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CHANGES IN THE INCOME DISTRIBUTION OF THE DUTCH ELDERLY BETWEEN 1989 AND 2020: A DYNAMIC MICROSIMULATION

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This paper analyzes the income distribution of the Dutch elderly using a microsimulation model. Microsimulation models allow for detailed estimates of the income distribution. Our model deviates from traditional models by explicitly considering the persistency and heteroskedasticity of real income shocks. In this way, modeling all underlying processes influencing household income becomes less necessary, which can improve the trade-off between refinement and tractability of microsimulation models. We show the results of three model specifications with different levels of refinement. The results are in line and indicate that between 2008 and 2020, the highest predicted annual growth among the elderly is for median-income households (about 1.2 percent). High-income households have a somewhat lower predicted growth (about 1.0 percent) and low-income households only have a predicted annual growth of 0.5 percent. Inequality therefore seems to increase in the lower part of the distribution, while it will probably decline in the upper part of the distribution.

JEL Codes: D31, J11, J14

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1. INTRODUCTION

In most developed countries the aging of the population places an increasing financial burden on society through pay-as-you-go financed social security, pension, health, and long-term care systems (OECD, 2011). Since the 1990s, social

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security programs and pension schemes in many developed countries are, therefore, being redesigned (e.g., Gruber and Wise, 2004).

Policies aimed at alleviating the costs related to the aging society can be based on the notion that the financial burden is shared between generations (see Bovenberg and Ter Rele, 2000; Van Ewijk *et al.*, 2006). Alternatively or at the same time, one could call upon intragenerational solidarity, such as solidarity within the elderly generations.[1] In order to assess the viability of proposed reforms to redesign pension schemes in developed countries, policymakers require insights into the income distribution of current and future generations of pensioners in a situation of no policy changes. It is important to also note that without pension reforms, the future income distribution of pensioners will differ from the current distribution due to developments in longevity and in demographic and socio-economic compositions. For instance, in many countries the number of divorces is increasing and female labor force participation has increased strongly during the last decades, so that many more women will receive occupational pension income in the future. Also, there are productivity differences between cohorts that lead to income differences.

Using a microsimulation model, detailed estimates on the future income distribution are possible. Internationally, there are several microsimulation models built for income predictions and pension issues.[2] For example, the MIDAS (Microsimulation for the Development of Adequacy and Sustainability) model simulates the adequacy of pensions in Belgium, Italy, and Germany (Dekkers *et al.*, 2008). Pensim2 for the U.K. estimates the future distribution of pensioners' income and aims to analyze the distributional effects of proposed changes to pension policy (Emmerson *et al.*, 2004). In Sweden the SESIM model, started in 1997, investigated the Swedish national system of study allowances. Since the year 2000 the focus has shifted from education to pensions and the model now studies the income of the Swedish babyboomers and the financial sustainability of the Swedish pension system (Flood *et al.*, 2006). Other examples of microsimulation models that have been constructed mainly because of the growing concern about population aging are DYNASIM3 and the MINT (Modeling retirement Income in the Near Term) model for the U.S. (Panis and Lillard, 1999; Toder *et al.*, 1999; Butricia *et al.*, 2001; Smith *et al.*, 2007), and DYNACAN for Canada (Harding, 2007).

This paper constructs a dynamic microsimulation model to predict the evolution of the income distribution of the Dutch elderly until 2020, taking into account demographic and socio-economic changes. In contrast to previous microsimulation studies, for the income predictions we estimate a fixed effects income equation and we study the income process by explicitly paying attention to the modeling of the error terms. Households may experience income shocks, the distribution of which may be different for different types of households. In addition, income shocks may have persistent effects, and the degree of persistency may

[1]In the Netherlands an increasing part of the pay-as-you-go public pension scheme is financed by general tax revenues. Consequently, the 65+ population also pays for the state pensions and due to the progressive Dutch tax system, this policy redistributes income within the elderly generation.

[2]Merz (1991), Li and O'Donoghue (2012), and Zaidi and Rake (2001) explain, review, and classify microsimulation models around the world.

vary over the lifecycle. Therefore, we allow for autocorrelation, with the autocorrelation pattern being a function of age.

The advantage of using fixed effects and modeling the autocorrelation pattern of the error terms of the income equation is that this reduces the necessity to explicitly model the underlying processes that determine household income. Yet, more complex simulation models give more underlying information. For example, only after explicitly modeling labor market status, can we say more about the income positions of the elderly with and without occupational pension income. Modeling the income process, however, can improve the trade-off between refinement and tractability of microsimulation models.

The dynamic aging approach as implemented in this paper is also applicable to other countries, when analyzing distributional income effects of demographic and socio-economic changes. For illustrative reasons we use in this paper three levels of refinement for the income equation. The first specification contains only age and period effects. It models no other underlying processes that influence income (for example, labor market states) and thus relies heavily on the modeling of the income process. In the second specification household demographics are added, and the third specification also incorporates the labor market status of household members. In these specifications changes in demographic variables or labor market status lead to income shocks. The main results of the three specifications are rather similar. From this finding we cautiously conclude that adding other background characteristics will not affect the simulation results dramatically.

The results show that next generations of Dutch pensioners probably have higher equivalized household incomes than current generations of pensioners, especially for median income households. Between 2008 and 2020, equivalized household income of the elderly in the age group 65–90 is predicted to grow on average by about 0.5 percent per year for the 10th percentile, about 1.2 percent for the median, and about 1.0 percent for the 90th percentile. These may not be specifically Dutch trends. For example, in other OECD countries the female labor force participation has also increased strongly in the last decades. Therefore, depending on the pension rules in different countries, women have built up (more) pension rights, which may also in other OECD countries lead to future pension incomes that grow relatively the most for median-income households.

If one aims to quantify the effects of different pension policies, then it is important to model labor supply responses explicitly (Creedy and Duncan, 2002). This is beyond the scope of this paper, however. This paper offers insights into the development of the future income distribution, induced by increased longevity and ongoing demographic and socio-economic changes. On the other hand, if labor market outcomes of a certain policy measure are known, they can be incorporated into the model.

This paper is structured as follows: the next section describes the relevant features of the Dutch pension system. Section 3 describes the data and Section 4 presents some descriptive analyses on the income distribution and labor force participation. Section 5 describes the microsimulation model, after which Section 6 summarizes the estimation results. Section 7 presents the simulation results and the paper concludes with Section 8.

2. The Dutch Pension System

As in many European countries, the Dutch pension system consists of three pillars. The first pillar is a pay-as-you-go system and involves a flat rate public pension benefit for all residents from the statutory retirement age of 65 onwards. Everyone who has lived or worked in the Netherlands between the age of 15 and 65 receives a public pension (as do those who do not work). The level of the public pension is linked to the minimum wage and depends on the number of years residing in the Netherlands. Couples who have lived in the Netherlands between the age of 15 and 65 each receive 50 percent of the minimum wage, and single pensioners receive 70 percent of the minimum wage. People that have not lived in the Netherlands from the age of 15 do not receive the full amount of first-pillar pension benefits. If they have a very low or no occupational pension and almost no wealth, the first pillar is topped up with social assistance to guarantee a social minimum.

The Dutch second pillar consists of capital funded occupational pensions, of which the primary responsibility lies with employers and employees. Occupational pensions in the Netherlands have a mandatory nature, such that 90 percent of the employees have a pension scheme with their employer. All people who have earnings above the minimum wage rate build up pension rights, as do part-time workers, proportional to their part-time factor. The unemployed and disabled build up some pension rights in some collective agreements. After the age of 65, unemployment and disability benefits from the government stop and people receive their public and occupational pensions just as everyone else does. Labor contracts are mostly terminated at the statutory retirement age of 65 according to collective agreements.

