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Analyzing labour supply of elderly people

A life-cycle approach

Paul de Hek, Frank van Erp

CPB Netherlands Bureau for Economic Policy Analysis
Van Stolkweg 14
P.O. Box 80510
2508 GM The Hague, the Netherlands

Telephone +31 70 338 33 80
Telefax +31 70 338 33 50
Internet www.cpb.nl

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Abstract in English

In light of the ageing of the Dutch society, policy measures aim at increasing the participation rate of elderly workers, particularly in the age-group between 55 and 64. This paper develops a stylized numerical simulation model describing consumption, savings and labour supply behaviour over the life cycle to analyze the labour-market implications of such proposals. For example, we simulate a shift in the (normal) retirement age from 65 to 67, the elimination of the Social Security premium exemption after age 65, and a premium on first-tier pension benefits if the commencement date of these benefits is postponed. Each of these reforms affect the economic outcomes via wealth effects, income effects and inter- and intratemporal substitution effects. The stylized model offers a profound theoretical underpinning which helps us to understand these policy effects over the entire life cycle of individuals. However, the numerical outcomes should be taken with some caution as the model ignores insights of behavioural economics (such as 'framing effects').

Sleutelwoorden: Life-cycle policies; Lifetime labour supply; Retirement

Abstract in Dutch

Als bijdrage aan het beperken van de kosten van de vergrijzing, worden verschillende maatregelen overwogen om de arbeidsmarktparticipatie van 55-64-jarigen te vergroten. Om de gevolgen van deze maatregelen voor de arbeidsmarkt te analyseren, wordt in dit paper een gestileerd numeriek simulatiemodel, gericht op consumptie, besparingen en arbeidsaanbod over de levenscyclus, ontwikkeld. Wij bekijken onder andere de gevolgen van een verschuiving van de pensioengerechtigde leeftijd van 65 naar 67 jaar, van fiscalisering van de aow en van een premie op uitstel van de aow-uitkering. Via vermogenseffecten, inkomenseffecten en inter- en intratemporele substitutie-effecten heeft elk van deze maatregelen invloed op consumptie en arbeidsaanbod. Het gestileerde model biedt een stevige theoretische onderbouwing waardoor we deze beleidseffecten over de gehele levenscyclus van individuen kunnen benoemen. Tegelijkertijd beperkt dit de mogelijkheid om harde conclusies aan de numerieke effecten te verbinden omdat verschillende mechanismen niet in het model zijn opgenomen. In het bijzonder betreft dit de inzichten van 'behavioural economics' zoals 'framing effects'.

Key words: Levensloopbeleid; Arbeidsaanbod over de levenscyclus; Pensionering

Contents

Preface

This document describes the outcomes of a research project through which the Ministry of Economic Affairs, the Ministry of Finance and the Ministry of Social Affairs and Employment enabled CPB to participate in the Network for Studies on Pensions, Ageing and Retirement (Netspar). It develops a life-cycle model for consumption, saving and labour supply, with a focus on retirement of elderly workers. The model is calibrated using Dutch data on retirement patterns and used to simulate the impact of a number of institutional changes on life-time labour supply and discrete labour-market exit.

Compared to other models at CPB, this life-cycle model is unique in describing retirement by elderly workers. The model is, however, highly stylized in a number of ways, which renders it less suitable for drawing firm policy conclusions. For instance, the model is of a partial nature, only describing household behaviour. Moreover, people are fully rational and forward looking and only differ in their ability to work beyond the age of 50. Last but not least, compared to other CPB studies the model ignores insights of behavioural economics. Therefore, the quantitative effects obtained from the simulations presented in this study may differ from the CPB's actual assessment of concrete policy reforms in the Netherlands, as for instance reported for the Bakker Committee (CPB (2008)). The main contribution of the simulations is therefore not to produce reliable quantitative effects of policy changes, but rather to gain insight in the key determinants of life-time labour supply in a stylized economy. The quantitative simulation outcomes of the present study serve to get a rough idea about the magnitude of various channels through which policies affect labour-market behaviour.

The model has been constructed and implemented by Frank van Erp and Paul de Hek. Adri den Ouden en Jan Bonenkamp provided assistance. A steering committee of Sjef Ederveen, Jos Jansen and Pieter van Winden provided useful guidance to the research and gave valuable comments on preliminary drafts. The research also benefited from discussions, seminars and comments of a number of fellows from Netspar and CPB.

Coen Teulings
Director

Summary

In light of the ageing of the Dutch society, current policy debates partly focus on increasing the participation rate of elderly workers, particularly in the age-group between 55 and 64. Such discussions include, for instance, a shift in the age of retirement from 65 to 67, or the elimination of the age-specific Social Security premium exemption of elderly. These policy proposals are likely to affect old-age participation incentives. However, they may also affect people in younger age-groups as they may anticipate these changed institutional arrangements and adjust their labour supply, savings and consumption in response. Therefore, a comprehensive analysis of the labour-market implications of such proposals requires that the effects on other stages of the life cycle are taken into account as well. Despite some limitations, life-cycle models provide a suitable framework for such an analysis.

