On the impact of indexation and demographic ageing on inequality among pensioners

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On the impact of indexation and demographic ageing on inequality among pensioners

Validating MIDAS Belgium using a stylized model.

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1. Introduction

A common criticism on dynamic microsimulation models is that they are a ´black box´. These models are usually very complex and include many different processes. This, and the many individual interactions, makes it very difficult to validate the model, and specifically to see which procedures underly the observed simulation results. One way to reduce the black box obviously is to assess the consequences of separate routines by comparing the simulation results from the base variant with simulation results that arise when this specific routine is excluded from the model. This approach however has several problems. First of all, a typical dynamic microsimulation model has many routines, so producing and comparing all these partial analyses would not only take an enormeous amount of time, but would also even add to the confusion, for it would be impossible to keep an overview. Next, running the model while keeping some routines out is not always possible. This is typically the case with the more fundamental routines pertaining to demographic ageing. Finally, as there are many higher-order effects and interactions, blocking one specific routine would alter the impact of other routines, and a partial analysis could go on *ad infinitum*.

This paper is a follow-up to the session on model validation "would you trust this model?" during the 2nd IMA conference in Ottawa. It proposes another strategy to reduce the black box problem of dynamic microsimulation models. The starting point is Morrison´s (2007, 5) definition of validation, being "the comparison of the model's results to counterpart values that are known or believed to be correct, or that are consistent with one's assumptions, [or] other trustworthy models' results". Our strategy is to select and use simple standard simulation models to simulate the same phenomena as the MSM does. This way, one can explain some general simulation results of the latter by making a reference to the former. The standard simulation model should obviously meet some demands in order for it to be as complementary as possible with a dynamic MSM. First of all, it needs to be simple, in order to avoid one black box being replaced by another. Secondly, it needs to simulate relevant processes; a standard simulation model that shows the impact of meteorological conditions on the price of chicken food is not very relevant when one wants to explain the simulation results of a dynamic MSM on social security. Third, the standard simulation model needs to be flexible in that it can show the impact of as many phenomenae as possible, while starting from a very simple, even basic, setup. Fourth and finally, the standard simulation by itself needs to be credible, because this credibility is used to reduce the black box property of the MSM.

As an example, the discussion of the simulation results of the Belgian version of the MIDAS model (Dekkers et al. 2009, idem 2010) hinges on the relation between demographic ageing, the indexation of pensions to the development of wages, and inequality of pensions and the poverty risk among pensioners. For the reasons discussed above, these claims were not substantiated in the paper. The remainder of this paper proposes a simple model that will be used to show some general relations between indexation, retirement age, demographic ageing and the inequality of pensions. The conclusions drawn from this model certainly will not be surprising for those developing dynamic MSMs. But the purpose of the model exactly is to show that a simple model can be used to draw strong and general conclusions. This model then can be used to back up the key simulation result from the dynamic MSM MIDAS, being the inequality of pension benefits.

2. The base model

Suppose a basic model, in real terms, where there are a 100 individuals in time $t \geq 0$, each of a different age (so, $age_t=[0,\ldots, 100]$, $\forall$ $t=[0, \ldots, 100]$.

Next, assume that everybody retires at 60 and dies at 100, and assume furthermore that the pension benefit at 60 equals € 100. Finally, suppose that pensions lag behind the development of wages with a constant fraction Ψ. In real terms, this means that pensions decrease with a rate Ψ with increasing age at any t. So in the starting year 0, pension benefits $p_{0,age}$ equal $100(1-\Psi)^{age-60}$, and pensions at time $t>0$ then amount to

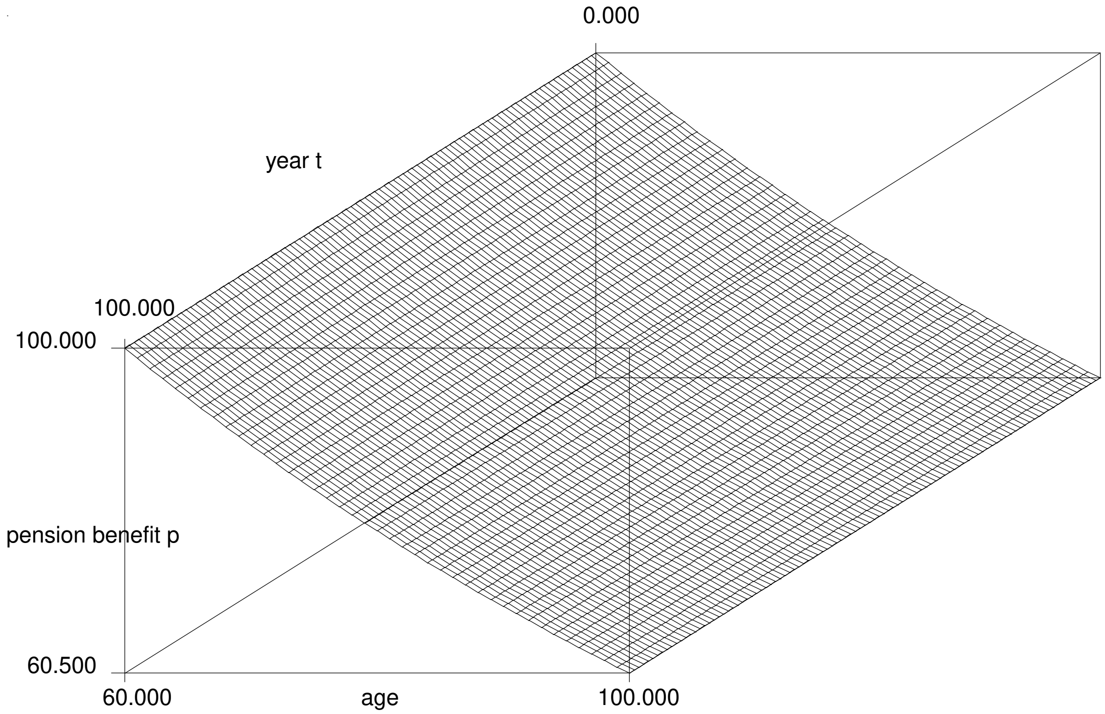
$$P_{t,age}=\begin{cases} p_0(1-\psi)^{(t)}, & if \quad age_0 > 60) \\ 100(1-\psi)^{(t)-(60-age_0)}, & if \quad age_0 < 60 \,\&\, age \geq 60) \end{cases} \qquad (1)$$

And $age_t=age_0+t$. The condition $age_t \leq 100$ $\forall$ t applies to all equations, and is therefore left out. The first line of (1) describes those that are retired in the starting year, and the second line describes the pension benefit of those that retire between 2000 and t.

The below Figure 1 plots the pension benefits $P_{t,age}$ for a situation where Ψ equals 1.25%. The pension benefit obviously decreases with age, but as the age distribution itself remains constant over time, the results are time-independent.