Occupational pensions mainly consist of defined benefit pension plans, that are transferable to a surviving spouse. The benefits are determined by pre-retirement earnings, years of employment, and by the rules of the public and private pension systems. Until the 1990s most pension plans aimed to pay a pension income of 70 percent of final gross wage from the age of 65 if an employee had worked full-time for at least 40 years. From the early 1990s onwards, pension funds have lowered their ambition; they now aim to pay 70 percent of the average career salary, instead of 70 percent of the final gross salary.

The third pillar is formed by private individual pension products. Everyone can buy third-pillar pension products to save for extra pension benefits, but they are mainly used by the self-employed and employees in sectors without a collective pension scheme. Until a major tax reform in 2001, everyone could buy life annuities fiscally attractive up to a certain limit (2808 Euros in the year 2000). After this reform the limit was reduced to 1002 Euros in 2001. Only self-employed individuals and people with a gap in their pension entitlements can buy life annuities fiscally attractive up to higher amounts.

3. Data

The data are taken from the 1989–2007 Income Panel Study of the Netherlands (IPO, Inkomens Panel Onderzoek; CBS, 2009) and the 1995–2007 population register (GBA, Gemeentelijke Basisadministratie; CBS, 2010), both gathered by Statistics Netherlands.

3.1. *Income Panel Study (IPO)*

The IPO, a representative sample of Dutch households, consists of an administrative panel dataset with income information. Most of these data are from the Dutch National Tax Administration. In the IPO, so called "key persons" are randomly drawn from the Dutch population and are followed over time. Data on all household members of the key persons are also available. Major advantages of having administrative data are a very low attrition rate and a high level of representativeness. It is a well-known fact that the rich and the poor are often under-represented in surveys, institutional households are in general not included, and the elderly population and single-person households have relatively low participation rates in surveys (Alessie *et al.*, 1990; Knoef and De Vos, 2008). Another advantage of administrative data is that the observed variables are measured with a high degree of accuracy. A drawback of the IPO is that it lacks some crucial background variables, such as education levels. Variables that are included in the data are individual characteristics (such as gender, date of birth, and marital status), household characteristics (such as family composition), and financial variables related to income. As from the year 2000 the IPO dataset has been revised because of major tax reforms. Details about this revision can be found in Knoef (2011).

The raw sample consists of 1,835,819 observations. We remove 1.5 percent of the sample because of a missing age or a missing or non-positive household income. Furthermore, we exclude households with nine or more household members and households where the key person is a member of a multiple couple household, a child, or a student. This selected sample consists of 1,290,226 observations. Then, we select all households where the key person is born between 1917 and 1970 and is of age 36–90,[3] which leaves us with 911,079 observations. Finally, households in the bottom or top 0.1 percent of the income distribution are regarded as outliers and excluded from the analysis. Because of the revision mentioned above, the year 2000 is presented two times in the data. We keep the year 2000 before the revision instead of the year 2000 after revision, since the tax reforms that caused the revision started in 2001. The resulting sample consists of 861,336 observations.

3.2. *Population Register (GBA)*

GBA is the population register in the Netherlands. This register provides, among other things, information on marital status of all people registered in Dutch municipalities.[4]

[3]In this way we can make predictions until 2020 for the population of age 50–90, because the cohort born in 1970 reaches the age of 50 in 2020 and the cohort born in 1917 is of age 90 in the last wave of the data (2007). In this study we ignore new immigrant families. For the elderly we expect the effect of this ignorance to be small.

[4]Individuals not registered as residents are, for instance, NATO personnel, diplomats, and individuals illegally residing in the Netherlands.

Data are available from January 1, 1995 to January 1, 2008. Just as in the IPO, we select all persons born between 1917 and 1970 in the age group 36–90 years. Furthermore, since we want to estimate transitions between t and $t + 1$, the marital status in $t + 1$ has to be known. Therefore, 2006 is the last year we can use and persons who, for example, emigrate or decease in $t + 1$ are excluded at time t.

We end up with 6,812,340 individuals in 1995, increasing to 8,673,138 individuals in 2006. The percentage of married people who divorce between t and $t + 1$ increased from 0.7 percent in 1995 to 0.8 percent in 2006. Furthermore, per year on average 2.5 percent of the divorced persons make a transition into marriage. Most widows and widowers are relatively old and do not remarry again. On average, 0.4 percent of the widows and widowers make a transition into marriage from one year to the other. More details about yearly transitions in marital status can be found in the online appendix.

4. Developments in Income

Before making predictions about the future income distribution of the Dutch elderly, this section describes developments in the past. We use equivalized net household income, which is defined as the sum of all incomes received by the household, net of taxes and social insurance contributions, measured in 2005 euros using the consumer price index and, for multiple-person households, divided by the equivalence scale provided by Statistics Netherlands (Siermann *et al.*, 2004).[5] Henceforth, any reference to "income" should be read as "net equivalized household income."

The choice of the equivalence scale can affect inequality rankings (Buhmann *et al.*, 2005). We use the equivalence scale proposed by Statistics Netherlands because it is based on the Dutch situation. Kalmijn and Alessie (2008) found that the modified OECD scale and the equivalence scale of Statistics Netherlands yield very similar results. We analyze the distribution of net equivalized household income for all key persons of the households in the sample, as this is a representative randomly drawn sample of the Dutch population (see Section 3.1).

Table 1 shows the distribution of income for key persons in the age groups 50–64 and 65–90, respectively. In the age group 50–64, mean income increased by 21 percent, from 20,114 euro in 1989 to 24,351 euro in 2007. In the age group 65–90, income was fairly constant during the 1990s. It increased by only 1 percent between 1990 and 1999, compared to 9 percent between 2000 and 2007. This is probably related to the fact that no indexation of public pension benefits occurred in the early 1990s.

The Gini coefficient and the decile ratios show that inequality in the age group 50–64 increased between 1989 and 1995 and remained fairly constant thereafter. This is in accordance with the results of Gottschalk and Smeeding (2000), who also found a growing inequality in a number of other OECD countries from the mid-1980s to the mid-1990s. Caminada and Goudswaard (2001) found that the

[5]Our income concept takes into account labor income, transfer income, capital income, income taxes, taxes on wealth, social insurance contributions, tax deductible mortgage interest, and the imputed rent (a percentage of the value of an owner-occupied house over which one has to pay taxes).

TABLE 1
Descriptives Equivalized Household Income

Year	Mean	p10	p50	p90	$\frac{p90}{p10}$	$\frac{p90}{p50}$	$\frac{p50}{p10}$	Gini
Age 50–64								
1989	20,114	11,310	18,346	30,705	2.71	1.67	1.62	0.228
1992	21,183	11,473	19,242	32,495	2.83	1.69	1.68	0.241
1995	21,718	11,320	19,490	34,049	3.01	1.75	1.72	0.250
1998	22,747	12,025	20,534	35,206	2.93	1.71	1.71	0.246
2001	24,203	12,838	21,786	37,468	2.92	1.72	1.70	0.247
2004	24,463	13,124	22,035	37,641	2.87	1.71	1.68	0.245
2007	24,351	12,814	21,528	38,257	2.99	1.78	1.68	0.258
Age 65–90								
1989	17,031	10,355	14,699	26,732	2.58	1.82	1.42	0.225
1992	17,626	10,542	14,935	28,176	2.67	1.89	1.42	0.236
1995	17,278	10,605	14,659	27,246	2.57	1.86	1.38	0.228
1998	17,916	11,275	15,192	27,758	2.46	1.83	1.35	0.221
2001	18,562	11,702	15,737	28,252	2.41	1.80	1.34	0.224
2004	19,189	12,073	16,366	29,316	2.43	1.79	1.36	0.222
2007	20,048	12,406	17,196	30,592	2.47	1.78	1.39	0.227

Source: IPO, own computations.

two main forces behind this phenomenon are a more unequal distribution of market incomes and changes in social transfers. Furthermore, in 1990 a revision of the tax system led to more inequality. According to SCP (2003), the growth in the number of two-earner couples also increased inequality between 1985 and 1994.

