates at a given age**




Worse levels of health are associated with higher probability of being not able to work. We assume the differences in participation between people with different levels of health to be due to disparities in ability to work. We assume that propensity to work is the same for people with the highest level of health as for people with lower levels of health. As a result, the proportion of people with lower levels of health that is able to work is equal to the participation rate that is associated to them divided by the participation rate for people with the highest level of health, or $P_x$:

$$A_x = \frac{L_{x,h}}{L_{x,1}} \quad (2)$$

where $L_{x,1}$ equals labour force participation for people with the highest level of health and $L_{x,h}$ labour force participation for people with lower levels of health. $A_{x,h}$ captures the proportion of people that is able to work with health *h* and can be regarded as the proportion of people with lower levels of health that a given labour market allows to work, or the general burden put by work on people's health. The total proportion of the population that is able to work is found on the basis of the proportion of people that is able to work (*A*) within each group of health (*H*) weighted by their respective size in the population:

$$A_x = \sum_h A_{x,h} H_{x,h} \quad (3)$$

where $H_{x,h}$ is the proportion of people at age $x$ with health $h$. On the basis of survey information on health and labour participation, we estimate for a given population the values for $A_{x,h}$ and $A_x$, which will in turn allow to find the values for $L_x$.

**Data source and manipulation**

The model presented in the previous section is based on differences in levels of participation between people characterised by different levels of health. It will be fitted using data coming from the Survey on Health, Ageing and Retirement in Europe (SHARE) (Börsch-Supan & Jürges, 2005; Börsch-Supan et al., 2005; Börsch-Supan et al., 2008; Börsch-Supan et al., 2013a; Börsch-Supan et al., 2013b; Malter & Börsch-Supan, 2013). We built fictive cohorts based on the unweighted cross-sectional[1] prevalences observed at waves 1, 2 (release 2.6.0, as of November 29th 2013) and 4 (release 1.1.1, as of March 28th 2013).[2] By pooling the observations coming from the 10 countries that participated to each of those waves, we obtain more observation to base our estimates upon; the resulting model is therefore not representative of the population of a single country but is rather a stylised representation of the western European reality. The countries at hand are Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden and Switzerland.

**Health**

Our model assumes the relationship between the health-specific participation rates to capture disparities regarding ability to work. The goal is to have a measure of health that relates the most to the fact of being active on the labour market but that is at the same time the least endogenous with the way people assess their labour status (Lindeboom & Kerkhofs, 2009).

---

[1] SHARE offers longitudinal data, which could have allowed to build a model based on transitions in health and labour status affecting the respondents from one wave to the other. However, the number of transitions obtained this way turned out to be too low for the purposes at hand. We therefore chose to treat each observation as a cross-sectional one and built fictive cohorts.

[2] "The SHARE data collection has been primarily funded by the European Commission through the 5th Framework Programme (project QLK6-CT-2001-00360 in the thematic programme Quality of Life), through the 6th Framework Programme (projects SHARE-I3, RII-CT-2006-062193, COMPARE, CIT5- CT-2005-028857, and SHARELIFE, CIT4-CT-2006-028812) and through the 7th Framework Programme (SHARE-PREP, N° 211909, SHARE-LEAP, N° 227822 and SHARE M4, N° 261982). Additional funding from the U.S. National Institute on Aging (U01 AG09740-13S2, P01 AG005842, P01 AG08291, P30 AG12815, R21 AG025169, Y1-AG-4553-01, IAG BSR06-11 and OGHA 04-064) and the German Ministry of Education and Research as well as from various national sources is gratefully acknowledged (see www.share-project.org for a full list of funding institutions)."

SHARE offers information on hand-grip strength for all of its waves in the form of a discrete value ranging from 0 to 100. It is an objective measure of health that is correlated to different health outcomes, *e.g.* limitations in activities of daily living and disability (Frederiksen et al. 2002), and is a predictor of death (Cooper et al. 2010). As a result, this measure of health can be thought of capturing well disparities in the physical ability to perform work. However, we can think of this measure not to cover the non-physical aspects affecting ability to work, such as mental health. We therefore combine information on self-assessed health to the one on grip-strength in order to create a composite variable of health taking this dimension into account. We use the U.S. version of the question on self-assessed health contained in SHARE for which the respondents were asked to choose between the categories 1. Excellent, 2. Very good, 3. Good, 4. Fair, 5. Poor when answering the question "Would you say your health is…" (Jürges et al. 2008).

The composite measure was created merging the two measures of health the following way. First, we merged two by two the categories of self-assessed health 1. and 2. and 4. and 5. The category 3. was left untouched so that we have 3 categories of self-assessed health. Then, we identified each respondent's highest hand-grip score. Based on that score, each respondent was assigned one of 3 categories so that the number of people corresponding to them approximately corresponds to the number of people associated to the three categories of self-assessed health.

**Table 1: Values for basing the composite measure of health**

| | Hand-grip strength[3] | | |
|---|---|---|---|
| Self-assessed health | Group 1 | Group 2 | Group 3 |
| Excellent or Very good | G | G | F |
| Good | G | F | P |
| Fair or Poor | F | P | P |

The third step was the merging of the three self-assessed health groups and the three hand-grip groups. Three groups of health were created where people with higher values of grip-strength and better self-assessed health were labelled as having a "Good" health; people with lower values of grip-strength and worse self-assessed health were labelled as having a "Poor" health;

[3] To the different groups of hand-grip strength correspond the following values: Men: Group 1) [49;100]; Group 2) [38;49[ + refusal and unknown; Group 3) [0;38[ + not able; Women: Group 1) [31;100]; Group 2) [24;31[ + refusal and unknown; Group 3) [0;24[ + not able.