This paper develops a numerical simulation model describing consumption, savings and labour supply behaviour over the life cycle of an individual. Regarding labour supply, it distinguishes between the participation decision (beyond the age 55) and the hours worked decision. Households differ in their health status after age 50, which explains why people choose different retirement patterns. The model is calibrated using Dutch data and thus replicates actual retirement patterns in the Netherlands. Thereby, we also include the actual Dutch institutions under which people optimize their life-time welfare. By aggregating the discerned groups, the model also reproduces the age profiles of consumption, labour income, financial wealth and retirement as found in the literature. Utility parameters are calibrated so that the model yields plausible wage and income elasticities of labour supply, as reported in the empirical literature.

The model is used to simulate a number of policy reforms in the Netherlands. These include a shift in the (normal) retirement age from 65 to 67, the elimination of the Social Security premium exemption after age 65, the impact of actuarially unfair early retirement benefits, and a premium on first-tier pension benefits if the commencement date of these benefits is postponed. These reforms affect the economic outcomes via wealth effects and inter- and intratemporal substitution effects.

First, wealth effects are caused by (lump-sum) changes in lifetime income. For instance a higher statutory retirement age reduces the period of receiving lump-sum first-tier pension benefits. This lower lifetime income reduces (lifetime) consumption and leisure and increases (lifetime) labour supply. In case of balanced budget analysis, the wealth effect is neutralized for the entire population, although there may be effects on the income distribution among the distinguished groups.

Second, changes in the (real) effective wage rate (including taxes, Social Security premiums and pension rights that are linked to labour income) induce both income and substitution effects.

Indeed, a lower real effective wage rate reduces lifetime income. Yet, it also induces households to substitute from consumption to leisure. Regarding consumption, income and intratemporal substitution effects work in the same direction. Regarding leisure, however, income and intratemporal substitution effects have an opposite sign. Due to the assumed positive labour supply elasticity, the substitution effect is dominant in our model so that a lower real effective wage reduces labour supply.

Finally, age-specific changes in the real effective wage rate induce intertemporal substitution effects. For instance, the elimination of the age-specific Social Security premium exemption of elderly induces households to reallocate labour from pre-65 to post-65 ages and tends to encourage pre-65 savings.

Armed with these key insights in the model, we can understand how policy reforms affect life-time labour supply, consumption and saving of individuals. By aggregating over the various groups distinghuished in the model, we obtain an indication of the size of the aggregate economic impact. We find that acuarially unfair early retirement schemes substantially reduce the participation rate of elderly workers.

The upward shift of the commencement date of first-tier pension benefits to age 67 does not result in an equal shift of the retirement age. The reason is that some groups are unable to shift their retirement age as they already face a constraint at a younger age. Second, some groups increase their hours worked when younger in order to increase savings and financial wealth. After age 64, this additional financial wealth is used to fund retirement in advance of age 67. This illustrates that individuals may be expected to adjust their labour supply long before they are affected by the policy change.

An effective policy reform to stimulate labour supply is the abolition of the statutory retirement age as agreed upon in many collective labour agreements. According to simulations, this reform will raise especially labour supply in the age group 65-69 as individuals capable of working will face a higher reward on their effort. Recently, the Dutch government proposed a 5% financial rate of return on postponed first-tier pension benefits. As the 5% premium is almost equal to the combined interest rate and the mortality rate in the model, we find that this policy will have neglible effects on incentives.

Note that the simulation results should be interpreted with caution for a number of reasons. First, with the exception of a probability of death, we neglect uncertainty in the model. Second, agents are fully rational and the model does not consider aspects emphasized in the behavioural economics literature. Third, the model only describes the supply side of the labour market and captures no interactions with demand and keeps wages fixed. Fourth, the model describes the empirical retirement patterns by just one source of heterogeneity, while various other forms of heterogeneity may matter, e.g. in ability, education, preferences or cohabitation. Fifth, apart from perfect foresight we also assume that the historical time path of individuals agrees with the optimal path. At each age, shocks - like a global financial crisis - may result in a gap between actual and optimal financial wealth of individuals, inducing adjustment of their labour supply choices. Further research in these directions may teach us how the outcomes of the model would change, both in qualitative and in quantitative terms.

1 Introduction

The Dutch population will age considerably over the next 40 years. The proportion of persons aged 65 and over to the working-age population – the so-called old-age dependency ratio – is projected to almost double, from 22% in 2000 to 40% in 2050.[1] This is likely to have a range of economic and social consequences. Clearly there will be upward pressure on public spending in terms of pensions, health and long-term care. To offset some of the pressure that an ageing population will place on the Dutch economy, the Dutch government aims to increase the participation of older people in the labour market.

In terms of broad demographic trends, the speed and magnitude of ageing in the Netherlands is modest compared to most other European countries. Indeed, all European countries aim to increase the labour-market participation of the elderly and have formulated goals on this in light of the Lisbon Process. In this connection, various policies are considered by European governments. For elderly workers, policy reforms focus on the financing of (early) retirement schemes, the mandatory character of retirement savings, the mandatory retirement age, employment protection (which is especially strict for elderly workers), and other design features of social insurances (such as unemployment benefit duration that is conditional on employment history).

It is inherently difficult to assess the economic impact of policies regarding labour market participation of elderly workers. A policy measure, such as the abolition of early retirement schemes, will not only affect the persons in the relevant age category, but also change behaviour at earlier stages of the life course. Moreover, policies aimed at labour market participation will also affect consumption and saving behaviour. For example, individuals may in anticipation of a change in early retirement schemes already adjust their consumption, savings, and labour supply trajectories.