For the age group 65–90, inequality is lower and shows a different pattern. It grew between 1989 and 1991, but declined in the years after 1991. Since 1998, inequality in the age group 65–90 has been quite stable. Several factors may have induced these trends, such as changed early retirement schemes, the development of the pension system, the business cycle, and the increased number of women receiving occupational pension incomes.

In a number of OECD countries (OECD, 2004), female participation rates have strongly increased across cohorts and time. For the Netherlands, Euwals *et al.* (2011) claim that changed attitudes toward the combination of paid work and children have played a major role in the Netherlands. This trend will have considerable consequences for the income structure of the next generations of pensioners, as more two-earner couples today will lead to more couples receiving double pension incomes in the future. More two-earner couples can lead to a pooling effect: the inequality within the group of households with two earners is lower than that of couple households with one earner. This means that an increase in the proportion of two-earner households will, at a certain point, reduce household income inequality.

5. Microsimulation Model

Microsimulation models are used for income predictions and pension issues internationally. These models are in general very demanding multi-year projects with huge data demands (Harding, 2007). One often needs to combine various data sources with different samples, resulting in a reliance on matching of "statistical twins" (e.g., Geyer and Steiner, 2010) and on surveys that often suffer from representability problems, especially when focusing on the elderly population. In surveys, the elderly population living in private households is often under-represented and nursing homes are often excluded.

In a microsimulation model the quality of the input data is of prime importance: if the baseline data are not representative, the predictions of the population will not be representative either (Martini and Trivellato, 1997). Our study uses a long and representative administrative panel. Although administrative data contain less detailed information on the characteristics of persons and households, the panel aspect of the data allows us to take into account unmeasured variables such as education, ability, and cohort effects.

To simulate the income distribution of the elderly until the year 2020, we use an open dynamic population model with cross-sectional aging. In the model each characteristic for each person is updated each year (dynamic aging). By contrast, in microsimulation models with static aging individual characteristics are constant over time. Then, the weights attached to each individual change over time and mimic the process of demographic aging. Static aging is well suited for short- to medium-term forecasts (3–5 year), where it can be expected that large changes have not occurred in the underlying population (Li and O'Donoghue, 2012). An example of a model with static aging can be found in Soede *et al.* (2004), who analyze future incomes in six European countries. Cross-sectional aging means that we first simulate all individuals for one year, then for the second year, and so forth. Longitudinal simulation models, on the other hand, simulate individual one for all years, the same for individual two, and so forth. Cross-sectional aging allows us to have interactions between household members. For example, husbands and wives make joint labor supply decisions, and the death of a household member can influence the labor market states of the remaining household members. Our model is open, as marriage and birth lead to new synthetic household members. In closed microsimulation models the matching of spouses is restricted to persons within the sample.

Figure 1 shows the design of the model. The representative households in the Dutch Income Panel of the year 2007 form the base population of the model and are the starting point of the simulation. We dynamically age all members of these households until 2020 in the aging module, where people age, they may decease, divorces may take place, children may leave their parental home, new partners or children may enter the household, and labor market states may change. We take into account that mortality risks vary between different parts of the income distribution and explain the implementation of this in Section 5.1. To predict the transitions in household demographics and labor market states transition models are used, which are estimated with IPO and GBA data. Sections 5.2 and 5.3 explain the transition models with regard to marital status and children, while Section 5.4 describes the transition models with regard to labor market status.

After the aging module households move into the income module, where household incomes are predicted using the simulated characteristics of the households until 2020. To this end, we estimate a fixed effects income equation, taking into account age and period effects, household demographics, and labor market

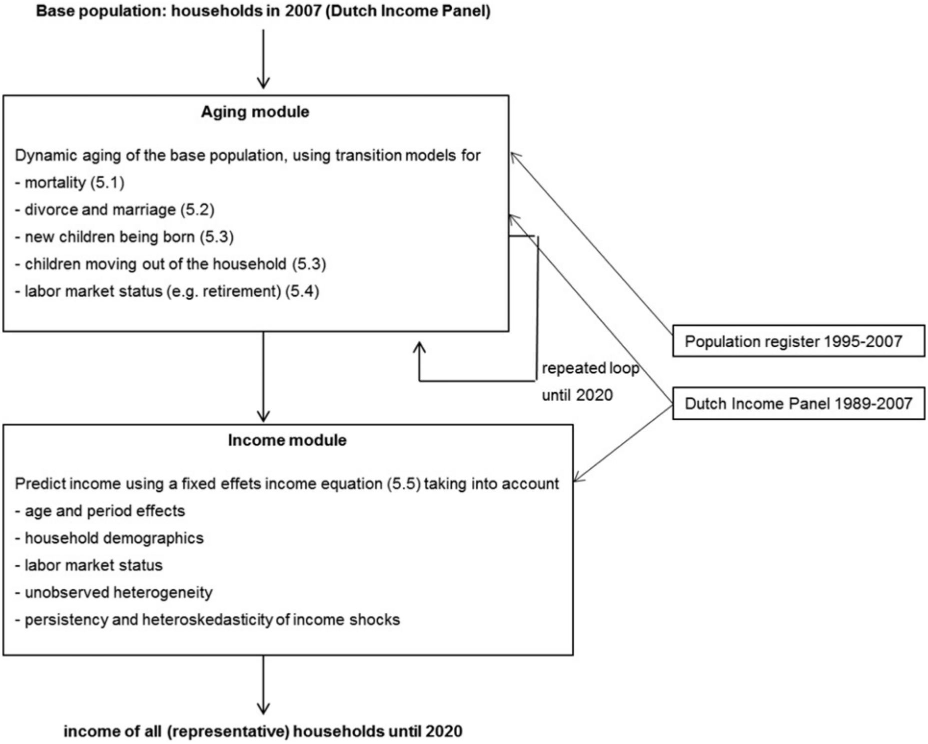

Figure 1. Design of the Microsimulation Model

status. The fixed effects take into account unobserved heterogeneity and we consider the persistency and heteroskedasticity of income shocks. Section 5.5 explains the income equation in detail.

5.1. *Differential Mortality*

In the aging module, where we age all household members in the microsimulation model from 2007 to 2020, persons may decease. To determine whether an individual in the sample deceases or not, we apply Monte Carlo simulations (see, e.g., Law and Kelton, 1982). Therefore, for each individual and at each period from 2008 to 2020, we draw a random value from the uniform distribution. If this random value is lower than the predicted mortality rate, the individual deceases. We use predicted mortality rates per age, cohort, and gender published by Statistics Netherlands and adjust the mortality rates of the first and fourth income quartile using the degree of differential mortality found by Kalwij *et al.* (2013) for the Netherlands. If we do not take into account differential mortality we would underestimate the income level of the elderly, as low income households would survive relatively too often and high income households would survive not often enough.[6]

[6]When we do not take into account differential mortality, the average yearly income growth of pensioners between 2008 and 2020 is 0.15 percentage points lower.