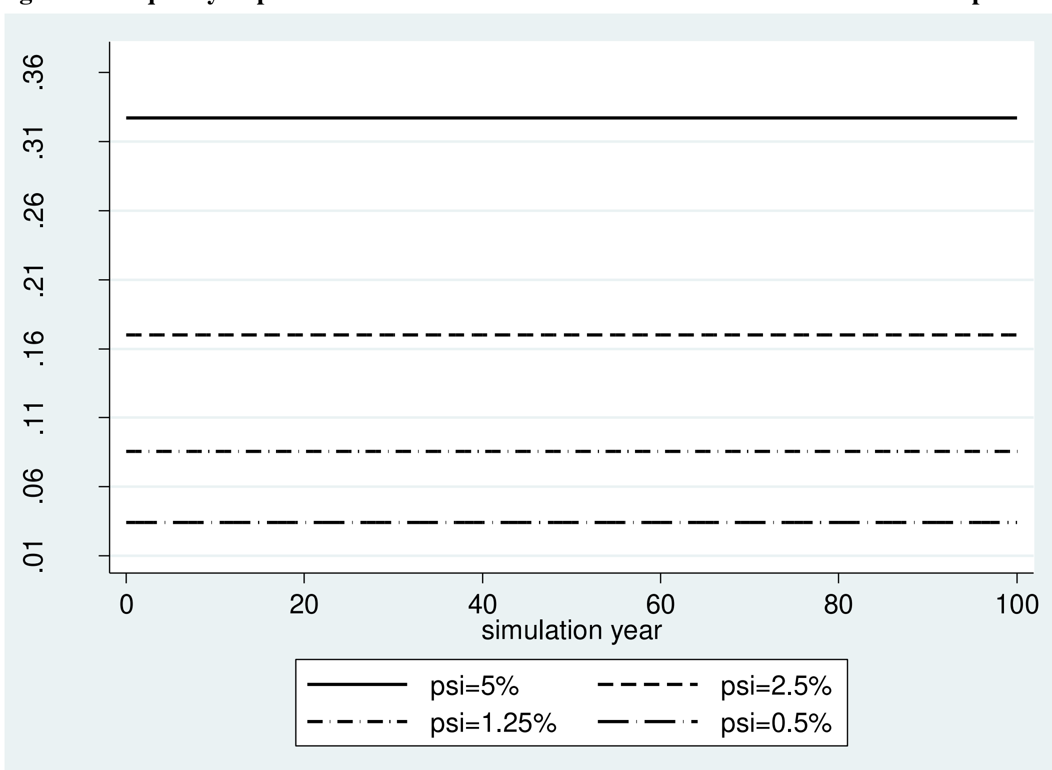
Hence, this simple model results in inequality being constant over time, and increasing with an increasing value of the parameter Ψ. The below Figure 2 shows the level of inequality of pensions in this base model for various values of the indexation parameter Ψ. The higher this parameter, i.e. the more benefits of those in retirement lag behind the development of wages over time, the more the benefit of older pensioners decreases; not in amounts but in real terms, and the higher income inequality will be. Indeed, a value of Ψ=5% results in the gini being equal to 33%; a more realistic value of Ψ equal to 1.25% still causes the Gini to be equal to 8.55%.

Figure 1: base model (Ψ=1.25%)



Source: own calculations

Figure 2: inequality of pensions in the base model for various values of the indexation parameter Ψ.



Source: own calculations

Next, we discuss various extensions of this simple model. First, the impact of an intertemporal change of the indexation parameter Ψ will be discussed, in combination with changes of the retirement age. Third, the impact of two driving forces behind demographic ageing will be considered separately as well as jointly.

3. Changes of the indexation of pensions, and the impact of the retirement age

A first extension of the model is to allow for intertemporal one-shot changes of the lag-parameter Ψ. The Belgian case shows that this is a relevant extension. The Ageing Working Group (EC, 2007, Table 3.1, p. 53) assumes in its projections on the financial sustainability of pensions in Belgium that pension benefits lag with 1.25% behind the development of wages. Fasquelle et al. (2008: 2) show that this lag was on average 1.8 percent between 1956 and 2002. This difference implies a reinforcement of the future link between wages and pension benefits. What will be the impact of this reinforcement on inequality? Suppose that the lag parameter changes from Ψ_1 to Ψ_2 in the period *cht*, with 0<*cht*<100. The pension benefit of an individual of age in year t equals

$$P_{t,age}=$$

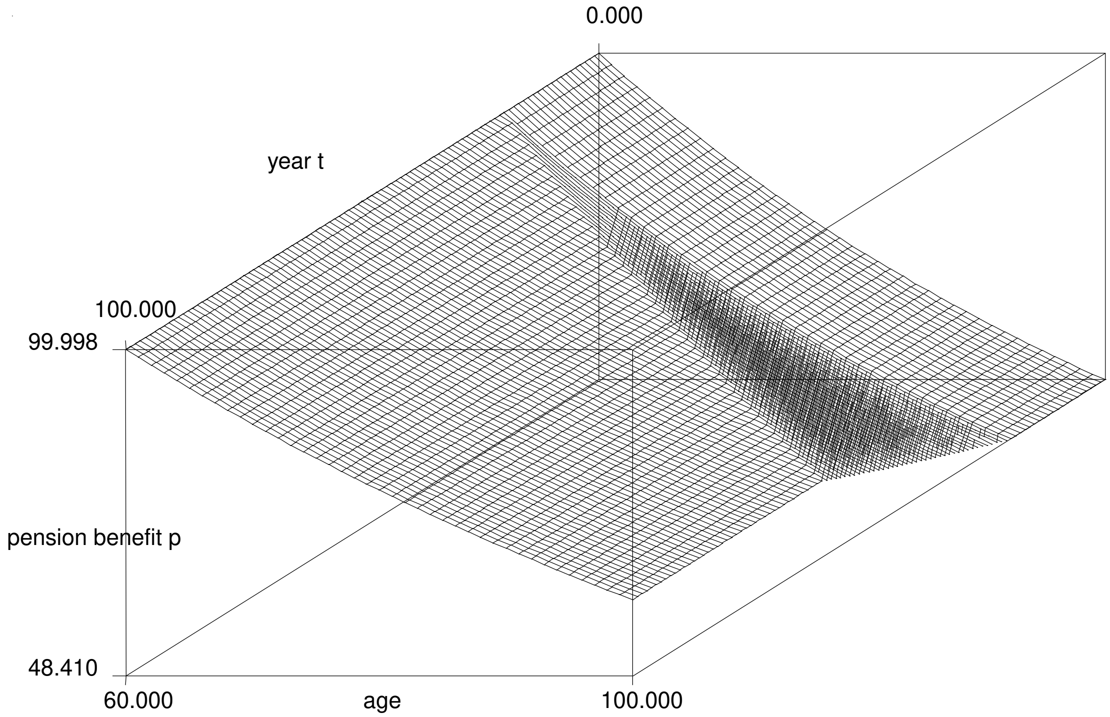
$$\begin{cases} p_0(1-\psi_1)^{(t)}, & \text{if} \quad (age_0 > 60)\ \&\ (t < cht) \\ p_0(1-\psi_1)^{(cht)}(1-\psi_2)^{(t-cht)}, & \text{if} \quad (age_0 > 60)\ \&\ (t \geq cht) \\ 100(1-\psi_1)^{(t)-(60-age_0)}, & \text{if} \quad (age_0 < 60)\ \&\ (age \geq 60)\ \&\ ((60-age_0) < cht)\ \&\ (t < cht) \\ \dfrac{100(1-\psi_1)^{(cht)}(1-\psi_2)^{(t-cht)}}{(1-\psi_1)^{(60-age_0)}}, & \text{if} \quad age_0 < 60\ \&\ age \geq 60)\ \&\ ((60-age_0) < cht)\ \&\ (t \geq cht) \\ 100(1-\psi_2)^{(t)-(60-age_0)}, & \text{if} \quad (age_0 < 60)\ \&\ (age \geq 60)\ \&\ ((60-age_0) \geq cht)\ \&\ (t \geq cht) \end{cases}$$

(2)

The first and third lines of equation (2) are simple replications of (1) and pertain to the years before the change of Ψ in *cht*. The second line describes the situation where the lag variable changes for those that were retired in the starting year. The fourth line describes the pension benefit at time t of someone who retires after the starting year, but before the year cht in which Ψ changes. Finally, the fifth line reflects the situation of someone who retires after *cht*.