To understand the decision of people regarding exit, or partial exit, from the labour market, we develop a model that describes the main interactions between institutions, labour-supply behaviour, and savings. The model is built on a life-cycle framework. In particular, to properly analyse the time allocation of households over the life cycle, an intertemporal framework that explores the interactions between savings and labour supply is essential.

This study develops an applied life-cycle framework that can be used to explore a variety of policies aimed at raising labour supply of the elderly. The model contains heterogeneous agents who differ according to their health situation over their life cycle. As a result, agents with better health retire later. This allows us to distinguish between different types of individuals, that (may)

[1] OECD (2005)

react differently to specific policy measures.

As any model, this model has certain limitations. For example, the model only consists of a household sector. That is, the role of the demand side is limited to some exogenous restrictions, ignoring equilibrium dynamics between supply and demand. Another simplification concerns the absence of uncertainty. Agents in the model know exactly what will happen over their entire life cycle. This, for example, excludes savings for precautionary reasons. Moreover, we assume that agents are fully rational. This ignores the behavioural aspects as emphasized in the behavioural economics literature.

Chapter 2 contains a short summary of the literature regarding retirement behaviour in the context of structural life-cycle models. In particular, we concentrate on (the few) models that jointly analyse saving and labour supply decisions, including retirement. The studies described show a variety of explanations for retirement behaviour, like age-dependent preferences, fixed costs, borrowing constraints, institutional arrangements. In chapter 3 we describe the core of the applied life-cycle model. This model is an extension of the household sector of the Yaari-model (Yaari, 1965) which is the standard intertemporal life-cycle model in economic textbooks. Endogenous labour supply is the main extension to these models. In chapter 3 we also briefly describe the key features of this extended life-cycle model.[2] The calibration procedure is described in chapter 4. This contains explanations of the strategy, the chosen values of the parameters and exogenous variables, and the method of aggregation.

The model is used to conduct a number of simulations. In chapter 5 we analyse the economic effects of several policy proposals to cope with ageing, such as eliminating the exemption of Social Security premiums after age 65, shifting the statutory retirement age from 65 to 67, and introducing more flexible pension schemes. Our description of these simulations consists of a discussion of the incentives underlying the particular policy measure and the resulting aggregate effects. These effects are obtained with an open budget, concerning both the government and the pension funds. However, in some cases a balanced budget simulation might be more appropriate. In order to approximate the economic effects of balanced budget simulations, we conduct two additional simulations: one regarding a cut in the income tax rate, and one regarding a cut in the pension premium. The combined effects of one (or both) of these simulations and an open budget simulation turn out to be a good approximation of the effects of a closed or balanced budget analysis, either with respect to the government budget or with respect to the budget of the pension funds (or both).

Chapter 6 contains an agenda for future research. The full model and its technical derivations are relegated to the appendix which is available on request.

[2] See Van Erp and De Hek (2007) for an extensive description of the key features of this model.

2 Related literature

Most studies of saving for retirement take the timing of retirement as given (e.g., Scholz et al., 2006; Apps and Rees, 2004; Dynan et al., 2004), while studies of the timing of retirement typically treat accumulated wealth as given (e.g., Rust and Phelan, 1997; Stock and Wise, 1990). Moreover, most studies estimate their model on the basis of an aggregate employment rate by age (or the probability that a person is employed at a certain age), which is gradually declining. As a consequence, they do not explain why individuals often retire from full-time work, without first resorting to part-time work. One way to overcome this problem is to force the agents to either work full time or not work at all.[3]

In this chapter we discuss some life-cycle models that are closest to our model. In particular, we concentrate on (the few) models that jointly analyse saving and labour supply decisions, including retirement. In doing this, we are mainly interested in the rationale behind the retirement decision. Why do people retire, when do they retire, and how (abruptly or gradually)?

Gustman and Steinmeier (2005) estimate a life-cycle model of retirement and saving, with an emphasis on (being able to explain the timing of) the retirement decision. At each point in time, the individual must decide how much to save and whether or not to retire (with exogenous mortality risk). That is, agents either work full time, half time (partial retirement), or not (complete retirement). To be able to explain the age 62 retirement spike, individuals are supposed to have differing rates of time preference (low wealth relative to lifetime earnings translates into high time preferences, and vice versa). A borrowing constraint restricts assets to be non-negative. The utility function contains a term which measures the value of leisure relative to consumption. This term is assumed to be increasing in value as the individual ages and finds work more difficult (depending also on health status and cohort). As a result, leisure becomes more attractive over time, which eventually results in retirement.

The model[4] implies that those with high discount rates often retire at 62, the early entitlement age. Some of these individuals are liquidity constrained and simply cannot afford to retire before the Social Security benefits become available. In addition, individuals with high time preference heavily value lost benefits from working after 62, while largely ignoring potential increases in later benefits. Declining actuarial adjustments beginning at 65 induce those with low discount rates to retire at 65.

The model is used to examine a rise in the Social Security early entitlement age from 62 to

[3] See also Bloom et al. (2006), Kalemli-Ozcan and Weil (2005).