With regard to the degree of differential mortality, Kalwij *et al.* (2013) find, in line with findings in other European countries (e.g., Von Gaudecker and Scholz (2007) for Germany and Osler *et al.* (2002) for Denmark) a quartile ratio Q1/Q4 of 2.2 for men and 1.7 for women from the age of 65. This means that mortality rates in the first income quartile are 2.2 times higher for men and 1.7 times higher for women, relative to the fourth quartile. From the age of 65 we therefore adjust mortality rates such that mortality rates in the first quartile are 2.2 (or 1.7 for women) times higher than in the fourth quartile, keeping the average mortality rate equal. Before the age of 65 mortality rates are small, such that differential mortality will not make a relevant difference.[7]

5.2. *Transitions in Marital Status*

Using the population register, we model the following transitions in marital status from year to year: married–divorced, unmarried–married, widow(er)–married, and divorced–married. Logit models are employed for men and women separately to estimate transition probabilities between the various marital states. We use age and year of birth as explanatory variables and assume period effects to be negligible compared to age and cohort effects. We do not explicitly model transitions into widowhood. Becoming a widow(er) depends on the death of a partner. This probability is incorporated via mortality (described in Section 5.1).

We assume people to make at most one transition in marital status per year and apply Monte Carlo simulation to assess whether a change indeed occurs. In case of a divorce, the partner of the key person is removed from the household, and in case of marriage a new household member is added. These new household members have the same age as their partners and the opposite gender.

5.3. *Transitions in the Number of Children*

The probability of a child leaving the parental home from one year to the other is estimated using a logit model, where age and gender of the child are the explanatory variables. For this estimation we select all children in IPO in 2006 and check whether they are still in the household in 2007. Thus, for the years 2008–20 we assume children to have the same behavior with regard to leaving their parental home as the children between 2006 and 2007.[8]

The probability of a newborn child in the household is also modeled with a logit model. The explanatory variables are the age and gender of the key person in the household, whether there is a couple in the household, and the number of children which are already present in the household. For this estimation we select all households in the years 1989–2006 and we determine, given the characteristics

[7]To determine which households belong to the first and the fourth income quartile, we use the income position corrected for the age profile (using the fixed effects income equation where only age and period effects are taken into account).

[8]Children are defined as all persons younger than 30 who are at least 18 years younger than the key person of a household.

in $t - 1$, whether a new child has entered the household during the next year. The simulation model ignores children already born to enter the household.

5.4. *Transitions in Labor Market Status*

The model distinguishes three labor market states: (1) receiving labor income; (2) receiving occupational pension income; and (3) receiving none of these two ("other"). In order to belong to (1) or (2), labor income or occupational pension income has to be at least 500 euro per year. In case an individual receives both labor income and pension income the highest income component counts.[9]

We model the transitions between the three labor market states and assume "occupational pension" to be an absorbing state. Concerning singles, we estimate multinomial logit models for men and women separately. The labor market states of the two members of a couple are interrelated. For couples we therefore treat the three labor market states of a husband and a wife as $3 \times 3 = 9$ univariate outcomes. For instance, we estimate the transition probability from the state where both husband and wife work to the other eight states with a multinomial logit model. The explanatory variables used in the estimations are age, cohort, marital status, and the number of children.

Using the parameters of the transition models, we estimate the transition probabilities for all singles and couples, given their age, marital status, and labor market status in the previous period. Here, we also use Monte Carlo simulation to determine whether a transition takes place.

To determine the labor market status at time $t + 1$ with the transition models, we need the labor market status at time t. A problem arises for new household members and children who enter adulthood. To determine an initial state for them we estimate a multinomial logit model per gender, with age and cohort as explanatory variables. The increased labor market participation of women therefore enters the model in two ways: via the initial labor market states of women, and via cohort effects in the labor market transition models.

5.5. *Income Equation*

To predict income trends for future generations of pensioners we model household income using a fixed effects model with age, period, and socio-economic variables. Socio-economic variables enable us to take into account developments in the income distribution due to different socio-economic characteristics of future pensioners. The fixed effects allow us to control for time-invariant omitted variables that influence the income of a household. They capture education, ability, and cohort effects that incorporate productivity differences between generations (Kapteyn *et al.*, 2005). Since we assume that individual household dummies, which reflect education, ability, etc., are important in explaining household income, not including these dummies would be a suboptimal predictor according to Hayashi

[9]The number of people receiving both labor and occupational pension income is low. In the period under consideration a number of people received incentives to retire (very) early. Gradual retirement was an uneconomic choice and almost did not occur. For example, workers retiring later than the earliest possible early retirement date were not compensated by higher benefits or lower taxes, so that in fact they faced an implicit tax rate of more than 100 percent (Kapteyn and De Vos, 1999).

(2000). However, we have to assume that our sample period (T = 19 years) is long enough to consistently estimate the fixed effects. Fixed effects are in line with Haveman *et al.* (2007), who found that pre-retirement economic advantages continue into retirement. We could find one other microsimulation model using fixed effects. That is the MINT model that uses fixed effects to take into account unmeasured heterogeneity in lifetime pre-retirement earning profiles (Toder *et al.*, 1999; Butricia *et al.*, 2001).

The fixed effect reflects the financial well-being of a household, corrected for household size and other explanatory variables. When the household composition in the simulation changes, most likely because of a divorce or the death of a partner, we assume that, apart from the effect of the divorce or widowhood, the financial well-being of the remaining partner remains the same (we do not change the fixed effect). In reality this is often the case because of widow pensions or alimentation. Also, when people divorce, ex-partners in the Netherlands often receive half of their ex-partner's occupational pension after the age of 65. In the model we assume that the percentage change of income due to divorce or widowhood is the same for everyone. However, when there are systematic differences between income groups regarding mobility, this may affect the simulation results.

The disadvantage of a fixed effects estimator in microsimulation models is that it rules out out-of-sample simulations (Wolf, 2001). However, in this analysis we can use a fixed effects model because our target population is future pensioners, who are already born and available in the data. In the simulation the income profiles are estimated with the same data as the base population is derived from. The fixed effects income equation is

$$y_{it} = \alpha + \beta' x_{it} + \mu_i + v_{it}, \tag{1}$$

where y_{it} is the "log" of equivalized household income[10] of household i in time period t, α is a scalar, x_{it} is the it-th observation on K explanatory variables, β is a parameter vector of size K, μ_i is the unobserved individual effect, and v_{it} is the error term. We have to assume strict exogeneity

$$E(v_{it}|\mu_i, x_{i1}, \ldots, x_{it}, \ldots, x_{iT}) = 0 \tag{2}$$

and identify α using the normalization $\sum_{i=1}^{N} \mu_i = 0$. The strict exogeneity assumption implies that there is no feedback effect from income to the explanatory variables. This means, for example, that we have to assume that within a cohort income has no effect on retirement decisions. On the other hand, the influence of the income growth among cohorts on retirement decisions is taken into account by modeling cohort effects in the transition models. The estimation of α, β, and μ_i is explained in the online appendix.

We estimate three specifications of the income equation with different levels of refinement of the model. In the first specification, the vector x_{it} only contains age and period effects. With this specification income mobility only results from

[10]If one were to simulate income components separately, one should take into account the correlations between components. There is no need for that in this paper.

income shocks. By adding additional variables to the vector x_{it}, more individual heterogeneity is introduced in the income path. In the second specification, we add demographic variables such as household size and marital status. Including household size as an explanatory variable, in addition to the equivalence scale already used in the dependent variable, leads to information about the income effect of an additional man, woman, or child in the household. For example, if the coefficient for the number of adult men in the household is positive, we can conclude that on average, the income of one additional man exceeds his marginal costs of living (determined by the equivalence scale). The third specification also takes into account the labor market states of household members. Whether people are active in the labor market, inactive, or retired, influences household income.