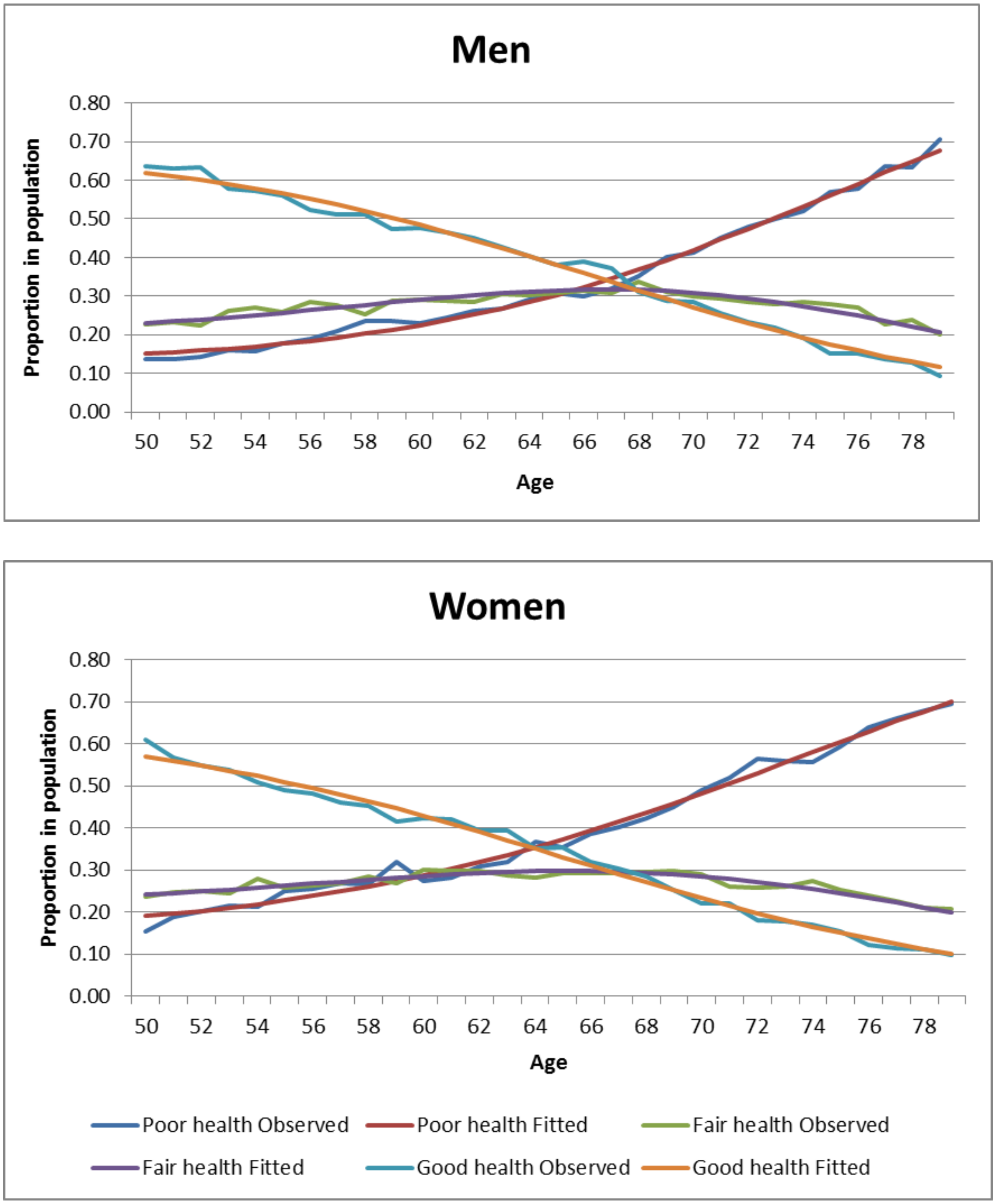
finally, people in between were labelled as having a “Fair” health. The exact values on which the repartition is based is schematised in Table 1. 521 male observations and 405 female observations were dropped because they contained no information on neither both measures of health nor on labour participation, leaving us with a total of 34 105 male observations and 40 012 female observations aged 50 to 79 years old (we assume participation to be equal 0 from age 80). In order to attenuate the effects of random error and produce smoothed estimates, and in order to simulate the effects of postponement of poor health to older age (upcoming section), we fitted a logistic model to the frequencies for people with good and poor health. The fit is based on the observed frequencies for single years of age. The Add-in *Solver* available for Excel 2010 (Microsoft Office, 2010) was used for estimating the curves, which can be described by the following equation:

$$H_{x,h} = c_h + \frac{a_h e^{b_h(x-m_h)}}{1+e^{b_h(x-m_h)}} \qquad (4)$$

where $b$ determines the strength of age-related changes in health ($b$ is negative for people with good health and positive for people with poor health), $m$ is the age where the slope is the steepest, $c$ is the lower boundary for people with health $h$ (*i.e.* the minimum proportion of people with health $h$ at age $x$) and $c + a$ is the upper boundary (*i.e.* the maximum proportion of people with health $h$ at age $x$). Leaving the other parameters unchanged, the effect of postponement of poor health (see “Fitting the model below”) is simulated by increasing the value of the parameter $m$ by $y$ years.

Figure 3 provides the observed and fitted curves and table 2 the estimated values for the different parameters. Since the proportions in the three health states add up to 1 for each age, the estimated frequencies for people with fair health equal 1 minus the sum of the values for poor health and good health.

**Figure 3: Observed and fitted health frequencies by age and sex**



| **Table 2: Parameters of the logistic equation used to model the health frequencies** | | | | |
|---|---|---|---|---|
| | Men | | Women | |
| | Poor health | Good health | Poor health | Good health |
| c | 0,1206 | 0,000 | 0,1354 | 0,000 |
| a | 0,8794 | 0,6943 | 0,8646 | 0,6602 |
| b | 0,1344 | -0,1283 | 0,1148 | -0,1219 |
| m | 74,9458 | 66,5481 | 73,4853 | 65,0039 |

**Participation**

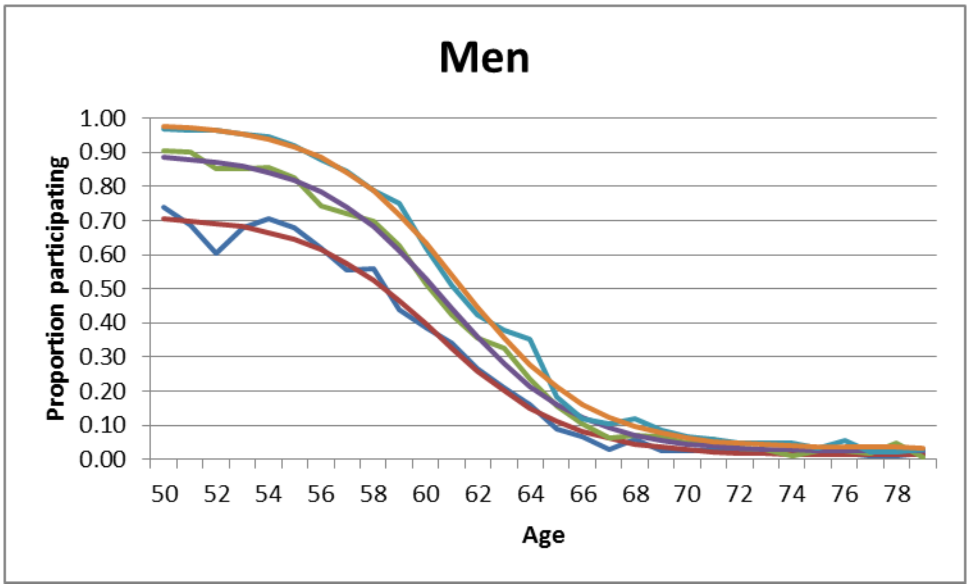
We identified among each group of health the proportion of people who were participating on the labour market at the time of the interview. What we are interested in is the link between people's level of health at the moment of the interview and their actual involvement on the labour market, while we are less concerned with the way they perceived this involvement.

People who declared working 15 hours a week or more were considered as active, no matter how they assessed their labour status. People who considered themselves as working but who declared working less than 15 hours a week, or people who considered themselves unemployed at the time of the interview, were considered as active only if they did not receive the previous year any pension, early retirement or disability benefits. People who declared not being working 15 hours or more per week and who declared to never have worked before were considered as inactive, even if they did not receive any government benefits.

**Fitting the model**

The health- and age-specific levels of participation are found by dividing the number of participating people inside of each group of health by the total number of people corresponding to each of those groups. For the same reasons as mentioned above, we fitted the age-specific participation rates for the three groups of health using a logistic equation (similar to equation (4)). To facilitate the estimation of ability to work (equations 2 and 3), we impose the restriction that all curves must have the same *b* value. This implies that differences in participation across people in different health states are explained by differences in the upper and lower bounds of participation (*i.e.* participation at young and old ages respectively) and the modal age at exit from the labour market. Figure 4 provides the observed and fitted participation rates for the three groups of health and for both sexes and table 3 the values for the different parameters. Table 3 shows that both the upper bound of participation ($a + c$) and the modal age at retirement ($m$) increase with an improvement of health.