What happens when Ψ decreases from 1.8 to 1.25 in *cht*=20? The

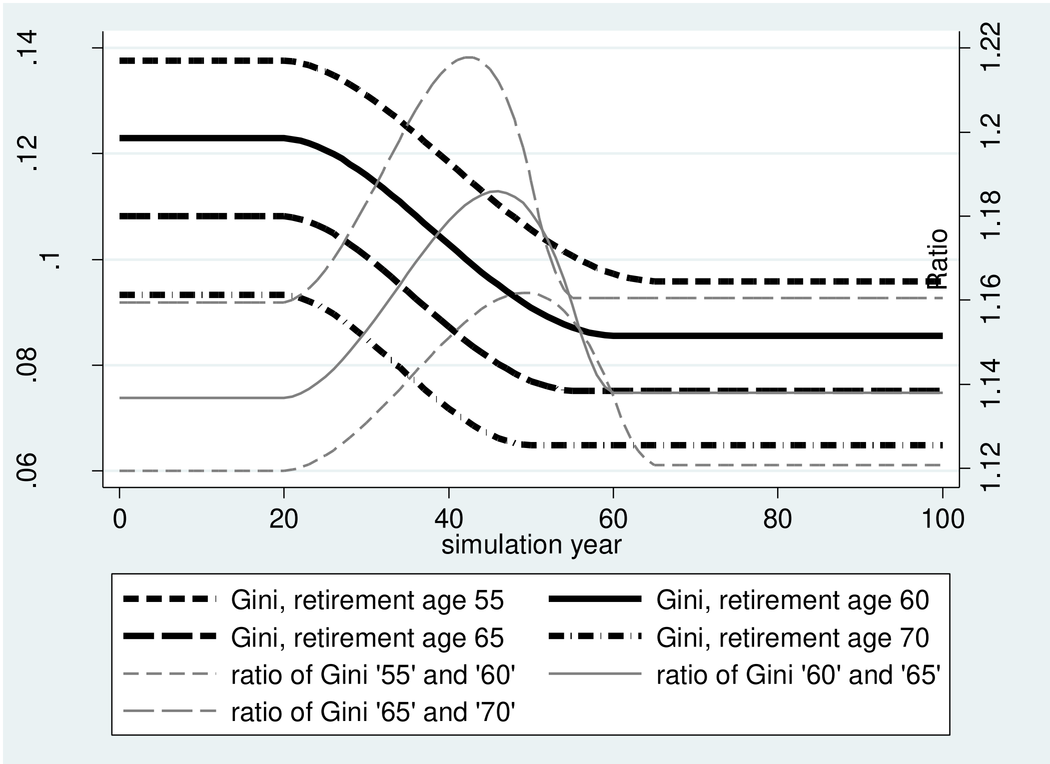
Figure 3: Ψ decreases from 1.8 to 1.25 in t=20



Source: own calculations

The pension benefit at death starts a gradual increase that Figure 3 at t=20, which depicts a situation where the lag between wages and pensions (i.e. the relative decrease of the latter over time) becomes smaller. The surface at that time starts to increase up the x-axis, meaning that the average pension at each age increases. Furthermore, the downward slope of the surface becomes smaller. The interpretation of this is that the relative decrease of the benefit of older retirees is slowed down as a result of strengthening the link between pensions and wages, not only relative to workers but also to younger retirees (who retired later). As a result, the inequality of pension benefits will gradually decrease. After a while, the individuals who have had their pension uprated under the weak linkage regime will decease, and the population of pensioners will increasingly consist of those that only have had their pensions indexed under the more generous regime. Hence, inequality will settle down at a lower level. This development is shown in Figure 4. For the time being, consider only the development of the Gini with retirement age 60 and the lag-parameter Ψ decreasing from 1.8 to 1.25 in t=20. This is the full line in Figure 4 that must be set against the left vertical axis. These results hence are equivalent to the results shown in Figure 3. The Gini starts off a bit higher than 0.12 and remains on that level until t=20, then a gradual decrease sets in, and inequality stabilizes again around t=60 at a level around .085. The transition phase is therefore 40 years and this obviously is equal to the (maximum) number of years that an individual is in retirement. This confirms that the new ‘steady state’ is reached when all individuals who have had their pension being uprated under the weak linkage will decease

Figure 4: the impact of a decrease of Ψ from 1.8 to 1.25 in t=20 on the inequality of pension benefits



Source: own calculations

The first conclusion from Figure 4 is that a strengthening of the link between wages and pension benefits will decrease inequality of pensions (and therefore inequality in general, and the risk of poverty).

The number of years that a typical individual is in retirement therefore sets the transition phase following a change of the indexation parameter. But let us look at this interaction of the retirement age and changes of the indexation parameter Ψ in more detail. First of all, the various dotted lines Figure 4 above show the impact of the indexation parameter when the typical individual does not retire at 60, but at 55, 65 or 70 years old. Given the value of the indexation parameter Ψ, the lower (higher) the retirement age, the higher (lower) inequality, because one receives the pension benefit for more years and the total lag ($\Psi^{(100\text{-age of retirement})}$) therefore increases (decreases).

The retirement age does not only affect the base-level of inequality, it also affects how fast the system reacts to changes of the indexation parameter Ψ. This is shown by the gray lines in Figure 4 that must be compared to the right vertical axis. The long-dotted line shows the ratio of inequality with retirement age 65 and 70; the full line shows the ratio of inequality with retirement age 60 and 65. Finally, the short-dotted line shows the ratio of inequality with retirement ages 55 and 60. The fact that the highest retirement ages results in the highest curve shows that the marginal impact of an increasing retirement age increases. Put differently, if the retirement age is low, then a change has a smaller impact on inequality as when the retirement age is high. The reason for this is that the numbers of years that one receives a pension benefit decreases with an increasing retirement age. An increase of the retirement age by one year hence has a proportionally stronger impact if one is closer to the age of death. Furthermore, the higher the retirement age, the faster inequality reacts to a change in the indexation parameter Ψ, and the sooner the impact wears off. A society with a low retirement age digests a change of the indexation parameter considerably more slowly.

4. Demographic ageing, indexation and inequality

The simple model described in the previous section shows the impact of indexation and the retirement age on the inequality of pensions. It does so assuming a situation of no demographic ageing. So inequality is a direct function of the distribution of the individual pension values:

$$Gini_t = F\{P_{t,60}, \quad \ldots \quad , P_{t,age>60}, \quad \ldots \quad , P_{t,100}\} \qquad (3)$$

Where F denotes the steps to derive the Gini out of the vector of pensions. The values of $P_{t,age}$ are again derived using equations (1) or (2). In this section, the retirement age is again equal to 60.

Now demographic ageing can be the result of past changes in the fertility rates, or by decreases of mortality rates, i.e. a continuous increase of life expectancy. If there has been and important but temporarily increase of the fertility rate in a certain period, then this will result in a 'baby boom generation', being some adjacent cohorts that are larger than the surrounding cohorts. A second process that can result in demographic ageing is a continuous increase of life expectancy. This model can mimic both processes and therefore simulate their impact on pension inequality.