[4] The study analyzes married males who have a 'reasonable' history of full-time work in their adult lives. The data set is taken from the Health and Retirement Study, including information on Social Security benefits, pension plans, and their wife's income and retirement status. The parameters are estimated using the generalized method of moments (GMM) estimator. The theoretical moments are simulated (using backward induction).

64.[5] For the same reasons as above – liquidity constrained and/or heavily discounting the future – this induces 5% of the population to delay retiring, shifting the retirement spike from 62 to 64 (in contrast to French, 2005, see below). That is, the percentage of individuals retiring at age 62 is reduced by (almost) 5 percentage points, whereas the percentage of individuals retiring at age 64 is raised with (almost) 5 percentage points.

Blau (2005) also estimates a life-cycle model in which both consumption and employment are choices, and the labour supply decision of the agents is restricted to a choice between working (full time) and not working (retired). The agent in the model is assumed to be a married man (although behaviour of the spouse is not modeled), and his age ranges between 50 and 100. Wages are assumed to be constant with respect to age. The agent is not allowed to borrow. He derives utility from consumption, and leaving assets to one's wife in the event of death. Employment yields disutility, affected by the health status of the individual. In addition, the model includes Social Security retirement and disability programs, employer pensions, a consumption floor provided by government welfare programs, stochastic processes for earnings and asset returns, layoff risk, job offer risk, health risk, and mortality risk. Ex ante, agents are the same, ex post, agents differ due to different realizations of the shocks.

The issue examined here is whether the model[6] can generate simulated consumption and retirement behaviour that resembles the general patterns of behaviour found in the data. In particular, the study focuses on explaining the drop in consumption at retirement, without resorting to non-separable preferences.[7] Concerning the employment profile, the changes in the slope of the age-employment relationship, indicating periods of increased retirement, are mostly due to Social Security and pension incentives in the model. Health status changes smoothly with age, inducing smooth changes in employment probability. That is, participation slowly declines before 62, the early retirement age, and after 70, the maximum social security entitlement age, mainly due to changes in health and adverse realizations of the shocks (e.g., low wage rates, unemployment). Between 62 and 70, retirement is mainly driven by the (actuarial unfair) Social Security and employer-provided pension benefits.

Van der Klaauw and Wolpin (2006) aim to forecast the impact of changes in the Social Security program. For this reason, they develop and estimate a model of retirement and savings[8], incorporating limited borrowing, stochastic wage offers, health status and survival, Social

[5] This simulation assumes that the employer-provided pension plans will not change.

[6] The model is calibrated to data from the Health and Retirement Study (HRS). The model solution was used to simulate life-cycle trajectories for 10,000 artificial agents.

[7] The findings suggest that the combination of uncertainty and choice of retirement date is critical for generating a drop in consumption at retirement.

[8] The model is estimated on a sample of relatively poor households from the first three waves of the HRS.

Security benefits, Medicare and employer provided health insurance coverage, and intentional bequests. In addition, they model the joint labour supply decision of married couples, and include expectations over changes in Social Security policy. Hours worked, if positive, is allowed to take two values, part-time hours or full-time hours. Employment choices are further restricted in that all individuals are assumed to stop working (permanently) at age 75. Individuals become eligible to apply for Social Security at age 62. Postponement of first receipt of benefits increases benefits by some percentage (depending on age). Health status, which is assumed to be either good or poor, affects the parameters in the utility function. Estimates imply that the marginal utility of consumption is smaller, and the marginal disutility of hours of work is greater for those in poor health. The transition from work to retirement is caused by declining wages, rising Social Security benefits, and changes in health status. The estimated model forecasts large and heterogeneous behavioural responses in reaction to changes in Social Security rules.

French (2005) estimates a life-cycle model of labour supply, retirement, and savings behaviour. The agent chooses both hours of work and retirement (participation). Future health status and wages are uncertain. Individuals can save to insure themselves against health and wage shocks as well as for retirement, but cannot borrow against future labour, Social Security, and pension income to smooth consumption in the face of an adverse shock. The analysis[9] focuses on men aged 30-95. Hourly wages follow a hump-shaped pattern, while part-time workers earn less per hour than full-time workers. Health is either good or bad. Bad health reduces the available time for work and leisure. Declining wages, deteriorating health and large pension and Social Security work disincentives push hours worked downwards. Retirement occurs if the desired level of hours worked falls below the level determined by the fixed costs of work. The model establishes that the tax structure and the actuarial unfairness of Social Security and pensions are key determinants of the high observed job exit rates at ages 62 and 65. In French (2005), pension eligibility is not a choice variable. Rather, he assumes that all individuals begin drawing pension benefits at age 62. This explains the large impact of the tax structure on labour supply at age 62, as many people would be pushed into higher tax brackets if they continued to work.

The model is used to conduct three simulations: (i) shifting the early retirement age from 62 to 63, (ii) a 20% reduction in Social Security benefits, and (iii) eliminating the tax wedge caused by the Social Security earnings test. Simulations from the model indicate that shifting the early Social Security retirement age to 63 would leave years in the labour force largely unchanged. This is explained by the next two facts. First, total benefits are largely unaffected, as recomputation formulae almost fully replace benefits lost. Thus, there is no wealth effect.

[9] The paper uses the method of simulated moments to match life-cycle profiles (labour force participation, hours worked, and assets) estimated using data from the Panel Study of Income Dynamics to life-cycle profiles generated by a dynamic programming model. This produces estimates of preference parameters such as the intertemporal elasticity of substitution and the time discount factor.