**Figure 4: Observed and fitted participation rates by sex, age and health group**



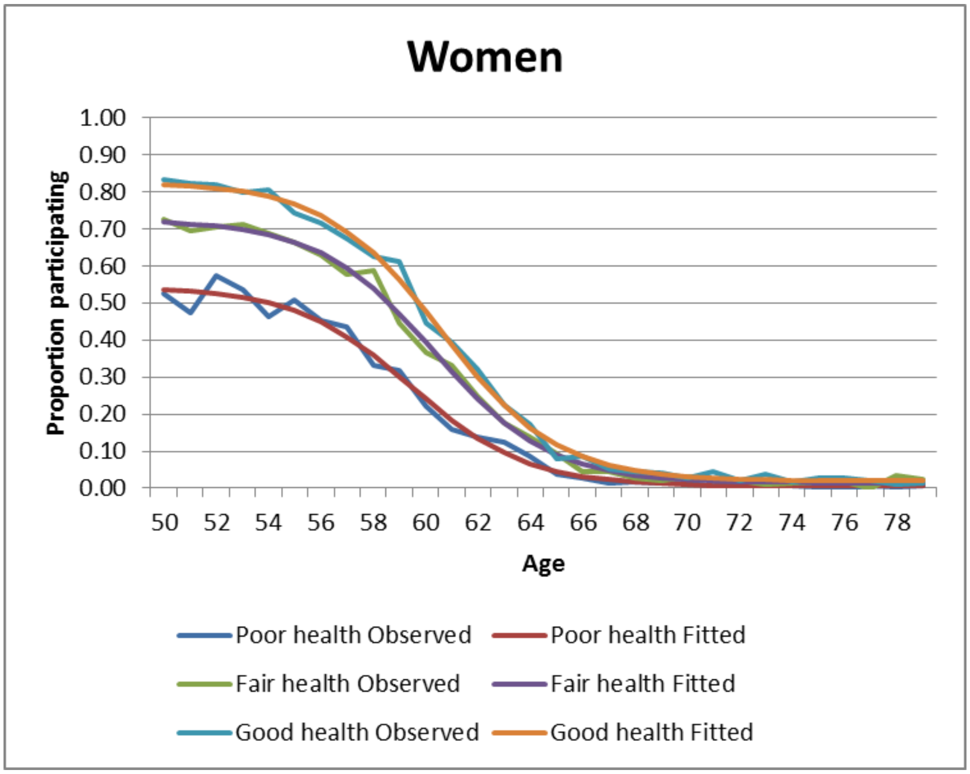



**Table 3: Parameters of the logistic equation used to model the health-specific participation rates**

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Poor | Fair | Good | Poor | Fair | Good |
| c | 0,0122 | 0,0235 | 0,0335 | 0,0054 | 0,0145 | 0,0195 |
| a | 0,7029 | 0,8731 | 0,9530 | 0,5375 | 0,7098 | 0,8070 |
| b | -0,3990 | -0,3990 | -0,3990 | -0,4497 | -0,4497 | -0,4497 |
| m | 60,4749 | 60,8146 | 61,3233 | 59,4551 | 60,3089 | 60,5940 |

According to the model, the participation rates associated to people who are part of the group with good health represent propensity to work because we assume that it contains no work-related disability (see the curve “Fitted good health” in figure 4). In order to find age-specific rates of ability to work, we first identified the age-specific level of ability to work for the groups with fair and poor health as prescribed by equation (2). The age-specific level of ability to work for the group with perfect health equals its health-prevalence, because everyone who is part of this group is supposed to be able to work. Summing up these three health-specific levels of ability to work weighted by their corresponding health frequencies provides age-specific rates of ability to work as described by equation (3).

According to equation (1), combining the set of rates of propensity to work (figure 4) to the one of ability to work (figure 5) allows to obtain total rates of participation. Figure 6 showcases the estimated as well as the observed total participation rates.