Occupational pensions of the elderly depend on their labor market histories and we do not, or do not completely, observe these. For example, when young people are unemployed this influences their old-age income. Fortunately, the youth unemployment rate in the Netherlands is low and long-term unemployment (unemployed for more than one year) does not often occur.[11] Also, some of the people with unemployment benefits do build up some second-pillar pension rights paid by their old employer.[12] Furthermore, the fixed effects control for this as persons who are disadvantaged in the labor market have a relatively low fixed effect which translates into relatively low income during working life and retirement. Nevertheless, the above mentioned data limitations prevent taking into account individual-specific impacts of economic downturns in our microsimulation model.

Age and period effects are implemented as dummy variables, so that their relationship with income is very flexible. However, these age and period effects cannot be identified empirically together with the fixed effects. To identify age and period effects when fixed effects are controlled for, we follow an identification strategy similar to the one of Deaton and Paxson (1994) and assume that all time dummy coefficients add up to zero and are orthogonal to a linear time trend. We thus assume that all period effects are due to unanticipated business cycle shocks.

Households experience income shocks, the size of which may depend on characteristics of the household (heteroskedasticity). For example, income shocks may be larger during working life than during retirement. Furthermore, the question arises how long income shocks persist (autocorrelation), and whether the persistency of a shock depends on age.

When a household experiences an income shock in period t, this may have an effect on the income in the periods following t. The error term v_{it} might therefore follow an autoregressive scheme. To model this we fit the following auxiliary regression model of order two[13]

$$v_{it} = \rho_{1,it} v_{i,t-1} + \rho_2 v_{i,t-2} + \varepsilon_{it}, \tag{3}$$

[11]Between 1996 and 2004 the long-term youth unemployment rate was on average only 1.47 percent.

[12]This depends on collective agreements. In the public sector, people who become unemployed still build up 37.5 percent of their pension rights during the period in which they receive unemployment benefits.

[13]We find that higher orders are of no importance.

where we assume ε_{it} to be serially uncorrelated. The persistency of a shock may depend on age. For example, one would expect that income is more smooth over time after retirement, implying a higher autocorrelation of the residual component after retirement than before. Kalmijn and Alessie (2008) provide support for this and report that the two-year autocorrelation of equivalized income is quite stable during midlife, but moves to a higher level after the age of 65. Therefore, we allow $\rho_{1,it}$ to be a function of age.

As explained above, the variance of an income shock may depend on the characteristics of a household. We take this heteroskedasticity into account by investigating the distribution of ε_{it} for several mutually exclusive groups of households; for example, the group of households where the key person is younger than 65 and the group of households where the key person is older than 65, for singles and couples. For each group we draw income shocks from the empirical distribution of residuals in 2001–07 for that group $(\hat{\varepsilon}_{i,2001}, \ldots, \hat{\varepsilon}_{i,2007})$.[14]

In the predictions we assume period effects to be zero, such that the predicted incomes are free from the effects of the business cycle. Finally, we take into account that as from 2015, a partner bonus for younger partners of state pension beneficiaries with no or low income will be abolished. We subtract the partner bonus for all households who are no longer eligible for a partner bonus, and in which the younger member of the couple has no labor income. SZW (2009) found that the remaining household income for most of these households will not reach the eligibility limit for social assistance.

6. Estimation Results

6.1. *Income Equation*

Table 2 presents the estimation results of the fixed effects income equation for three different specifications. The first specification includes only age and period variables. In the second specification, household demographics are added, and in the third specification, labor market states are also added.

In all three specifications, age effects increase until about the age of 55 and decrease afterwards. As from the age of 70 they increase again, probably because of selective attrition through mortality. Although we use a fixed-effects model, there may be selection related to idiosyncratic errors. Because of selective attrition our sample may not be random at the higher ages, and if this is the case this means that the coefficients cannot be estimated consistently. Therefore, we cannot interpret the age coefficients as "causal" effects of age on income and we should view the estimates with care, especially among the higher ages. To let high-income people survive more often than low-income individuals, we implemented differential mortality in the aging process of the model (Section 5.1).

The shapes of the age profiles for the second and third specification are very similar, while the age profile of the first specification is more pronounced. The first specification has relatively high age effects around the age of 54, caused by children leaving their parental home. Equivalized household income increases when

[14]By using the years as from 2001, possible effects caused by the revision of the data are excluded.

TABLE 2

ESTIMATION RESULTS FIXED EFFECTS INCOME EQUATION

	Coef 1	SE	Coef 2	SE	Coef 3	SE
age dummies[a]	yes		yes		yes	
year dummies	yes		yes		yes	
# adult men			0.131	0.0018	0.037	0.0028
# adult women			0.061	0.0018	–0.030	0.0023
# children			–0.068	0.0015	–0.059	0.0015
widower			0.138	0.0072	0.084	0.0071
widow			0.044	0.0051	–0.044	0.0058
divorced (man)			0.033	0.0062	0.021	0.0060
divorced (woman)			–0.123	0.0077	–0.140	0.0076
unmarried (man)			0.057	0.0091	0.050	0.0088
unmarried (woman)			–0.071	0.0120	–0.080	0.0119
# labor (man)					0.120	0.0026
# labor (woman)					0.118	0.0018
# occ. pension (man)					0.058	0.0032
# occ. pension (woman)					0.099	0.0034
$\rho_{0,1}$	–0.074	0.6553	0.789	0.6698	0.984	0.6705
$\rho_{1,1}$ (age/10)	–0.464	0.4741	–1.050	0.4844	–1.182	0.4848
$\rho_{2,1}$ ((age/10)^2)	0.303	0.1261	0.438	0.1288	0.468	0.1289
$\rho_{3,1}$ ((age/10)^3)	–0.052	0.0146	–0.065	0.0149	–0.068	0.0149
$\rho_{4,1}$ ((age/10)^4)	0.003	0.0006	0.003	0.0006	0.003	0.0006
$\rho_{5,1}$ (age > 65)	0.116	0.0099	0.122	0.0101	0.126	0.0101
$\rho_{6,1}$ (age = 63)	0.034	0.0082	0.039	0.0083	0.044	0.0083
$\rho_{7,1}$ (age = 64)	0.070	0.0086	0.080	0.0087	0.082	0.0087
$\rho_{8,1}$ (age = 65)	–0.123	0.0089	–0.121	0.0089	–0.128	0.0089
$\rho_{9,1}$ (age = 66)	–0.184	0.0094	–0.195	0.0096	–0.201	0.0096
ρ_2	0.065	0.0012	0.054	0.0012	0.055	0.0012
α	9.909		9.746		9.805	
σ_μ	0.370		0.369		0.342	
σ_ε	0.210		0.205		0.202	
R^{2b}	0.6881		0.7122		0.7225	
N	86,1336		86,1336		86,1336	

Notes: Reference categories are "age 65" and "married." For the identification of age, period, and cohort effects the method of Deaton and Paxson (1994) is used. Clustered standard errors are used to take into account the correlation of the error terms in the same household.

[a]The coefficients of the age specific dummy variables can be found in Appendix C.

[b]These R^2's take into account the household-specific effects.

children leave their parental home, as the equivalence scale captures the fact that children cost money.[15] Specifications two and three correct for the presence of children, hence they have lower age effects around the age of 54. The estimated period effects follow the development of the business cycle.

The second specification shows that households with more adults have on average a higher equivalized household income. On average adults thus yield more income than "costs" (in terms of the increase in the equivalence scale). Households with more children, on the other hand, have on average a lower equivalized income. Kalmijn and Alessie (2008) found that this is mainly due to an increase in expenditures by having children and only to a lesser extent due to a decline in the personal income of women after the birth of children.

[15]Money transfers between parents and children not living in the same household cannot be taken into account because they are not available in the data.