4.1. Demographic ageing resulting from a 'baby boom generation'.

A first reason for demographic ageing is the existence of a 'baby boom generation', caused by past changes of the fertility rate. In the stylized context of our model, this can be reflected by a non-uniform distribution of age in the initial period 0. Equation (3) can be written as

$$F\{\Pi_t\} \text{with } \Pi_t = \begin{vmatrix} P_{t,60} & \ldots & P_{t,age>60} & \ldots & P_{t,100} \end{vmatrix} \text{ or}$$

$$\Pi_t = \begin{vmatrix} P_{t,60} & \ldots & P_{t,age>60} & \ldots & P_{t,100} \end{vmatrix} \begin{vmatrix} 1 & . & 0 & . & 0 \\ . & . & . & . & . \\ 0 & . & 1 & . & 0 \\ . & . & . & . & . \\ 0 & . & 0 & . & 1 \end{vmatrix} \qquad (3')$$

Then a simple extension of this model is to include the impact of ageing by introducing weights, as

$$Gini_t^W = F\left\{\Pi_t^W\right\}$$

And

$$\Pi_t^W = \begin{vmatrix} P_{t,60} & \dots & P_{t,age>60} & \dots & P_{t,100} \end{vmatrix} \begin{vmatrix} w_{t,60} & . & 0 & . & 0 \\ . & . & . & . & . \\ 0 & . & w_{t,age>60} & . & 0 \\ . & . & . & . & . \\ 0 & . & 0 & . & w_{t,100} \end{vmatrix} \qquad (4)$$

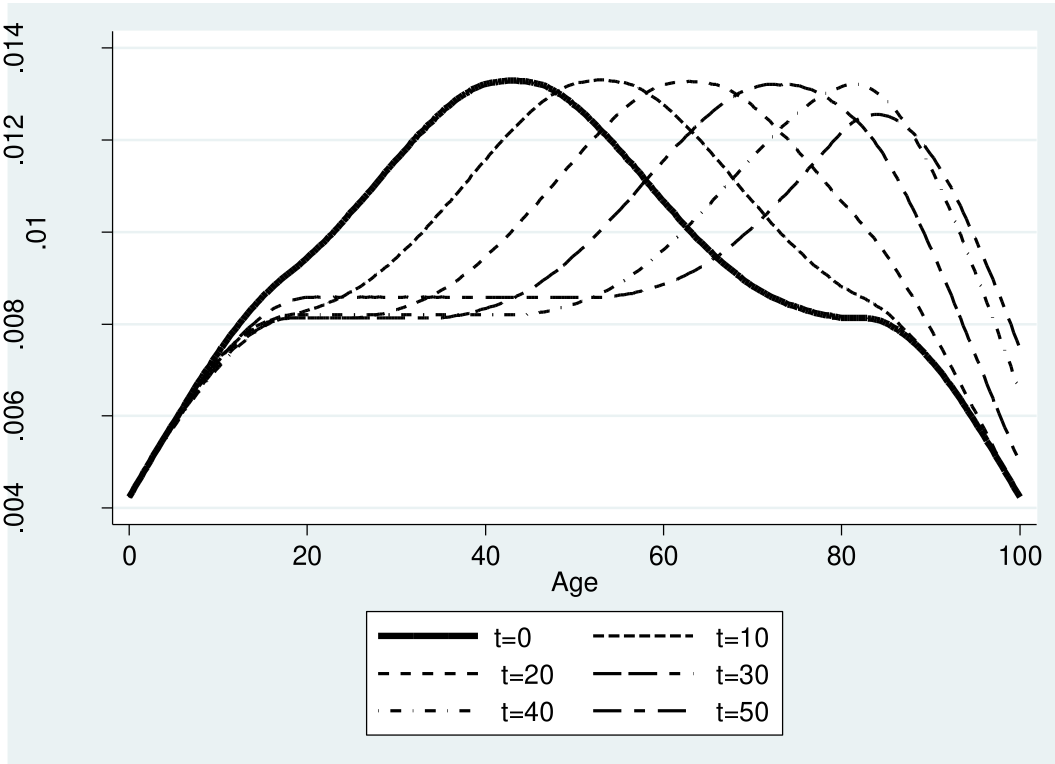
with $w_{0,age0}$=N(43,23) and $w_{t,age}=w_{0,(age-t)}$.

The variable $w_{t,age}$ is essentially a frequency weight used to change the proportional size of age-groups in order to reflect the impact of ageing. In the basic model, in real terms, there are 100 individuals in time t≥0, each of a different age (so, age_t=[0,…, 100], ∀ t=[0, …, 100]. Now we weigh this dataset in the starting year t=0 in such a way that the age distribution has mean 43 and standard error 23. These figures are derived from the Belgian PSBH dataset of 2002, used as the starting dataset of the MIDAS-model. These parameters however are only for purposes of discussion. The distribution of $w_{t,age}$ is for various years shown in Figure 5 and Figure 6. Demographic ageing is here represented as being the result of past changes in the fertility rates. There appears several adjacent ‘baby boom cohorts’ that are considerably larger than its surrounding cohorts.

The short run impact of ageing is shown in Figure 5[2]. The median of the distribution shifts to the right as the modal cohort becomes older. Furthermore, the distribution shifts to the right as the base situation (where all cohorts are of equal size) is restored. This is especially the case in the long run, as shown in Figure 6. Here, we see that the baby boom cohort shifts to the right even further. Once the right tail of the ‘bump’ reaches the age of decease (100), its size decreases and the flat part of the density function starts to increase. This reflects the situation that the baseline, where every cohort has the same size, is starting to be restored. In t=90, all members of the baby boom cohorts have deceased, and the population again is stable.

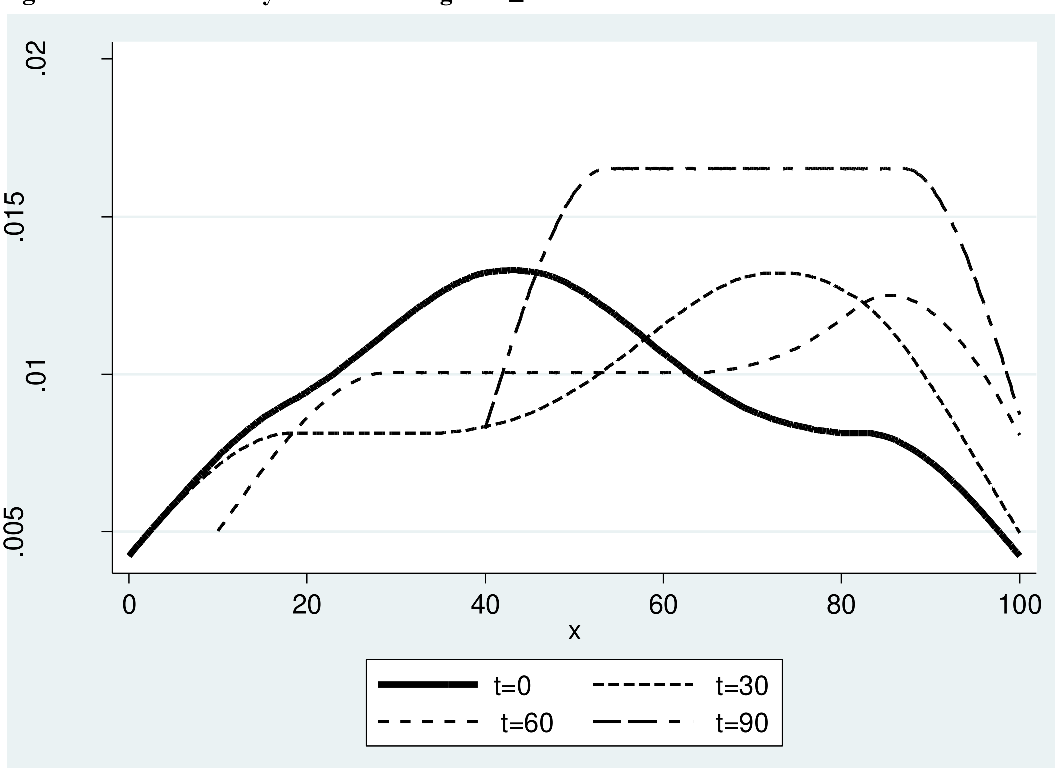
[2] Note that the KDE of $w_{0,age}$ does not fit a normal distribution. This is because in generating the weight, the corresponding ages were not bounded (i.e. they could be negative or more than 100), whereas the KDE’s shown in Figure 5 and Figure 6 are reflects the truncated distribution of age.