Second, borrowing constraints bind for very few individuals at age 62, implying that only these very few individuals are forced to retire later, when Social Security benefits become available.

Removing the tax wedge would delay job exit by almost one year. This reduction in the tax rate after 65 will increase lifetime wealth. The wealth effect will lead individuals to take more leisure. However, the substitution effect from this tax reduction causes individuals to raise hours worked after age 65. The substitution effect clearly dominates, inducing years in the labour force to rise by approximately one year.

By contrast, the 20% reduction in Social Security benefits would cause workers to delay exit from the labour force by only three months. This delay involves both a wealth and a substitution effect that work in the same direction. First, the loss of Social Security benefits causes a loss of lifetime wealth. This results in individuals working more hours throughout their lives, as they consume less leisure given the loss of wealth. Second, the policy measure also effectively reduces the high marginal tax rates of the earnings test. The associated substitution effect causes individuals to work more hours when eligible for Social Security benefits and fewer hours at younger ages.

3 The life-cycle model

3.1 Introduction

Our starting point is the standard life-cycle model as in Yaari (1965) and Hurd (1989). This model yields predictions of consumption and labour supply trajectories of individuals over their life-cycle. Section 3.2 starts with a description of the utility function, and describes the constraints that are active in the model. Section 3.3 focuses on institutions or policy variables like taxes, Social Security and the pension system. Finally, the key features of the model are described in section 3.4.

3.2 Utility function

Following the standard life-cycle model with lifetime uncertainty and (real) bequests, the (remaining) lifetime utility for a person with a current age of s years and a (maximum) finite lifetime of T years is given by

$$U_{c,v} = \sum_{t=s}^{T} \left(\frac{1}{1+\rho} \right)^{t-s} \left[\xi_{t,s} \mathrm{u}(c_t, v_t) + m_{t,s} \mathrm{v} \left(\frac{a_t}{\tilde{p}_t} \right) \right] \tag{3.1}$$

with

$$\mathrm{u}(c_t, v_t) = \frac{1}{1-\frac{1}{\gamma}} \mathrm{x}(c_t, v_t)^{1-\frac{1}{\gamma}}, \qquad \gamma > 0,\ \gamma \neq 1, \tag{3.2}$$

where ρ is the rate of time preference used for discounting the future, $\xi_{t,s}$ denotes the probability that the individual of age s will be alive at time t, and $m_{t,s}$ is the mortality rate at time t: $m_{t,s} = (\xi_{t,s} - \xi_{t+1,s})$. Notice that t is an age index. Lifetime utility consists of two parts. The first term in the right hand side of equation (3.1) describes the utility – when alive – derived from consumption c and leisure v, consisting of a CRRA utility function[10] as described in equation (3.2). The parameter $\gamma > 0$ is the intertemporal elasticity of substitution of the composite good x, consisting of the CES nest of consumption and leisure. The second term in the right hand side of equation (3.1) refers to the bequest motive. The desire to leave real bequests ($\frac{a_t}{\tilde{p}_t}$, to one's children, to other family members or to charity) is a potential explanation of the (substantial) amount of assets that people hold when they die. This particular type of (impure) altruism, commonly referred to as "warm glow preferences", assumes that parents derive utility from their bequests, rather than from the utility of their offspring. With respect to the functional form, we follow De Nardi (2004) and Ameriks et al. (2007) in parameterizing the bequest utility with two parameters: ω, controlling the strength of the bequest motive, and ϕ, measuring the degree to

[10] Constant Relative Risk Aversion

which bequests are a luxury good. That is, an agent leaving a bequest a receives direct utility

$$\mathrm{v}\left(\frac{a_t}{\tilde{p}_t}\right) = \frac{\omega}{1-\frac{1}{\alpha}}\left(\phi + \frac{1}{\omega}\frac{a_t}{\tilde{p}_t}\right)^{1-\frac{1}{\alpha}} \tag{3.3}$$

where α is the intertemporal elasticity of substitution of bequests, a end of period (nominal value of) private financial wealth and $\tilde{p}$ the consumption price.

In each period t the utility derived from consumption and leisure is described by a CES-function in which σ is the elasticity of intratemporal substitution between consumption and leisure,

$$\mathrm{x}(c_t, v_t) = \left[\mu_c{}^{\frac{1}{\sigma}} c_t^{1-\frac{1}{\sigma}} + \mu_v{}^{\frac{1}{\sigma}} v_t^{1-\frac{1}{\sigma}}\right]^{\frac{1}{1-\frac{1}{\sigma}}}, \qquad \sigma > 0,\ \sigma \neq 1. \tag{3.4}$$

The preference parameters μ_c and μ_v measure the relative weights of consumption and leisure in utility.[11] The functional form of the utility function differs with the ones in French (2005) and Gustman and Steinmeier (2005). We use a combination of CRRA- and CES-functions, while French (2005) assumes CRRA- and Cobb-Douglas functions and Gustman and Steinmeier (2005) use additive CRRA-functions.

Utility is maximised subject to a time and a budget constraint, resulting in optimal choices of leisure, labour supply and consumption. In addition, the model contains the opportunity to impose a borrowing contraint.