Marital status is significantly associated with income. Compared to divorced men, divorced women are relatively worse off. A divorce often coincides with the loss of an adult in the household, such that the total effect of a divorce for men is a 2.8 percent loss of income (0.033–0.061) and for women a 25 percent loss of income (–0.123–0.131). Widowers and widows are better off than unmarried men and women, and the unmarried are on average better off than divorced men and women. Men have on average 8 percent more income in widowhood than in marriage, but women are 9 percent financially better off in marriage than in widowhood.

The third specification takes labor market states into account, namely, the number of men and women receiving labor income, and the number of men and women receiving occupational pension income. Due to the possible endogeneity of labor market status, the estimated coefficients are likely to be biased and therefore we do not allow for a causal interpretation. That is because those people that we observe to be at work are probably the people that have unobserved (time-varying) characteristics that make it relatively profitable for them to work.[16] Nevertheless, the coefficients can be used in a least squares projection. The least squares projection is the best predictor in the class of linear predictors in that it minimizes the mean squared error. Hayashi (2000) devotes a section (2.9) on least squares projection. He explains that if the assumptions justifying the large-sample properties of the OLS estimator are not satisfied, OLS provides a consistent estimator of the best way to combine linearly the explanatory variables to predict the dependent variable as long as the researcher has a random sample available. As expected, the higher the number of working men and women, the higher is household income. An additional worker in the household increases equivalized household income on average by only 12 percent, which is related to the high amount of part-time work (especially among women) and the tax system. More household members with an occupational pension also increases household income. According to the model, the net effect of retirement is a reduction of household income by about 2–6 percent. These high net replacement rates correspond to net replacement rates reported by the OECD (2011).

The parameters $\rho_{0,1}$ to ρ_2 in Table 2 show the autocorrelation pattern over the lifecycle. ρ_1 (the first order coefficient, see equation (3)) is a function of age. We experimented with several specifications and also investigated whether it is relevant to specify ρ_2 as a function of age. We found that income shocks are persistent and that persistency increases with age. Only around the statutory retirement age of 65 income persistency is low, probably because the income composition changes from that age. In the first specification, ρ_1 increases from 0.22 at age 36 to 0.76 at age 90. In the second and third specifications, ρ_1 is somewhat smaller, especially before the age of 65. This can be explained by the fact that the added demographic and labor market status variables capture part of the persistency. Consider for instance a person faced with a negative income shock from a transition to unemployment. Specification three takes labor market status into account, so as long as the person

[16]The fixed effects do take into account "ability," but we have no information about time specific "good unobservables" that make it relatively profitable (or unprofitable) for people to select themselves into work.

stays unemployed the negative income effect persists. In the first two specifications labor market states are not taken into account explicitly. However, a person can receive a negative income shock, which may implicitly be caused by unemployment. The parameters $\rho_{0,1}$ to ρ_2 determine the persistency of the shock. This persistency increases with age, comparable to the duration of unemployment, which also tends to increase with age. Finally, σ_μ and σ_ε show that the individual variation is larger than the random component.

Future income shocks are drawn from the empirical distribution of the idiosyncratic residuals in the years 2001 to 2007. As shown by Kalmijn and Alessie (2008), the variance of equivalized income (logged) is relatively low after the age of 65. We therefore distinguish between households with key persons younger and older than 65. The standard deviation of the residuals is 40 percent higher for households where the key person is younger than 65 than for households where the key person is older than 65. In the third specification we also distinguish households that do receive labor or occupational pension income from those that do not receive any of these income components. For households where the key person is younger than 65, the standard deviation of the residual is 49 percent higher in households without labor or occupational pension income, compared to households with labor or occupational pension income. In households where the key person is older than 65, the standard deviation of the residual is 71 percent higher for households without occupational pension income, compared to households with an occupational pension. In the simulation these results lead to higher income shocks for young households and for households without labor and/or occupational pension income.

6.2. *Transition Models*

This section describes the estimation results of the transition models. The estimated coefficients are reported in the online appendix.

6.2.1. Marital Status

The estimation results show that old persons and persons in old cohorts divorce less often than young persons and persons in young cohorts. Men remarry more often than women after a divorce or the death of a spouse, but with age both men and women remarry less often. After a divorce, young cohorts remarry less often than old cohorts, while on the other hand young cohorts remarry relatively more often after the death of a spouse. Furthermore, with age less people are going to marry, but persons in young cohorts marry more often than persons in old cohorts. This may seem counterintuitive, as it is commonly known that persons in young cohorts marry less often than persons in old cohorts. However, this can be explained by young cohorts marrying later in life than old cohorts. Therefore, in the age group under consideration (36–90) the number of marriages is relatively high for young cohorts.

6.2.2. Children

As expected, with age more children leave their parental home. Furthermore, daughters leave their parental home earlier than sons. As from the age of 36, when age increases less children are being born. In addition, more children are born in young cohorts (who in general give birth to children later in life) than in old cohorts. Children are more often born in a couple household and in households where already one child is present than in single adult households and households without children. On the other hand, in households with two children or more there are relatively few births.

6.2.3. Labor Market Status

Transitions in labor market status are estimated for singles and couples separately.[17,18] The results show that individuals in young cohorts keep working longer than individuals in old cohorts. For example, the estimated probability for an employed 36-year-old single female to stay employed until the age of 60 is 10 percent for the cohort born in 1940, 20 percent for the cohort born in 1950, 32 percent for the cohort born in 1960, and 44 percent for the cohort born in 1970. Furthermore, divorced men and women experience transitions from work to "other" and from "other" to work relatively often, and for women the number of children is positively associated with transitions from work to "other" (e.g., out of the labor force).

Finally, we estimated gender-specific multinomial logit models for the initial labor market status of new household members and children who enter adulthood. All household members in the data are used. Labor force participation ("labor") increases until about the age of 40 and decreases afterwards, and with age more people receive an occupational pension. Persons in young cohorts have relatively often a labor or occupational pensions status, compared to persons in older generations.

7. Simulation Results

Corresponding to the three specifications of the income equation, we have three predictions of the income distribution until 2020. Before explaining the income predictions we describe the predictions of marital status and labor market status from the aging module, as they are input for the income predictions in the income module. Predictions of marital status are given in Table 3 for the age groups 50–64 and 65–90. In the age group 50–64, the most important finding is the growth in the share of unmarried and divorced people. In the age group 65–90 we find that widowhood among women decreases. This can be explained by life expectancy convergence among men and women, which leads to younger cohorts of women being less often widowed. Furthermore, the fall in widowhood can be

[17]The multinomial logit model assumes conditional stochastic independence of the error components of the alternative choices (IIA). We used two commonly used tests, the Hausman test and the Small–Hsiao test, to test the IIA assumption. The test results were inconclusive which means we have no unequivocal information about whether the IIA assumption was violated by our data; the final income results, however, appear not to be very sensitive to the inclusion of demographic and labor market transitions (the results of the first, second, and third specification are rather similar). Therefore, we cautiously conclude that transition models that relax the IIA assumption, such as the random effects multinomial logit model, would probably not influence the simulated income results very much.

[18]To save space, the detailed estimation results of the labor market transitions of couples are available on request.

TABLE 3
Predictions of Marital Status

	Men				Women			
Year	Married	Unmarried	Widowed	Divorced	Married	Unmarried	Widowed	Divorced
Age 50–64								
2008	75.6	9.9	2.0	12.5	71.8	7.5	6.2	14.5
2011	72.4	12.1	2.0	13.4	69.4	9.0	5.8	15.8
2014	68.9	14.5	1.9	14.7	67.4	10.7	5.1	16.9
2017	64.9	17.3	1.8	15.9	65.0	12.5	4.7	17.7
2020	61.2	20.1	2.0	16.8	61.9	15.2	4.5	18.4
Age 65–90								
2008	74.5	5.6	12.4	7.5	46.4	5.7	39.5	8.4
2011	73.2	5.8	12.3	8.7	48.4	5.5	36.6	9.5
2014	72.3	5.9	11.9	10.0	50.2	5.3	34.1	10.5
2017	70.8	6.4	11.9	10.9	50.4	5.5	32.4	11.8
2020	68.8	7.4	12.0	11.8	50.0	5.7	31.0	13.3

Note: Marital status for men and women. For example, in 2020 about 61.2 percent of men in the age group 50–64 will be married.