Figure 5: Kernel density estimator of age at t≤50



Source: PSBH, MIDAS starting dataset in 2002, and own calculations.

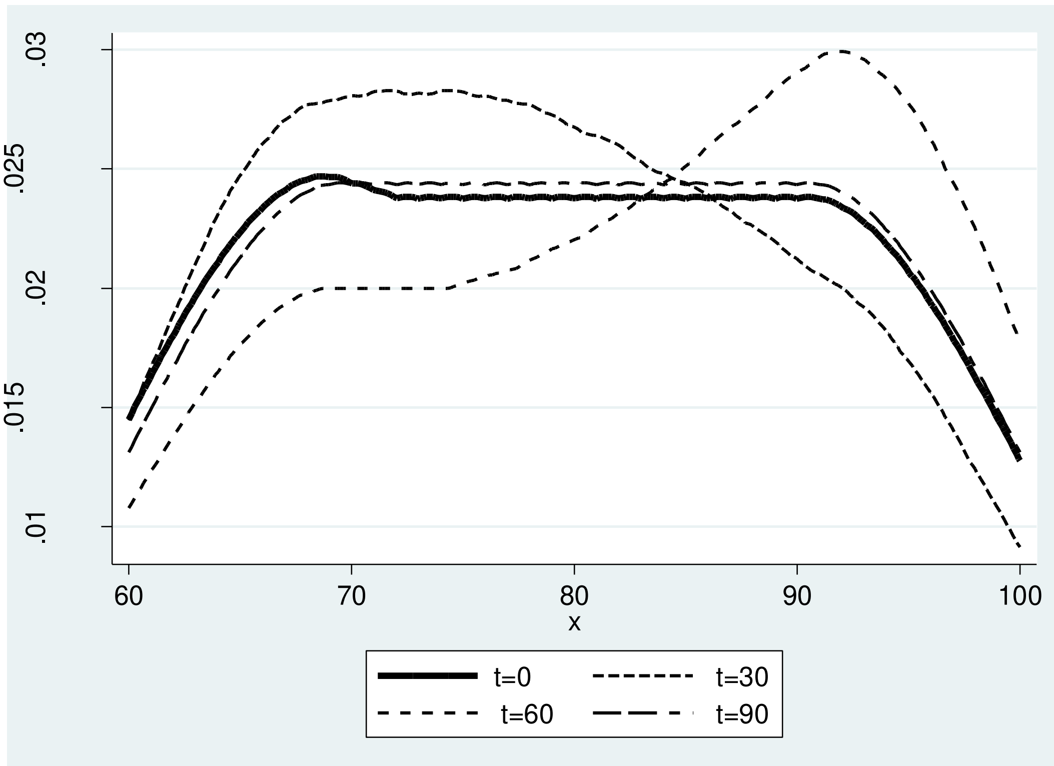
Figure 6: Kernel density estimator of age at t≤90



Source: PSBH, MIDAS starting dataset in 2002, and own calculations.

The below Figure 7 shows the densities of age > 60 for the same years as Figure 6.

Figure 7: Kernel density estimator of age ≥60 at t≤90



Source: own calculations

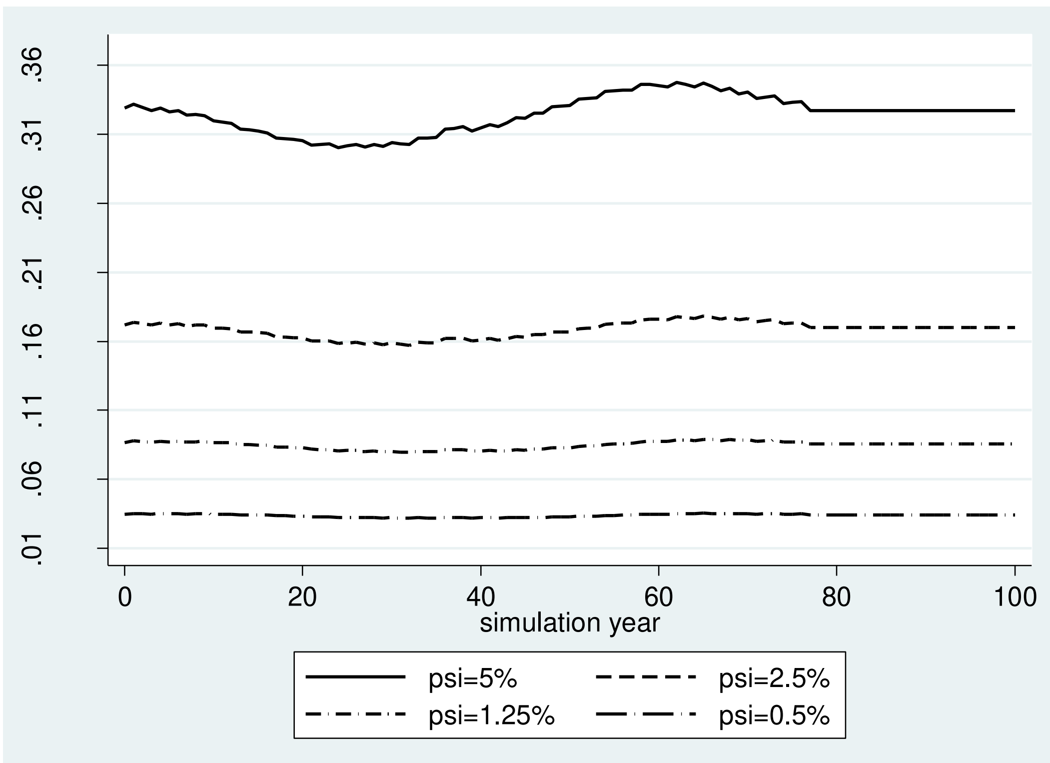
In the starting year, the modus of the age distribution is 43 and thus well below the retirement age of 60[3]. As a result, age is almost equally distributed in Figure 8, and there is only a small impact in the youngest ages. But as t increases, the oldest members of the baby boom cohorts enter into retirement. As a result, the frequency of youger ages increases at the expense of older ages (see the line of t=30 in Figure 7). Around t=17, the majority of the members of the 'baby boom' cohorts will have reached the retirement age. At this point, the frequency of older age groups increases at the expense of those of younger age groups (see the line of t=60). After that, as shown in previous graphs, the members of the baby boom cohorts decease, and the age distribution returns back to its normal, horizontal, shape (see the line of t=90), which is very close to the shape in the starting year.