**Figure 5: Ability to work by age and sex, raw and fitted data**

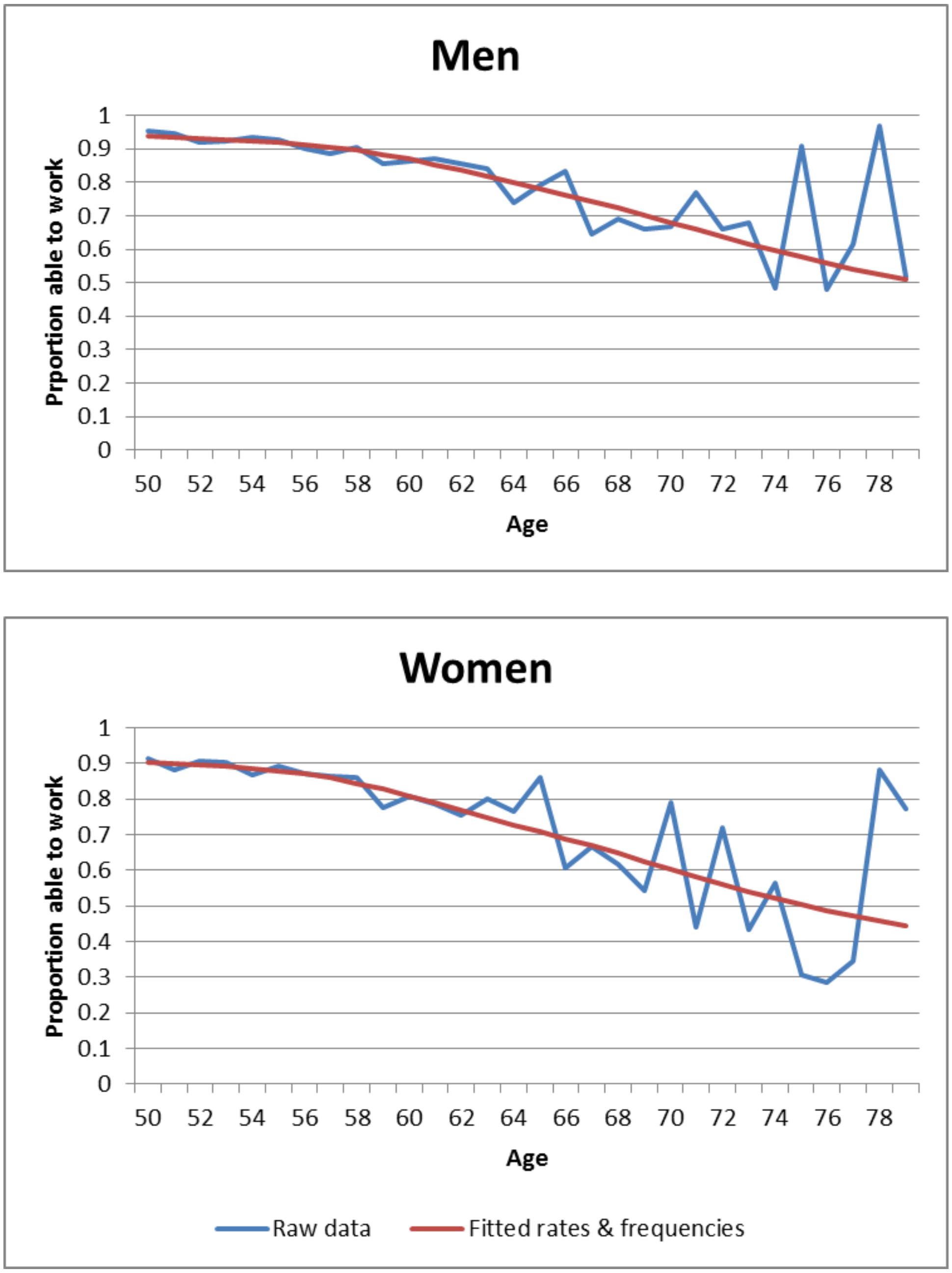
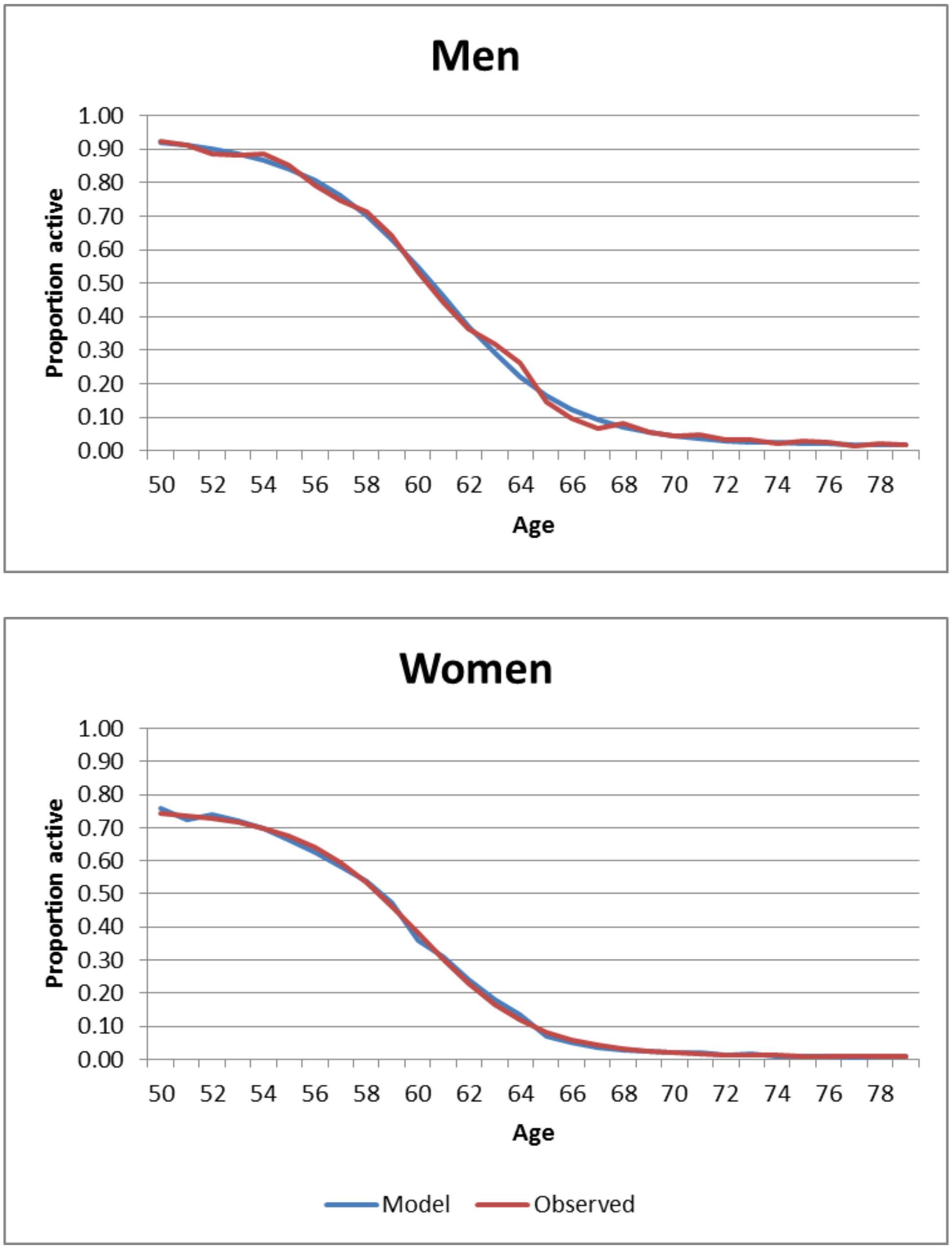


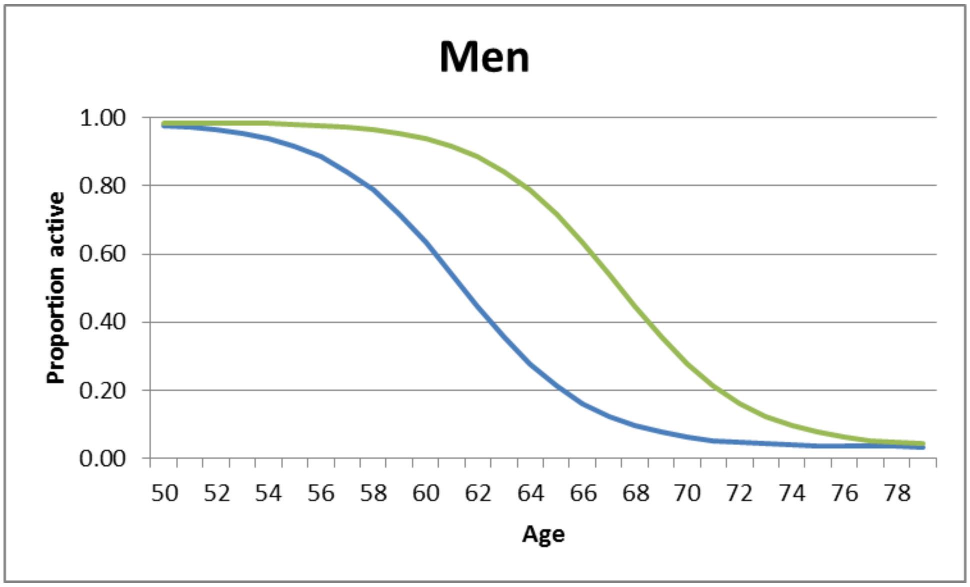
**Figure 6: Participation rates by year of age and sex as estimated following equation (1)**