TABLE 4
Predictions of Labor Market Status

	Men			Women		
Year	Labor	Occupational Pension	Other	Labor	Occupational Pension	Other
Age 50–64						
2008	62.6	19.6	17.8	46.3	15.0	38.6
2011	62.5	23.7	13.8	50.0	19.2	30.8
2014	64.2	24.3	11.5	54.2	22.3	23.5
2017	64.5	26.0	9.5	57.2	24.5	18.3
2020	66.0	25.6	8.4	59.4	26.8	13.8
Age 65–90						
2008	3.6	87.0	9.4	2.1	54.0	43.8
2011	3.7	87.8	8.5	2.5	56.2	41.3
2014	4.4	88.4	7.2	3.2	59.7	37.1
2017	4.1	89.6	6.2	3.0	65.4	31.5
2020	4.4	90.6	5.0	3.2	71.1	25.7

Note: In case a person receives both labor income and occupational pension income the labor market status is based on the highest income component. For example, in 2020 labor is the most important income source for 66.0 percent of men in the age group 50–64.

attributed to the babyboom generation reaching the age of 65. Therefore, the total age group 65–90 starts to contain relatively many "young" elderly who are widowed less often (composition effect). The results in Table 3 agree with the long-term projections of Statistics Netherlands (De Jong and Van Huis, 2003).

Table 4 presents predictions of labor market status. For both men and women, and both age groups 50–64 and 65–90, the share of people receiving occupational pension income increases. This especially holds for women, as a result of the strong increase in their labor force participation.

Using the predictions of marital status and labor market status described above, we predict equivalized household income for all households. Table 5 shows the results of the most extensive prediction, where household demographics and

TABLE 5
Predictions of Income

Year	Mean	p10	p50	p90	$\frac{p90}{p10}$	$\frac{p90}{p50}$	$\frac{p50}{p10}$	Gini
Age 50–64								
2008	24,559	13,325	22,040	37,995	2.85	1.72	1.65	0.243
2011	24,996	13,795	22,541	38,357	2.78	1.70	1.63	0.241
2014	25,531	14,009	22,989	39,244	2.80	1.71	1.64	0.239
2017	25,690	13,923	23,081	39,754	2.86	1.72	1.66	0.241
2020	26,173	13,855	23,303	41,102	2.97	1.76	1.68	0.244
Age 65–90								
2008	20,285	12,245	17,837	31,296	2.56	1.75	1.46	0.225
2011	21,227	12,378	18,936	32,828	2.65	1.73	1.53	0.229
2014	21,962	12,641	19,670	33,661	2.66	1.71	1.56	0.228
2017	22,445	12,841	20,163	34,236	2.67	1.70	1.57	0.230
2020	22,905	13,048	20,725	35,073	2.69	1.69	1.59	0.230

Note: In this paper income is always inflated/deflated to 2005 euros. This table shows the results of the most extended model specification, where demographic variables and labor market states are taken into account (model specification three).

labor market states are taken into account (model specification three). When interpreting the results one should take into account that the statistical uncertainty surrounding these predictions may be substantial and we have to make careful statements.[19]

Incomes in these tables are free from period effects, such as the effects of the business cycle. According to the predictions, income will increase on average by about 0.6 percent per year for the age group 50–64 and 1.0 percent per year for the age group 65–90 between 2008 and 2020. The Gini coefficient and the decile ratio p90/p10 show that inequality in the age group 65–90 will probably increase until about 2012 and stabilize thereafter. Focusing on the decile ratios p90/p50 and p50/p10, two contradictory developments seem to occur: an increasing inequality in the lower part of the income distribution and a decreasing inequality in the upper part of the income distribution. This shows the importance of investigating the entire income distribution by microsimulation, rather than just investigating the development of an inequality measure such as the Gini coefficient. Inequality indices differ in their sensitivities to income differences in different parts of the distribution, but one index cannot show the different developments occurring throughout the entire income distribution. For the age group 50–64 the Gini coefficient and the decile ratio p90/p10 show that inequality is predicted to decrease until 2012 but to increase thereafter. After 2012 inequality is predicted to rise in the upper part of the distribution as well as in the lower part of the distribution.

Figure 2 shows realizations and predictions of log income per age and cohort. For every cohort the figure presents the income of the 10th, the median, and the 90th percentile. Period effects are excluded for the predictions (the dashed lines) as well as for the realizations (the solid lines). We use *log* equivalized household

[19]When we want to compute confidence bands, we need drawings from the parameter distributions from every transition model and for the income equation, and we evaluate the model again for each draw. This, however, is not feasible, because of the enormous computation time required.

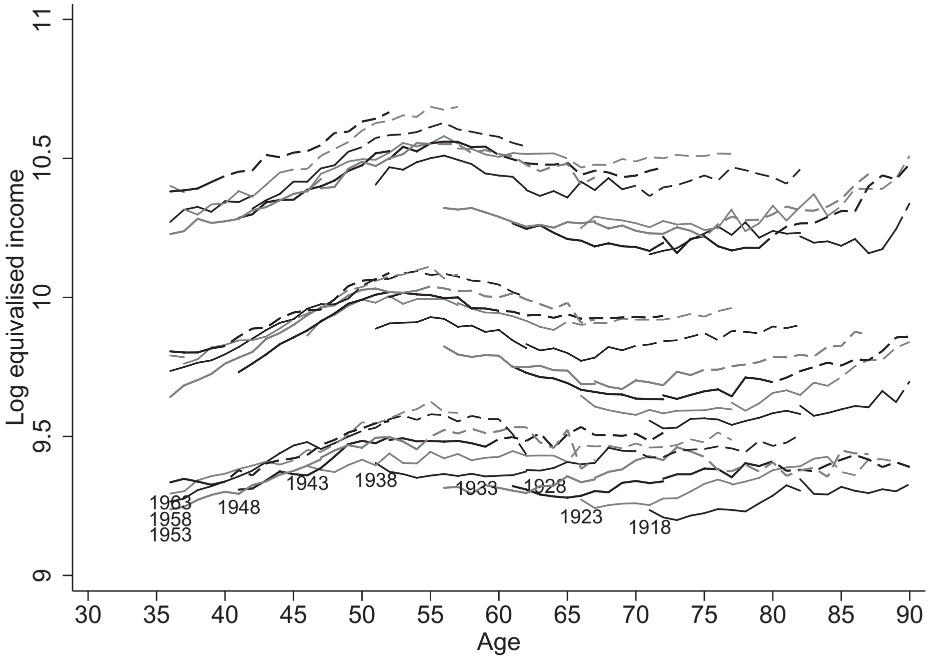

Figure 2. Log Equivalized Household Income per Age and Cohort

Notes: The 10th, median, and 90th percentile of log equivalized household income per age and cohort. The solid lines are realizations corrected for period effects; the dashed lines are predictions made with the most extended version of the microsimulation model (specification three).

income, as it is more interesting to compare relative than absolute changes. The age profile of the median incomes and the 90th percentile is stronger than that of the 10th percentile. As expected, young cohorts have higher incomes than old cohorts. However, for the 10th percentile cohort–time effects decrease between 2008 and 2020, while they do not decrease for median income households. These predictions indicate that the income growth is not the same for everyone.