Now what is the impact of introducing demographic ageing in our model? Figure 8 shows the impact using various values of Ψ, ranging from 5% to 0.5%. This figure confirms the conclusion from the first section of this paper, that inequality increases with the value of the lag. Secondly and not surprisingly, the impact of ageing increases with the size of the

[3] In this base situation, the average age of pensioners is obviously (100-60)/2 + 60=80.

lag. Indeed, when pensions increase by the same rate as wages (Ψ=0), then changes in the age distribution among the elderly has no impact on the distribution of pensions. The impact of ageing on inequality of pensions increases with the size of Ψ. The third conclusion is more surprising and is that the impact of this first type of demographic ageing appears limited. It is only when we apply a unrealistically high value for the lag (Ψ=2.5% or more) that a pattern emerges in the development of the Gini of pensions. This confirms Harding's (1993) conclusion that uprating to social policy hypotheses has a considerably stronger impact on pensions than ageing. Fourth and finally, demographic ageing caused by one baby boom cohort causes inequality of pensions to decrease at first, and then to increase, after which it returns to its stable level. This is because of the typical pattern pertaining to this type of ageing. In the starting year as well as t=90, age is nearly uniformly distributed, and inequality of pensions will therefore be on or close to its 'base situation value'.

Figure 8: the impact of ageing on pension inequality: changes of fertility rates



Source: own calculations

But as time goes by, the oldest members of the baby boom cohorts enter into retirement. As a result, the average age of pensioners will decrease, and this cet. par. will cause the inequality of pensions to decrease. Around t=17, the majority of the 'baby boom' will have reached the retirement age. At this point, the average age of the pension recipients will slowly start to increase –and so will inequality of pensions. This increase will continue until the last pensioners of the baby boom cohorts have deceased, and from that year on, inequality will settle down to its base value.

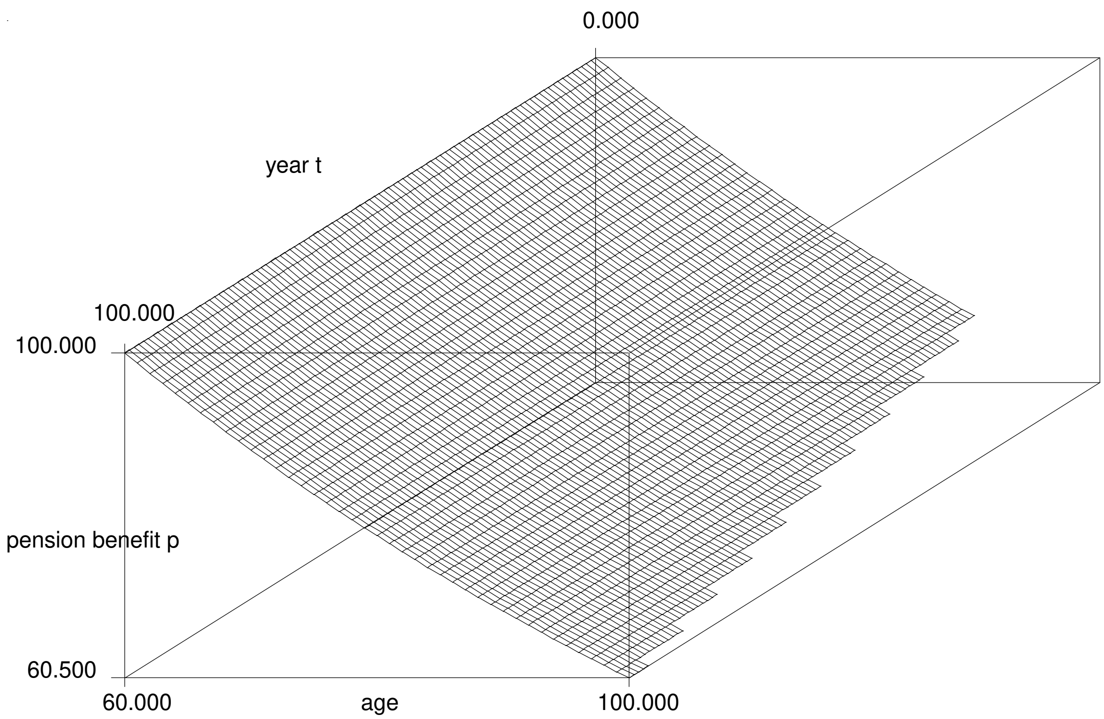
4.2. Demographic ageing resulting from a continuous increase in life expectancy.

This is a very simple extension of equation (3), where the ending age of 100 is replaced by a variable that depends on time

$$Gini_t = F\{P_{t,60}, \quad \dots \quad , P_{t,age>60}, \quad \dots \quad , P_{t,x}\} \qquad (5)$$

With x=g(t) $\forall$ t=[0, …, 100]. According to the most recent demographic projections, life expectancy at birth in Belgium will increase by 10.19 and 9.52 years over a period of 60 years (between 2000 and 2060) for men en women (see FPS Economy (2009)). This section shows the consequences of assuming that the age of death *x* increases by 10 years , from 90 in period 0 to 100 in period 100. Hence, *x* in equation 5 equals [90+((100-90)/100)*t]. The next Figure 9 shows the impact on pensions, assuming again a constant indexation parameter Ψ of 1.25% throughout the simulation period.

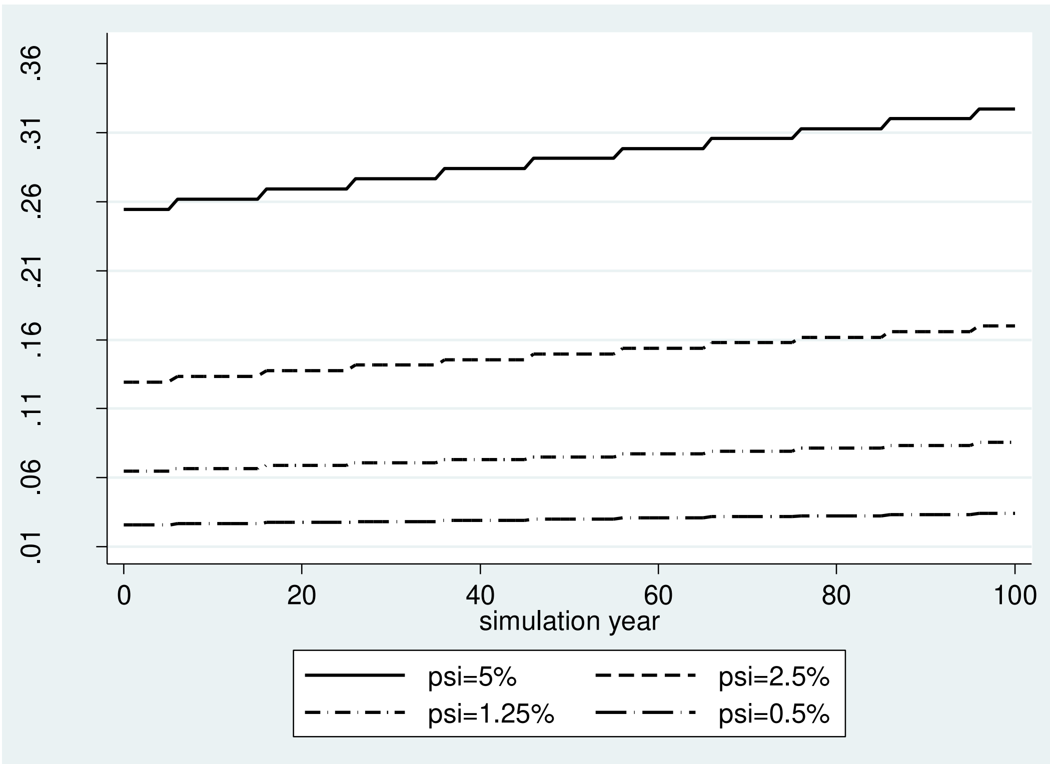
Figure 9: the impact of a continuous increase of life expectancy on pensions (Ψ=1.25%)



Source: own calculations

From period 0 on, the maximum age increases, so the south-east corner of the surface moves down (along the time-axis) and to the right (along the age-axis). Given the indexation parameter Ψ, the pension benefit at death decreases, and we can therefore expect the inequality of pensions to increase. This is confirmed by Figure 10 showing the positive impact of an increasing life-expectancy on income inequality[4]. This figure again confirms that a higher value of the indexation parameter Ψ obviously makes the inequality of pension benefits more vulnerable to changes in life-expectancy. In the extreme, when all pensions follow wages, the level of pensions will be independent of the age of the pensioner, and the inequality of pensions will be unaffected by whatever demographic change.