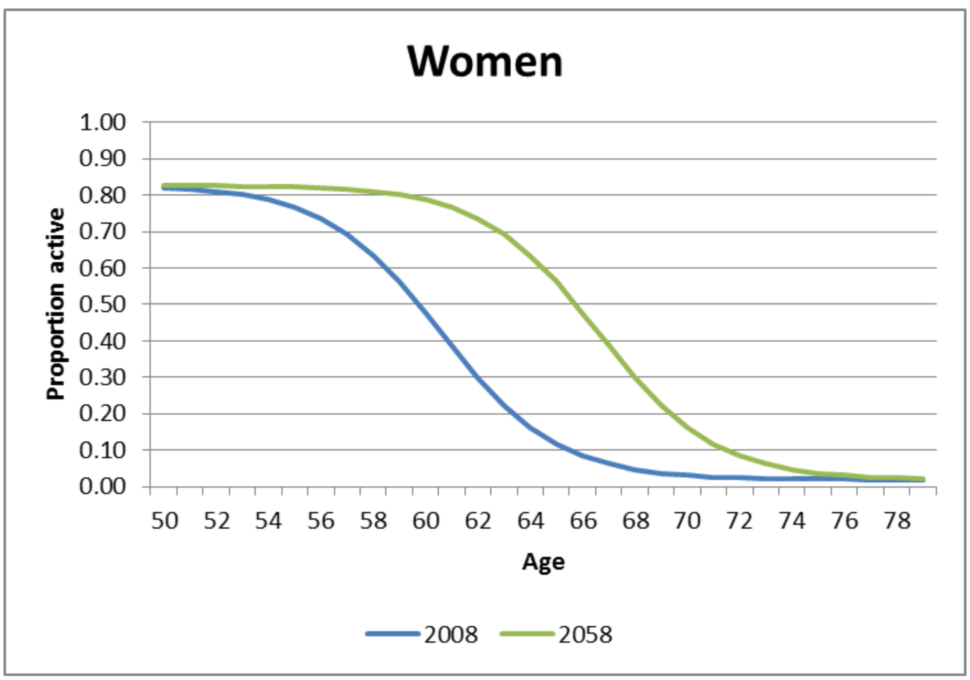



**Simulating changes in propensity to work and ability to work**

The aim of this paper is to provide insights into the extent to which declining ability to work at older ages could limit participation when age at retirement gets higher. Changes in the age at retirement will be captured by changes in the values of $P$, where the curve representing those values will move by a given number of years to the right. Additionally, while changes in the age at retirement occur, changes in ability to work and health are likely occur too. The present sub-section explains how changes in those two parameters are simulated.

**Figure 7: Propensity to work by year of age and sex, 2008 estimate and by 6 years postponed values**



*Changes in propensity to work*

Different countries have set up different strategies concerning the way they will prevent an unbalance between the number of contributors and recipients affecting their pension schemes. Different countries use mechanisms where the age at which people are entitled to pension benefits is planned to follow changes in life expectancy (OECD, 2011a). We present results supposing that propensity to work will raise by 6 years, which is the improvement in life expectancy at age 65 assumed by Eurostat in the high life expectancy variant of its population projection over the 50 years period comprised between 1 January 2008 (the middle point of the period covered by our data) and 1 January 2058. This means that 6 units are added to the value of *m* in the equation used to fit the participation rates for the group with perfect health (similar to equation 4). We assume that an increase in the age at which people can benefit from pension schemes will also affect the propensity to work at younger ages as it will increase the costs of early retirement. Figure 7 presents the estimated curves of propensity to work representing the changes in the age at retirement.

*Changes in ability to work*

As calculated above, age-related changes in ability to work are the result of changes in the health frequencies as well as in ability to work inside of the groups of poor and fair health (the good health group is assumed to have full ability through all ages). Changes through time for the first variable are simulated inducing a change in *m* in the equations modelling the health frequencies (table 2). Changes in the second one are simulated inducing a change in *m* in the equations modelling the health-specific rates of participation (table 3). Put differently, we can observe how rates of participation react to changes in our composite measure of health or to changes in health-specific ability to work, or to changes in both at the same time.

We choose to simulate changes in $A_x$ on basis of four scenarios that suppose different values for *m* either concerning the health frequencies or the health-specific participation rates. The first scenario is one where the *m* values are postponed following improvements in life expectancy at age 65 both concerning the health frequencies and the health-specific participation rates. This is our reference scenario because it is the scenario that provides changes in total participation that correspond to the expected 6 years change induced in the average age at retirement.