The *time constraint* reads

$$v_t + l_t + d_t l_t = l^{max} \qquad l_t \geq 0, \tag{3.5}$$

where l_t represents hours of work. In general, the total amount of time available in a given period, as represented by l^{max}, can be divided between working and non-working time. In the present model, non-working time in turn consists of time spent on leisure which generates utility, and time related to work that does not generate utility nor income. The latter non-working time contains e.g. travel time to and from work, and time needed to rest or recover from work. The amount of time spent in this way may depend on hours of work, that is, the more hours you work the more time you need to recover from work. This mechanism is captured in the (exogenous) variable d_t, representing a time surcharge on labour.[12]

As shown in the box (below), the variable d_t has also a preference interpretation. The same patterns of labour supply and consumption can be obtained by simultaneous changes in the

[11] In this paper, we ignore the possibility of minimum consumption or minimum leisure.

[12] Alternatively, this amount of time depends on labour supply participation only, unaffected by hours of work. In Van Erp and De Hek (2007) this is captured in the variable $l_{t,fixed}$, i.e. fixed labour costs. Fixed costs are also used by French (2005) to describe retirement behaviour. In this paper, we set these fixed costs to zero, and instead include a minimum labour supply constraint (see below).

parameters of the utility function. This interpretation is in line with the increasing disutility of work (depending on health status and/or age) as applied by Gustman and Steinmeier (2005), Blau (2005), and Van der Klaauw and Wolpin (2006).

Alternative interpretation of d_t

An alternative interpretation of d_t arises when the utility function is rewritten as

$$\tilde{x}(c_t,\tilde{v}_t) = \left[\mu_c{}^{\frac{1}{\sigma}} c_t^{1-\frac{1}{\sigma}} + \tilde{\mu}_v^{\frac{1}{\sigma}} \left(\tilde{v}_t - v_{t,min}\right)^{1-\frac{1}{\sigma}}\right]^{\frac{1}{1-\frac{1}{\sigma}}}, \qquad \sigma > 0,\ \sigma \neq 1. \tag{3.6}$$

with

$$\tilde{v}_t = v_t + d_t l_t \tag{3.7}$$

$$\tilde{\mu}_v = \mu_v (1+d_t)^{\sigma-1} \tag{3.8}$$

$$v_{t,min} = \frac{d_t}{1+d_t} l^{max} \tag{3.9}$$

This shows that d_t has also a preference interpretation. The same patterns of labour supply and consumption can be obtained by simultaneous changes in $\tilde{\mu}_v$, the relative weight of leisure, and $v_{t,min}$, the minimum amount of leisure needed.

In addition to the time constraint, we impose a *minimum labour supply constraint*. Agents are thus not allowed to work less than some minimum amount of hours per year, i.e.,

$$l_t \geq l^{min} \tag{3.10}$$

This restriction is imposed on the workers by the employers. Notice that we assume continuous labour supply, restricted by a lower bound and an upper bound.

The *budget constraint* follows from the accumulation of wealth[13],

$$a_t = (1+r_t^h)a_{t-1} + (w_t l_t + aow_t + pb_t) - ps_t - pp_t - tax_t - \tilde{p}_t c_t, \tag{3.11}$$

where a_t is end of period wealth, w_t the nominal wage rate (which may vary over time), aow_t first-tier pension (state) benefits, pb_t second-tier pension benefits, ps_t Social Security premiums employees'insurance, pp_t pension premiums, tax_t income tax and $\tilde{p}_t$ the price of the consumption good including consumption taxes. This price is defined by

$$\tilde{p}_t = (1+\tau_c)p_t \tag{3.12}$$

where τ_c is the consumption tax and $\tilde{p}_t$ the price of the consumption good (which may also vary over time).

[13] In this paper, we ignore unemployment and associated unemployment benefits, as well as other early retirement schemes and income transfers between households and other sectors.

The wage rate changes after withdrawal from the first job (t_{ret}) and is defined by

$$w_t = \begin{cases} w_{t,1} & \text{if } t < t_{ret} \\ w_{t,2} & \text{if } t \geq t_{ret} \end{cases} \tag{3.13}$$

Regarding both wage rates we assume a wage profile. The wage rate of the first job gradually increases up to the age of 50 years by almost 1% per year. Thereafter it remains stable until the age of quitting this (first) job. Next, the wage rate in the second job is lower than the wage rate of the preceding job and gradually declines.

The relevant interest rate on private financial wealth, r_t^h, is the difference between the nominal interest rate and the tax rate on financial wealth. So, defined by

$$1 + r_t^h = (1 + r - \tau_a) \tag{3.14}$$

where r is the nominal interest rate (assumed to be constant) and τ_a the tax rate on wealth.[14]

In terms of institutions, the current model contains

1. State pension (aow_t, first-tier of pension system)
2. Private pension (pb_t, second-tier of pension system)
3. Pension premiums (pp_t)
4. Taxes and Social Security premiums on current income (tax_t, ps_t)

End of period wealth (a_t), then is equal to wealth at the end of the preceding period (a_{t-1}), plus the net revenues of wealth ($r_t^h a_{t-1}$), plus current income ($w_t l_t + ers_t + aow_t + pb_t$) minus pension premiums (pp_t), minus taxes and Social Security contributions on current income (tax_t), and minus consumption ($\tilde{p}_t c_t$). Current income consists of wage income ($w_t l_t$), pension benefits paid by the government (aow_t) and pension benefits paid by pension funds (pb_t), if applicable. In section 3.3 we will discuss these elements more extensively.