Figure 10: the impact of ageing on pension inequality: a continuous increase of life expectancy



Source: own calculations

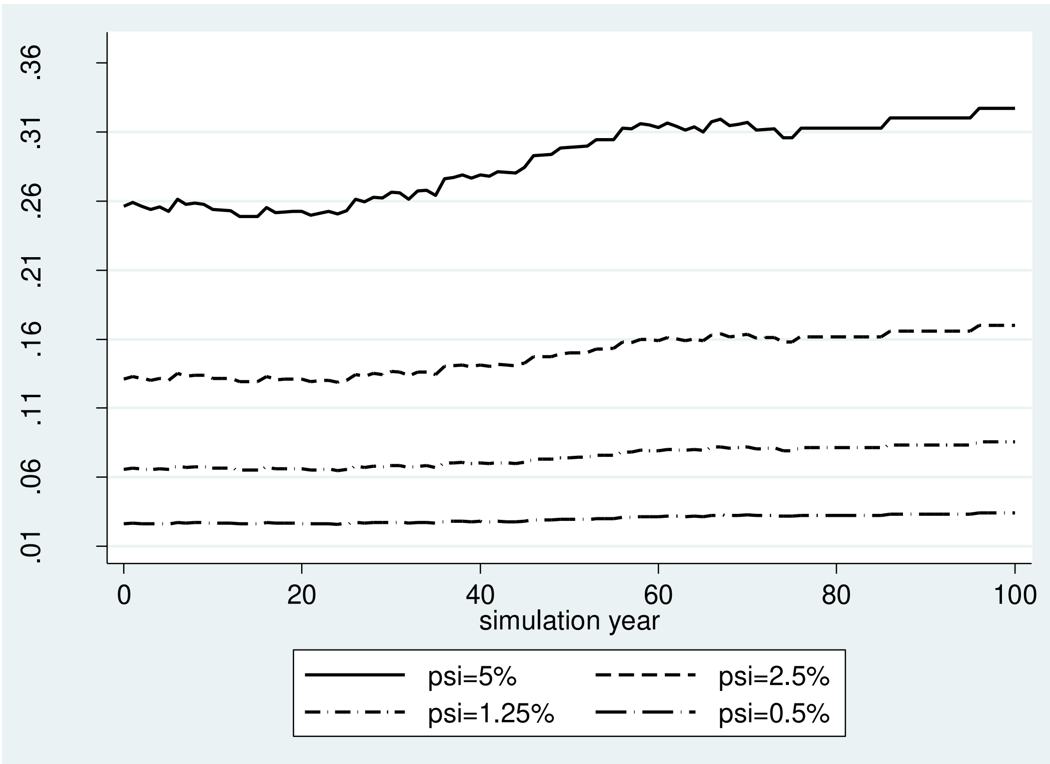
Hence, demographic ageing consists of two separate effects. First of all, there is ageing caused by past ruptures in the fertility rate. This causes some cohorts to be larger than others. Ageing occurs as such a large birth cohort becomes older. Secondly, ageing can occur through an increase of life-expectancy. The impact of the first underlying factor of demographic ageing on pension-inequality is ambiguous in that it depends on the median (or modal age group) of the distribution. In contrast, increasing life expectancy cet. par. has an unambiguously positive impact of the inequality of pensions. The Figure 11 below shows the combination of the two demographic phenomenae.

As in the previous figures, the baseline level of inequality increases with the indexation parameter Ψ. Equally obvious, the developments in Figure 11 are a combination of the results depicted in Figure 8 and Figure 9; the positive trend in inequality is caused by the

[4] Note that the simulation results of Figure 9 describe a situation where life expectancy gradually increases to 100, the level used in the previous simulations. Hence, the level of inequality in the last simulation year, t=100, equals that in the starting year in the previous Figure 7, given the level of Ψ.

development of life-expectancy, whereas the development of the babyboom generation through the various phases of retirement, causes the actual level of inequality to 'wobble' around this trend. At any moment in time, the actual level of inequality of pensions is therefore a function of the indexation parameter Ψ and demographic ageing. In this, the impact of the former is considerably more important in explaining the level of pension-inequality than the latter.

Figure 11: impact of ageing on pension inequality: the compound effect of fertility shock and increasing life expectancy

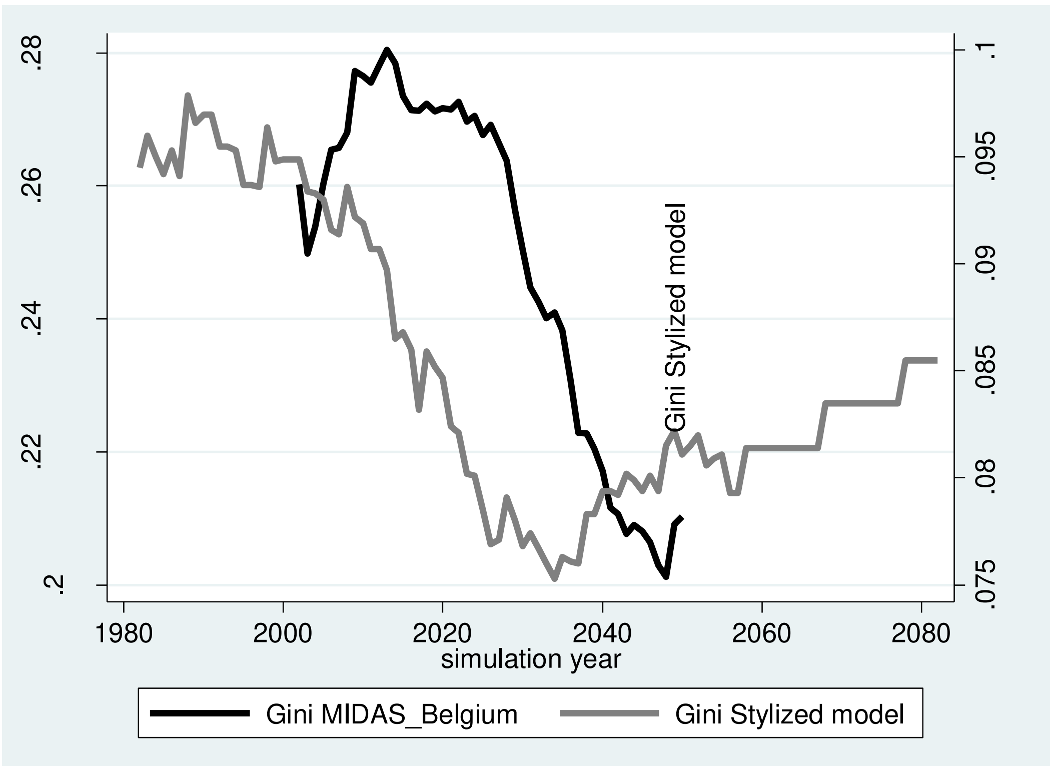


Source: own calculations

5. Validation of the Belgian MIDAS model

This section uses the stylized model presented in the previous sections to validate the simulation results from the Belgian version of the dynamic MSM MIDAS (henceforth MIDAS_BE). For a throughout discussion of MIDAS and its simulation results, please consult Dekkers et al., 2010. MIDAS is designed to simulate future developments of the adequacy of pensions in Italy, Germany and Belgium, following wherever possible the projections and assumptions of the AWG. MIDAS_BE starts from the PSBH cross-sectional dataset representing a population of all ages in 2002 (8,488 individuals). MIDAS consists of different modules, the demographic module, the labour market module and the pension module. The pension module of MIDAS_BE simulates first-pillar old-age pension benefits for private sector employees, civil servants and self employed. Furthermore, it simulates the Conventional Early Retirements (CELS) benefit, the disability pension benefit for private sector employees, and –finally- the widow(er)s' pension benefit, again for private sector employees, civil servants as well as self employed. The results of the fertility and mortality routines in the demographic module of MIDAS are aligned to the demographic projections of the AWG.