**Figure 8: Ability to work by year of age and sex, for three scenarios covering the 2008-2058 period**

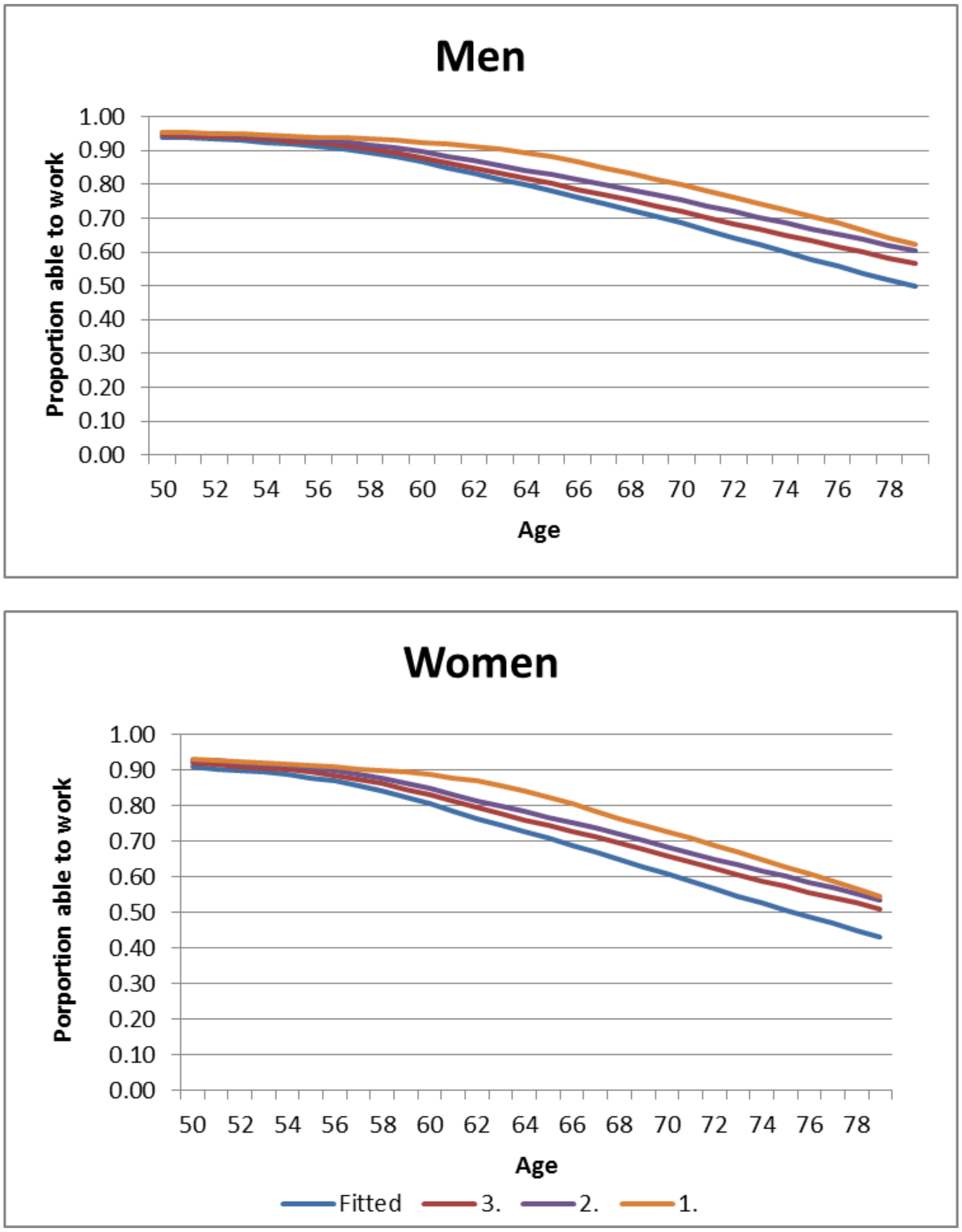
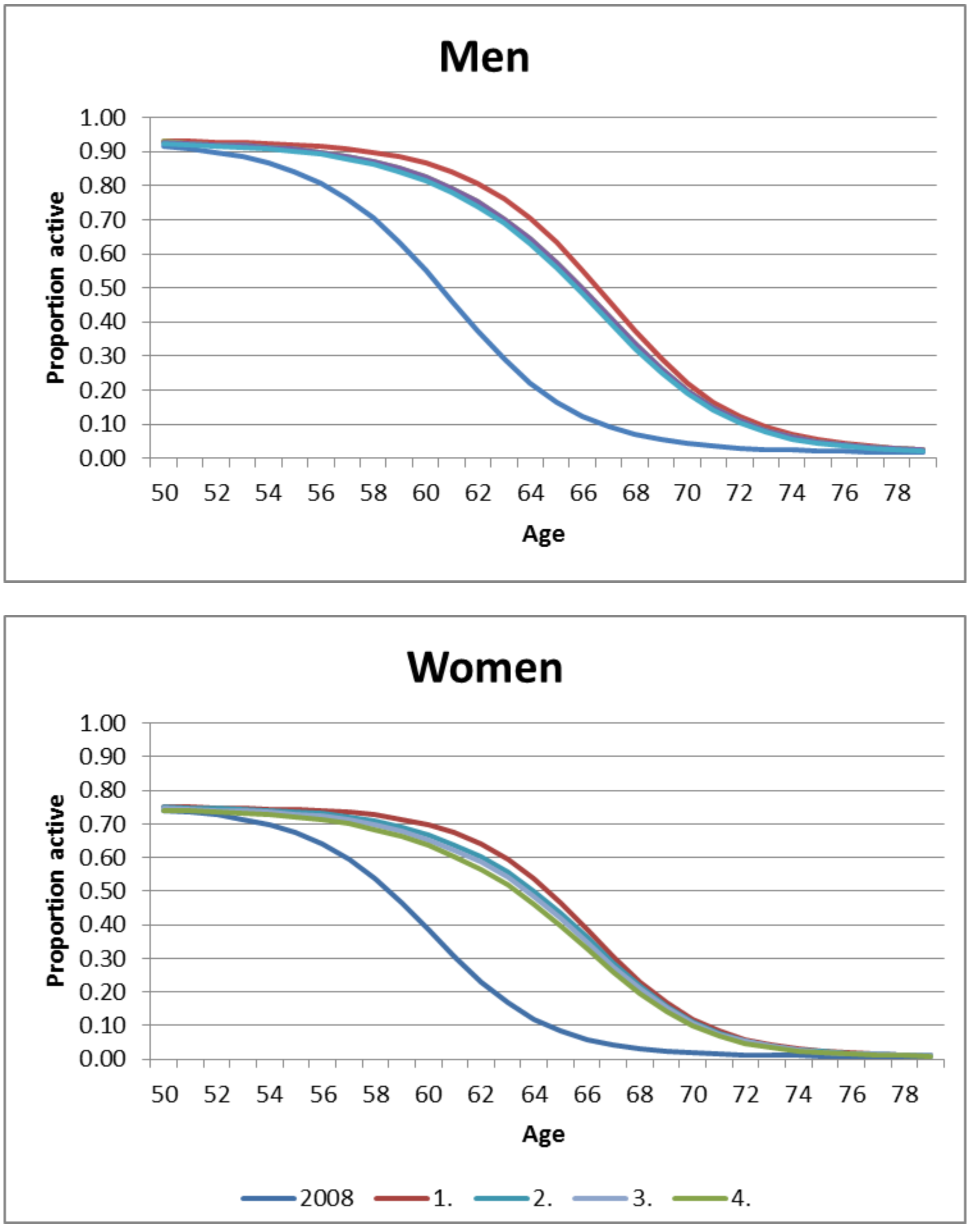


**Figure 9: Participation rates by year of age and sex, 2008 estimate and for four scenarios when propensity to work is postponed by 6 years**



The second scenario is one where only health improves at the same pace as life-expectancy, while ability to work inside of each health state stays constant. This is a scenario assuming that while health is improving, working settings make it harder for people with non-good health to stay on the labour market as they grow older.

The third scenario is one where only poor health is postponed by 6 years, while good health stays the same as estimated for the year 2008. This results in a raise in the prevalence of fair health, especially at older ages. This scenario corresponds to the situation observed by some authors where the onset of severe conditions is delayed while milder ones tend to be reported at a higher frequency over time (Jeune et al. 2008; Klijs 2012).

Finally, the fourth scenario will be one where neither health nor ability to work inside of health groups are changing. As a result, this is the scenario corresponding to our estimates for the year 2008 and will be used to assume constant ability to work through time.

Figure 8 presents the curves as estimated on base of the above mentioned assumptions. The combination of $A_{x,h}$ and $P_{x,h}$ provides total age-specific participation rates. The different sets of participation rates provided by the different scenarios are pictured in figure 9.

**The results**

Labour market participation varies strongly with age past age 50. The way it varies may however change through time. As an example, the rate of activity for men aged 55 years old reached 78.8 % in 2003 in Germany. In 2013, a similar rate of activity was reached at age 57,5 (Eurostat, 2015). As a result, a 57,5 years old man has in 2013 the characteristic that a 55 years old man had in 2003 as far as labour participation is concerned. The characteristics-based approach presented in Sanderson & Scherbov (2013) and applied in Sanderson & Scherbov (2014) makes use of characteristics to compare ageing between population sub-groups; here, we analogously use labour force participation as a characteristic to compare how a given population may age in the future.

Because the results are sensitive to the particular shape the participation curve has through years of age, we compare ageing through time referring to only one age in 2008. The reference age is the one at which 50% of people are still active on the labour market. Since there is no age at which everyone is active, we calculate this as a proportion of the 2008 sex-specific participation rates at age 50. As shown in Table 4, according to our estimates, 50% of men were still active in 2008 at age 61,0 and the same was the case at age 60,1 for women. Introducing changes in regulation that aim at having people postpone their retirement by 6 years will bring about an equivalent change in participation rates only if people's health and ability to work change accordingly. This is represented in Scenario 1, where 50% of men and women are still working exactly 6 years later. If ability to work inside of each health states stabilises over time while health improves (Scenario 2), the same figure is 0,3 points lower for both sexes. A failure in improving both ability to work inside of each health states and health over time (Scenarios 3 and 4) will result in reaching the 50% participation mark at even younger ages, although the differences are rather small.