Imperfect financial markets enter the model through the opportunities to impose a *borrowing contraint*. The most used form, also applied by French (2005), Gustman and Steinmeier (2005), and Blau (2005), is

$$a_{t-1} \geq 0 \ \text{ for } t \geq s \tag{3.15}$$

That is, we impose that agents are not allowed to borrow during their whole life span. This is particularly relevant in the presence of a mandatory pension system. The presence of a (sufficiently strong) bequest motive, in addition, implies that this borrowing constraint tends to be more pressing for the young.

[14] Note that the survival probabilities $\left(\frac{\xi_{t-1,s}}{\xi_{t,s}}\right)$ are not included in the relevant interest rate. In some related literature (e.g., Yaari, 1965) these probabilities are incorporated in the interest rate and reflect the presence of life-insurance or annuity markets, where competitive life insurance firms make payments to individuals (as a function of their asset levels) in return for receiving their positive assets when they die. However, these annuity markets and life-insurances do not exist in the real world and are inconsistent with the distribution of bequests among housholds.

3.3 Institutions

To analyse the retirement behaviour, the model contains several institutional arrangements, including the pension system and the tax system. The pension system distinguishes between early retirement pension, state pension (first-tier) and private pension (second-tier benefits). State pension is funded by Social Security premiums and/or taxes. Private pension is financed by mandatory pension premiums. These institutional benefits and taxes are discussed in the next sections.

3.3.1 Mandatory retirement

We distinguish two types of jobs. The first job is the main job, which provides the agent with a pension. After the agent retires from his main job, and starts to receive pension benefits, he may choose to take a second job. The (net) wage rate associated with this second job, however, is substantially lower than the (net) wage rate belonging to the main job – even after Social Security contributions are dropped. There are two reasons behind this supposed drop in wages. First, this may reflect the falling productivity of the elderly. This is not reflected in the wage rate of the main job, suggesting that wages of the elderly are higher than their productivity,[15] but manifests itself once the agent takes a new job. A second explanation of the wage drop is a loss of firm-specific human capital that may occur if a person changes jobs.

Agents are not allowed to work in their main job after the statutory retirement age. That is, once they reach the statutory retirement age, and are still at work in their main job, they face a compulsory dismissal.[16]

3.3.2 State pension

Reflecting current Dutch institutions, the retirement benefit paid by the government (aow) is specified by a fixed benefit after achieving a specific age ($t_{pa,1}$). These benefits are lump-sum transfers and independent from current and/or historical labour income.[17]

$$aow_t = \begin{cases} 0 & \text{if } t < t_{pa,1} \\ \delta & \text{if } t \geq t_{pa,1} \end{cases} \tag{3.16}$$

[15] Discrepancies between wage and productivity over the life cycle may arise for different reasons, for example due to the presence of implicit contracts. See e.g. De Hek and Van Vuuren (2008).

[16] In the Netherlands almost all collective labour agreements provide an opportunity to employers to dismiss employees at a particular age, often 65, without paying a dismissal allowance. In fact employment protection is (temporarily) elevated at this age. Although dismissal at this particular age is not obliged, in practice the majority of employers lays off its employees at this age. Therefore, from the perspective of employees, this age acts as an age of compulsory dismissal.

[17] In this respect this specification differs from French (2005) where benefits paid by the Social Security system depend on the retirement age and historical labour income. Equation (3.16) is actually a simplified version of the specification in our model. In order to assess the effects of some proposals put forward in the policy debate, we include a premium related to a prolonged participation in the labour market and a delayed commencement date of the state pension. This extended specification is written in the appendix which is available on request.

These benefits are financed by Social Security contributions (see section 3.3.4).

3.3.3 Private pension

The retirement benefit paid by the pension funds (pb) is determined by a *defined benefit* pension system.[18] Pension premiums are proportional to labour income minus an age-independent franchise (f_p), with a minimum amount of zero. Premiums are paid until the age of receiving second-tier pension benefits ($t_{pb,2}$). Furthermore, related to Dutch institutions, we assume a common pension premium. Note, the combination of a common pension premium and the defined benefit pension scheme results in an actuarial unfair pension scheme. In addition, for the sake of simplicity, we limit second-tier pensions to the first job ($t \leq t_{ret} - 1$). Therefore,

$$pp_t = \begin{cases} \tau_p \max\{0, w_t l_t - f_p\} & \text{if } t \leq t_{pb,2} - 1 \text{ and } t \leq t_{ret} - 1 \\ 0 & \text{if } t > t_{pb,2} \text{ or } t > t_{ret} - 1 \end{cases} \tag{3.17}$$

At the end of each year pension rights are equal to the pension rights at the end of the preceding year plus an accrual defined by an appropriate interest rate (r_t^{pf}), the accrual of pension rights in year t (po_t), minus paid pension benefits in year t (pb_t):

$$ap_t = (1 + r_t^{pf}) ap_{t-1} + po_t - pb_t \tag{3.18}$$

Regarding pension rights, the appropiate interest rate is defined by:

$$r_t^{pf} = (1 + r) \frac{\xi_{t-1,s}}{\xi_{t,s}} - 1 \tag{3.19}$$

Here, in contrast to the financial markets for private financial wealth, the relevant interest rate does include mortality rates as deceased participants of the pension scheme leave their pension rights to the remaining members. Furthermore, notice that the yield on pension wealth is not taxed.