Figure 12: Validation of the results of MIDAS_Belgium



Source: Dekkers et al., 2009, Figure 33, page 144, and own calculations.

The variants applied in the stylized model and discussed in previous sections of this paper, were chosen deliberately to fit the assumptions of MIDAS wherever possible. The age distribution of our stylized model had been based on the PSBH in 2002; the development of life expectancy cannot be based directly on the projections of MIDAS, but a reasonable increase of 10 years has been chosen. Furthermore, the AWG assumes a lag of ongoing pensions of 1.25% per year from 2002 onwards, whereas Fasquelle et al. (2008: 2) show that this lag was on average 1.8 percent between 1956 and 2002. As the stylized model simulates the same decrease in period *cht*=20, the starting year in the above

Figure 1 is set to 1982 so that *cht*=20 coincides with 2002.

The gini of equivalent total pension benefit generated by MIDAS_Be (from now on referred to as 'the MIDAS series') is the black line and should be compared to the left scale. It is equal to the inequality of pensions depicted in Figure 33 of Dekkers et al., 2009. The gini of pensions generated by the simple, stylized model (henceforth 'the stylized model series'), is simulated taking into account both types of ageing (weighting of the age-groups and an increase of life expectancy of 10 years over 100 simulation years), a decrease of Ψ from 1.8 to 1.25% and, finally, a retirement age of 60. The gini resulting from this 'full' version of the stylized model is the gray line in the above Figure 12 and should be compared to the right scale.

Obviously is the level of inequality from MIDAS_BE considerably higher than inequality simulated by the stylized model, because the latter ignores the impact of all incomes other than pensions and parameters other than the indexation and the age of the pensioner. Even though the level differs considerably, the development of both series is comparable. Furthermore, the proportional difference of both axes is comparable[5]. The most important difference is that it appears that the stylized model series from the stylized model precedes the MIDAS-series with roughly 20 years. The decrease of the MIDAS series itself is validated by the stylized model series, so remains to explain why the former follows the latter with such delay.

There are various possible explanations for this 'delay' in the MIDAS-series. First of all, the stylized model assumes fully equal earnings, causing all pensions to be equal to 100 euro in the year of retirement. This assumption of fully equal earnings is of course relaxed by the MIDAS model. Even though toned down by the redistributive elements in the pension system, the increasing development of earnings inequality from about 2005 on causes the inequality of pensions to increase over time as well. This effect is reinforced by an increase of the annual productivity growth rate from 1.5 to 1.8 in 2010 (see Dekkers et al.. 2009, section 4.3.1., page 101). A second reason is that the stylized model is affected by a few parameters, among which the indexation parameter Ψ is the most important. In contrast, the Belgian version of MIDAS includes other parameters (op. cit., section 4.3.1., page 101), linking the development of ceilings, floors and minimum pensions to the development of wages. Third, inequality of pensions in the latter model is based on equivalent household income, meaning that changes in the size and composition of the households in the sample affect the simulation results. Fourth, the pension module of MIDAS_BE not only includes employees' pension benefits, but also civil servants' pension benefits, early retirement benefits and minimum pension benefits. The indexation regime linking the development of these benefits to that of wages differs from the employees' pensions' indexation regime.

In short are the simulation results in MIDAS_BE a composite of many different pension types, indexation regimes and various other effects and changes, most of them unrelated to the change of the indexation parameter of employees' pensions. It therefore is not

[5] The proportional distance of the axis for the MIDAS-series is 0.2/0.28=0.714 versus 0.075/0.1=0.75 for the stylized model series.

surprising that the simulation results of MIDAS_BE react more sluggishly to the change of this indexation parameter than the stylized model does.

6. Conclusions

This paper presents a simple model that relates the indexation of pensions in conjunction with demographic ageing and the retirement age, to the development of inequality of pensions. This results in several conclusions. First, the more pensions lag with the development of wages, the higher inequality of pensions at any point in time. Furthermore, the higher the retirement age, the lower cet. par. the inequality of pensions. Third, the higher the retirement age, the faster inequality of pensions reacts to changes of the lag of pensions to the development of wages. Fourth, the two underlying causes of demographic ageing each have a different impact on the inequality of pensions. The impact of a baby boom generation on inequality is ambiguous and depends on the average age of this generation. If its members are young pensioners, inequality of pension benefits is reduced. As the members of the baby boom generation become older pensioners, inequality increases even slightly above its base level. The second cause for demographic ageing, an increasing life expectancy, has an unambiguous increasing impact on the inequality of pensions.

These findings obviously are not new. However, they are generated by a very rudimentary model; anyone can therefore see how the simulation results are generated and how the conclusions come about. Hence, there is no black box at all in this simple model, and the results can be used to validate and interpret trends in the results of dynamic MSMs in various countries. This would offer an effective way to counter the black box criticism.

The simulation results from the stylized model are then compared to the simulated prospective development of pensions' inequality in the MIDAS_Be model. The base level of inequality is obviously considerably different, and the simulation results of the latter react more sluggishly to the change of the indexation parameter than the former. But besides that, the developments of pension inequality in both models are remarkably comparable and the simulation results of the stylized model thus seem to validate the results of MIDAS_BE.

We believe that this stylized model, written in Stata, meets the demands of a model that can be used to validate dynamic MSMs. It is available upon request from the author and anyone is invited to adapt it to validate its own dynamic MSM.

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Appendix

To see the impact of a changing retirement age on inequality, we can use the fact that the maximal pension (of the youngest cohort of pensioners) is always 100, and that the pension benefit is a linear function of age at every t. So, inequality at every t is a linear function of the level of the lowest pension benefit present at every t, which is that of the 100-year-olds. So we look for $\left.\frac{\partial P_{t,age,RA}}{\partial RA}\right|_{age=100}$ where RA stands for Retirement Age.

This equation is the same as equation 1, but 60 as the retirement age is replaced by RA (Retirement Age).

$$P_{t,age} = 100(1-\psi)^{(t)-(RA-age_0)}, \quad if \quad age_0 < 60 \,\&\, age \geq 60)$$

Hence

$$\left.\frac{\partial P_{t,age,RA}}{\partial RA}\right|_{age=100} = -\ln(100(1-\psi)) \times 100(1-\psi)^{t-RA-100}\Big|_{age=100} \leq 0$$

So a higher the retirement age c.p. results in lower inequality. That the marginal impact of an increasing retirement age is positive. Put differently, if the retirement age is low, then a slight increase has a smaller impact on inequality as when the retirement age is high.

$$\left.\frac{\partial^2 P_{t,age,RA}}{\partial^2 RA}\right|_{age=100} = [\ln(100(1-\psi))]^2 \times 100(1-\psi)^{t-RA-100}\Big|_{age=100} \geq 0$$