**Table 4: Age at which 50% of people are still active on the labour market[4], according to different scenarios of health and health-specific ability to work, when age at retirement is postponed**

| **Sex** | **2008** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** |
|---|---|---|---|---|---|
| Men | 61,0 | 67,0 | 66,7 | 66,5 | 66,3 |
| Women | 60,1 | 66,1 | 65,8 | 65,6 | 65,4 |

**Discussion**

It is generally accepted that a higher age at retirement is both necessary and achievable in Europe. When assessing the levels participation could reach at older age when age at retirement is postponed, not much attention has been paid to the potential limiting effect of worsening health that affects people when they grow older. This paper first presented a simple population model that predicts variation in participation at older age using two terms representing ability to work on the one hand and propensity to work on the other hand. The model was fitted using survey information on age- and health-specific participation rates from the Survey on Health, Ageing and Retirement in Europe (SHARE) for three of the four waves comprised between the years 2004 and 2011 and for ten western European countries.

[4] Calculated as a proportion of people active at age 50 in 2008.

Changes in propensity to work were introduced supposing that they reflect possible changes in legislation around retirement. While incentives to work longer are greater, it may be the case that the interplay between people's health and the burden put on it by their work makes it impossible for them to keep on working. In order to explore the extent to which this reality can limit the anticipated effect of changes in legislation on participation at older ages, we built 4 scenarios containing different assumptions about how ability to work could evolve. The results were presented using Sanderson and Scherbov's (2013) characteristic-based approach where we compared how people may age in the future based on their behaviour concerning participation at older ages when age at retirement is postponed.

In light of our results, the extent to which poor health could limit participation at older age when age at retirement is postponed is rather small. This observation is best illustrated at hand of the results obtained through scenario 4. This scenario supposed that health as well as the ability to work inside of each level of health remained constant through time. This rather stringent assumption still allowed the participation-based age to grow by 5,3 years supposing a change in propensity to work of 6 years. This means that a 65 years old person will have the characteristics of someone aged at least 5,3 years younger nowadays when measures aiming at having people retire 6 years later are taken.

These results show that, among the model's two terms, propensity to work has a bigger impact on participation than ability to work has. This is at least the case if we consider a postponement of propensity to work by 6 years. This is due to the fact that ability to work, as modelled here, stays relatively high until fairly high ages. As a result, changes in regulation that aim at having people postpone their retirement in a small to moderate extent should have effects that are very close to the anticipated ones.

Bigger changes in propensity to work could have been considered, which would have allowed to witness a bigger limiting effect of total ability to work on participation. However, it has to be noted that our model is based on participating people. We saw that participation gets very low past age 65, and that the estimates become more and more erratic as we base them on older people. As a result, simulating a bigger change in propensity to work would have forced us to base our results on less reliable estimates, which we wanted to avoid. However, we suppose the time horizon covered by our analysis to offer sufficient insights for policy, as a raise of 6 years in the age at retirement could stretch out until 2058 if the measures are based on improvements in life expectancy at age 65 and if those are in line with Eurostat's high life expectancy scenario for population projections.

Our observations are based on a simple model that relies on differences in participation between people with different levels of health. Its validity is therefore dependent on whether those differences reflect people's actual propensity to work and ability to work. Propensity to work can be understood as the probability that someone who is healthy enough keeps on working instead of retiring. In the model, this behaviour was modelled assuming that people with the highest level of health (*i.e.* good health) were all healthy enough to work. This must however not be the case. There can be people among this group of health who actually needed to retire at some point because their health did not allow them to work anymore. Furthermore, the level of participation associated to this group is necessarily sensitive to its size, as a bigger group provides lower rates. As a result, slightly different results could be obtained basing the model on different methodological choices.

Ability to work, on the other hand, can be understood as the proportion of people that is able to work as measured based on the extent to which people with non-good health differed from people with good health in terms of participation. The age-related variation in ability to work was influenced by age-related changes in the measure of health (*i.e.* the speed at which people transit from one level of health to the other) and by the age-related changes in the relationship between the participation rates for people with non-good health and people with good health. Participation for people with non-good health declined faster than for people with good health mostly between age 55 and 75, which contributed to the decline in total ability to work to about the same extent as the changes in the size of the groups of health (results not presented).

We need to point out that assimilating the faster declining participation for people with non-good health to changes in ability to work comes down to assuming that differences in participation between groups of health are completely due to changes in ability to work. It may however be that those differences are due to lower propensity to work among people with non-good health. If this were the case, total ability to work would be higher and propensity to work lower. As a result, increased incentives to work at older ages would have a bigger influence and less disparity could be witnessed between the different scenarios.

While the values predicted by the model are subject to uncertainty, the model itself allows to have an overview of the mechanisms that would make work at ages older than those observed right now, impossible. In the terms of the model, that would be two things: first, a situation where big shares of people move to the non-good health states at ages shortly after the actual age at retirement; second, important differences in participation between groups of health which also grow as we consider older ages. As of right now, most measures of health do not showcase a dramatic drop in values before higher ages. Furthermore, even though its measurement is difficult and provides varying results, work-related disability remains relatively low between 50 and 65 years old. Estimates based on the proportion of people aged 50 to 64 years old receiving disability benefits provided figures varying between 1,7% and 15,6% in France and Sweden respectively (Börsch-Supan 2010). A dramatic increase of work-disability right after age 65 would be in contradiction with the most commonly used indicators of health. Furthermore, even though health may not be improving as fast as life-expectancy, it is also according to many measures not stagnating (Manton, 2008; Robine, 2009), which will provide more room for higher participation at older ages in the future.

The approach presented in this paper was to our knowledge a first attempt at quantifying ability to work for a given population and the way it affects total labour participation. The simple, transparent model that we presented can be replicated using different data sets that offer information on health and labour force participation. Another question that has not been assessed here concerns the extent to which ability to work and timing to retirement vary across people with different socio-economic statuses. Further research can assess the extent to which people with lower educational status—which typically have worse health and arguably occupy more challenging jobs—could be suffering a double disadvantage in terms of ability to work at older ages. In other words, it could be that some sub-groups are ageing faster than other in terms of labour force participation.

## References

Alavinia, S. and Burdorf, A. 2008. Unemployment and retirement and ill-health: a cross-sectional analysis across European countries. *International Archives of Occupational and Environmental Health* 82:39–45.

Bazzoli, GJ. 1985. The Early Retirement Decision: New Empirical Evidence on the Influence of Health. *The Journal of Human Resources* Vol. 20, No. 2, pp. 214-234.

Blöndal, S. and S. Scarpetta. 1998. The Retirement Decision in OECD Countries (OECD Economics Department Working Papers 202). doi: 10.1787/565174210530

Börsch-Supan, A. and H. Roth. 2010. Work disability and health over the life course. In *The Individual and the Welfare State: Life Histories in Europe*. ed. Börsch-Supan, A. et al. Springer, Berlin. Forthcoming

Börsch-Supan, A., A. Brugiavini, H. Jürges, J. Mackenbach, J. Siegrist and G. Weber. 2005. Health, ageing and retirement in Europe – First results from the Survey of Health, Ageing and Retirement in Europe. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).

Börsch-Supan, A. and H. Jürges (Eds.). 2005. The Survey of Health, Ageing and Retirement in Europe – Methodology. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).

Börsch-Supan, A., A. Brugiavini, H. Jürges, A. Kapteyn, J. Mackenbach, J. Siegrist and G. Weber. 2008. First results from the Survey of Health, Ageing and Retirement in Europe (2004-2007). Starting the longitudinal dimension. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S. and Zuber, S. 2013a. Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE). International Journal of Epidemiology DOI: 10.1093/ije/dyt088.