Figure 3 shows this more clearly by presenting the growth of the 10th, median, and 90th percentile of the income distribution between 1989 and 2020 for the elderly of age 65–90. As in the other figures, period effects are excluded for the predictions and the realizations.

Pensioners with median household income experience the highest income growth. As a result, inequality (indeed) increases in the lower part of the distribution and decreases in the upper part of the distribution. Relative poverty thus increases. On average the income growth of pensioners is predicted to be higher in the future than it was in the past. When we compare the realized average income growth of pensioners between 1989 and 2007 with the predicted average income growth between 2007 and 2020 in Figure 3, we find an increase in the average income growth per year for median income households from 0.8 percent until 2007 to 1.4 percent after 2007. The average income growth of the 90th percentile also increases, from 0.7 percent per year until 2007 to 1.0 percent after 2007. The 10th

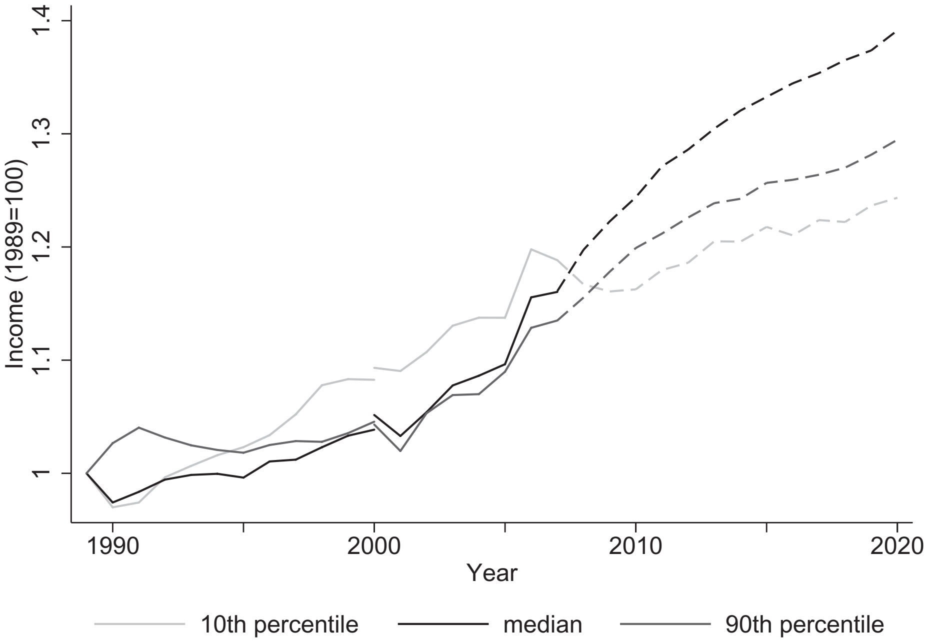

Figure 3. Indexed Growth of Equivalized Household Income for the Elderly of Age 65–90

Notes: Income growth for the 10th percentile, the median, and the 90th percentile. The solid lines are realizations corrected for period effects; the dashed lines are predictions made with the most extended version of the microsimulation model (the third specification).

percentile experiences a decrease in the average growth rate from 0.9 percent until 2007 to 0.3 percent after 2007. The results of specifications one and two are presented in the online appendix and lead to similar conclusions, indicating that the explicit modeling of demographic and labor market changes is not very important for investigating the future income distribution, when using fixed effects and modeling the error terms.

The lower part of the income distribution experiences a relatively low income growth. In this part of the distribution there are many households without occupational pension income. The question arises whether the growing inequality in the lower part of the distribution is caused by an increase in the inequality between households with and without occupational pension income. To answer this question we do a Theil decomposition, concentrating on the lower half of the income distribution. The online appendix describes the Theil decomposition method and Table 6 shows the results.

In the lower half of the income distribution, 21 percent of the households receive no occupational pension in 2010. In 2020 this proportion will shrink to about 15 percent. As expected, average income is higher for households with occupational pension income, compared to the households without occupational pension income. The Theil index is about two times higher for households without occupational pension income, but the inequality growth between 2010 and 2020 is higher for the households with occupational pension income. The Theil

TABLE 6

Theil Decomposition of Equivalized Household Income

Year	2010	2015	2020
% Households without occupational pension	20	18	15
Average income, households without occ. pension	12,455	13,358	14,008
Average income, households with occ. pension	14,880	15,705	16,059
Theil index, households without occ. pension	0.035	0.036	0.039
Theil index, households with occ. pension	0.014	0.016	0.022
Within group inequality	0.0174	0.0196	0.024
Between group inequality	0.0024	0.0018	0.0011
% Between group inequality	12	9	4

Note: This table concentrates on the lower half of the income distribution of pensioners (age 65–90). It shows the inequality within and between households with and without occupational pension income.

decomposition shows that in 2010, 11 percent of the inequality in the lower half of the distribution is caused by the inequality between the group of households with and without occupational pension income. By 2020 this is reduced to 5 percent. The increased inequality in the lower part of the distribution is thus not caused by a higher inequality between households with and without occupational pension income. Instead, the inequality between these two groups will decrease. This means that inequality between households with occupational pension income on the one hand and inactive/self-employed households without pension arrangements on the other will not increase.

8. Conclusions

This paper simulates the income distribution of the Dutch elderly using an open dynamic microsimulation model with cross-sectional aging. The model takes into account developments in household compositions (e.g., more divorces), developments in labor market states (e.g., higher female participation rates), and productivity differences between cohorts resulting in income differences. Furthermore, we consider differential mortality and increased longevity.

Methodologically the model contributes to the existing literature on microsimulation models by taking into account the persistency and heteroskedasticity of income shocks. This has the advantage that it reduces the need to model all underlying processes influencing income. This can improve the balance of refinement and manageability of microsimulation models. Another advantage is that this increases the possibilities to use administrative data, that are less detailed than surveys but are more representative, to make reliable predictions for the whole population.

To illustrate the inclusion of persistent and heteroskedastic income shocks in a microsimulation model and show the balance between refinement and manageability of a microsimulation model, we applied three model specifications, with different levels of refinement. The simulation results are about the same and we find that income shocks are persistent and that persistency increases over the lifecycle (even after the correction for fixed effects). As expected, the variance of income shocks is larger for working-age households than for retirement-age households, and is relatively large for households without labor and/or occupational pension income.

The results indicate that average income increases for future generations of pensioners. More specifically, we find that between 2008 and 2020, household income increases on average by about 0.6 percent per year in the age group 50–64 and 1.0 percent for pensioners of age 65–90. Income growth is not the same for everyone. Among pensioners of age 65–90, households with median income experience the highest income growth. During the years 2008–20 their income is predicted to grow on average by about 1.2 percent per year, while this is about 1.0 percent for households at the 90th percentile and only 0.5 percent for households at the 10th percentile of the income distribution. The trend that pension incomes increase relatively the most for median income households may also hold in other OECD countries, where trends in female labor force participation and longevity were similar.

Inequality indices such as the decile ratio p90/p10 and the Gini coefficient show that inequality among pensioners in the age group 65–90 will probably increase up to 2012 and stabilize thereafter. However, a closer inspection of the whole distribution reveals that inequality will probably grow in the lower part of the distribution, while it declines in the upper part of the distribution. The growing inequality in the lower half of the income distribution is probably not caused by an increasing inequality between households with and without occupational pension income. Instead, inequality between households with and without occupational pension income will probably decrease. The contradictory movements in the lower and upper part of the distribution underline the importance of investigating the whole income distribution by using a microsimulation model, instead of just analyzing the development of one inequality index such as the Gini coefficient.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

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