Börsch-Supan A., M. Brandt , H. Litwin and G. Weber (Eds). 2013b. Active ageing and solidarity between generations in Europe: First results from SHARE after the economic crisis. Berlin: De Gruyter.

Cooper, R. 2010. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. *BMJ* 2010;341:c4467

Eurostat. 2015. Active population by age, sex and nationality. Eurostat database. http://ec.europa.eu/eurostat/data/database. Updated on 31-03-2015.

Frederiksen, H., Gaist, D., Petersen, H.C., Hjelmborg, J., McGue, M., Vaupel, J.W. and K. Christensen. 2002. Hand-grip Strength: A phenotype suitable for identifying genetic variants affecting mid- and late-life physical functioning. *Genetic epidemiology* 23:110-122.

Gruber, J. and D. A. Wise. 1999. Social Security Programs and Retirement around the World. Chicago: University of Chicago Press.

Gruber, J. and D. A. Wise. 2004. Social Security Programs and Retirement around the World: Micro-Estimation. Chicago: University of Chicago Press.

Kalwij, A., Alessie, R. and M. Knoef. 2013. Pathways to retirement and mortality risk in the Netherlands. *European Journal of Population* 29:221-238.

Karpansalo, M., Manninen P., Kauhanen J., Lakka TA. and J.T. Salonen. 2004. Perceived health as a predictor of early retirement. *Scandinavian Journal of Work, Environment and Health* 30(4):287-292.

Klijs B., Mackenbach, J.P. and A.E. Kunst. 2010. Disability occurrence and proximity to death. *Disability and Rehabilitation* 32(21):1733-41.

Jeune B. and H. Brønnum-Hansen. 2008. Trends in health expectancy at age 65 for various health indicators, 1987–2005, Denmark. *European Journal of Ageing* 5:279–85.

Jürges, H, Avendano, M. and J.P. Mackenbach. 2008. Are different measures of self-rated health comparable? An assessment in five European countries. *European Journal of Epidemiology* 23:773–781

Lindeboom, M. and M. Kerkhofs. 2009. Health and Work of the elderly: Subjective Health Measures, Reporting Errors and Endogeneity in the Relationship between Health and Work. *Journal of Applied Econometrics* 24: 1024-1046.

Malter, F. and Börsch-Supan, A.(Eds.) 2013. SHARE Wave 4: Innovations & Methodology. Munich: MEA, Max Planck Institute for Social Law and Social Policy.

Manton, K.G. 2008. Recent declines in chronic disability in the elderly US population: risk factors and future dynamics. *Annual Review of Public Health* 29 : 91–113.

Microsoft. 2010. Microsoft Excel [computer software]. Redmond, Washington: Microsoft.

OECD. 2005. Pensions at a glance: Public Policies Across OECD Countries [electronic resource]. Paris: Organisation for Economic Cooperation and Development. ISBN 92-64-01871-9 – No. 53769 2005
OECD. 2010. Sickness, Disability and Work: Breaking the barriers. *OECD Publishing*, Paris.
OECD. 2011a. "Linking Pensions to Life Expectancy", in Pensions at a Glance 2011: Retirement-income Systems in OECD and G20 Countries, OECD Publishing.
OECD. 2011b. Pensions at a glance 2011: Retirement-income systems in OECD and G20 countries [electronic resource]. Paris: Organisation for Economic Cooperation and Development. Dois: 10.1787/pension_glance-2011-en.
OECD. 2013. Pensions at a Glance 2013: OECD and G20 Indicators, OECD Publishing. http://dx.doi.org/10.1787/pension_glance-2013-en
Robine, J.-M., Saito, Y. and C. Jagger. 2009. The relationship between longevity and healthy life expectancy. *Quality in Ageing* 10 (2) : 5-14.
Sanderson, W.C. and Scherbov, S. 2013. The characteristics approach to the measurement of population aging. *Population and Development Review* 39: 673–685.
Sanderson, WC. and Scherbov, S. 2014. Measuring the Speed of Aging across Population Subgroups. *PLoS ONE* 9(5): e96289. doi:10.1371/journal.pone.0096289
Scherbov, S., Sanderson, W.C. and M. Mamolo. 2014. Quantifying policy trade-offs to support aging populations. *Demographic Research* Volume 30 article 20, pp. 579-608.
Smith, P., Chen, C., Mustard, C., Bielecky, A. and D. Beaton. 2013. Examining the relationship between chronic conditions, multi-morbidity and labour market participation in Canada: 2000–2005. *Ageing and Society* Available on CJO 2013 doi:10.1017/S0144686X13000457
Vaupel, J. and E. Loichinger. 2006. Redistributing work in Aging Europe. *Science* 312: 1911-1913.
Wise, D.A. 2012. Social security and retirement around the world: Historical trends in mortality and health, employment, and disability insurance participation and reforms. Chicago: University of Chicago Press.
Zaidi, Asghar, Katrin Gasior, Maria M. Hofmarcher, Orsolya Lelkes, Bernd Marin, Ricardo Rodrigues, Andrea Schmidt, Pieter Vanhuysse and Eszter Zolyomi, 2013, Active Ageing Index 2012: Concept, Methodology and Final Results European center Vienna march 2013.

## Appendix A1: Frequencies for the composite measure of health

| **Men** | | | |
|---|---|---|---|
| | Hand-grip strength | | |
| Self-assessed health | Group 1 | Group 2 | Group 3 |
| Excellent or Very Good | 4 755 | 4 669 | 1 768 |
| Good | 4 376 | 5 798 | 3 229 |
| Fair or poor | 1 957 | 3 536 | 3 988 |

| **Women** | | | |
|---|---|---|---|
| | Hand-grip strength | | |
| Self-assessed health | Group 1 | Group 2 | Group 3 |
| Excellent or Very Good | 4 692 | 5 220 | 1 936 |
| Good | 4 686 | 6 815 | 4 070 |
| Fair or poor | 2 049 | 4 255 | 6 272 |

In response to population ageing, new policies have been introduced in many European countries to incite workers to retire at older ages. However, a certain proportion of older workers already do not reach the official age at retirement because of poor health. Considering that health worsens with age, we ask to which extent the efficiency of the new policies can be dampened by poor health. We propose a simple population model that captures the interaction between work, retirement and ability to work and which parameters are estimated on basis of information on health and labour force participation contained in the Survey on Health, Ageing and Retirement in Europe (SHARE). Changes in the model's parameters are introduced in order to simulate different levels of health and of ability to work when age at retirement is postponed. The outcome are different sets of age-specific participation rates and the results are presented drawing on Sanderson and Scherbov's characteristics-based approach using participation as a characteristic. A small limiting effect of health on the levels of participation is found when age at retirement is postponed, suggesting that health should not be a hurdle to higher participation at older ages in the context of policy changes pursuing a moderate postponement of retirement.

The Netherlands Interdisciplinary Demographic Institute (NIDI) is an institute for the scientific study of population. NIDI research aims to contribute to the description, analysis and explanation of demographic trends in the past, present and future, both on a national and an international scale. The determants and social consequences of these trends are also studied.

NIDI is a research institute of the Royal Academy of Arts and Sciences (KNAW).