The accrual of pension rights (po_t) in principle takes place until the time of withdrawal from the first job ($t < t_{ret}$), unless individuals are provided with the possibility to advance the commencement date of receiving pension benefits ($t < t_{pb,2}$). In the present case of a defined benefits scheme the accrual of rights is equal to the present value of the growth of promised pension benefits. Assuming an annual growth of β of the labour income, this present value is $\beta w_t l_t D_{2,t}$ and the accrual of pension rights follows

$$po_t = \begin{cases} pp_t & \text{if pension system is defined contribution, } t < t_{pb,2} \text{ and } t < t_{ret} \\ \beta w_t l_t D_{2,t} & \text{if pension system is defined benefit , } t < t_{pb,2} \text{ and } t < t_{ret} \\ 0 & \text{if } \ t < t_{pb,2} \text{ and } t \geq t_{ret} \end{cases} \tag{3.20}$$

with $D_{2,t}$ the discount factor defined by

$$D_{2,t} = \sum_{j=t_{pa,2}}^{T} \left(\frac{1}{1+r} \right)^{j-t} \frac{\xi_{j,s}}{\xi_{t,s}} \tag{3.21}$$

[18] In addition, the model offers the opportunity to introduce alternative pension systems, such as defined contribution.

where $t_{pa,2}$ is the pivot age of the (defined benefit) pension scheme.

Payments of second-tier retirement benefits (pb_t) by pension funds starts at age $t_{pb,2}$. Usually, and in the baseline scenario, this age is equal to the age an individual stops working in his first job (t_{ret}). The pension fund then imposes the amount of total pension benefits, which consists of a fixed annuity during the period of retirement ($pb^g_{t_{pb,2}}$). This annuity level, in which the first-tier pension benefits starting at age $t_{pb,1}$ are incorporated, follows from the equivalence between the present value of future retirement benefits and the available pension rights, including the present value of first-tier pension rights (ap^{aow}_t), at the moment of retirement,

$$pb^g_{t_{pb,2}} = \Gamma^{-1}_{t_{pb,2}} \left(ap_{t_{pb,2}-1} + ap^{aow}_{t_{pb,2}-1} \right) \tag{3.22}$$

with

$$\Gamma_{t_{pb,2}} = \sum_{u=t_{pb,2}}^{T} \left(\frac{1}{1+r} \right)^{u-(t_{pb,2}-1)} \frac{\xi_{u,s}}{\xi_{t_{pb,2}-1,s}} \tag{3.23}$$

$$ap^{aow}_{t_{pb,2}-1} = \sum_{u=t_{pb,1}}^{T} \left(\frac{1}{1+r} \right)^{u-(t_{pb,2}-1)} \frac{\xi_{u,s}}{\xi_{t_{pb,2}-1,s}} aow_u \tag{3.24}$$

The amount actually paid by second-tier pension funds (pb_t) depends on the sequence of the commencement dates of first and second tier pension benefits ($t_{pb,1}$, $t_{pb,2}$). Second tier pension benefits are adjusted over time to smooth total pension income of households. That is, if individuals receive simultaneously both first and second-tier pension benefits, second-tier benefits are equal to the difference between total ($pb^g_{t_{pb,2}}$) and first-tier pension benefits (aow_t). If first-tier pensions benefits are not yet received, the pension funds temporarily pay the fixed annuity ($pb^g_{t_{pb,2}}$) and, from the commencement date of first-tier pension benefits on, the difference between total and first-tier benefits. Thus,

$$pb_t = \begin{cases} 0 & \text{if } t < t_{pb,2} & \text{and } t_{pb,2} \leq t_{pb,1} \\ pb^g_{t_{pb,2}} & \text{if } t_{pb,2} \leq t < t_{pb,1} & \text{and } t_{pb,2} \leq t_{pb,1} \\ pb^g_{t_{pb,2}} - aow_t & \text{if } t_{pb,1} \leq t \leq T & \text{and } t_{pb,2} \leq t_{pb,1} \\ & & \\ 0 & \text{if } t < t_{pb_2} & \text{and } t_{pb,2} > t_{pb,1} \\ pb^g_{t_{pb,2}} - aow_t & \text{if } t_{pb,2} \leq t \leq T & \text{and } t_{pb,2} > t_{pb,1} \end{cases} \tag{3.25}$$

These specifications of the pension system deviate slightly from French (2005) and Gustman and Steinmeier (2005). In our model the age of retirement is endogenous and the pension benefit is related to that age. In Gustman and Steinmeier (2005) the pension benefits are exogenous. French (2005) imposes the retirement age regarding pensions at 62 years. Only the time individuals begin drawing from the state pension is endogenous.

3.3.4 Taxation and Social Security premiums

In this basic set-up we distinguish three sources of taxation.[19] Taxes are levied on current income, the stock of wealth, and consumption. Taxes on consumption and wealth are already discussed in section 3.2 as part of the budget constraint. Taxes on current income are proportional, as captured by the rate $\tau_{y,t}$. Notice that the tax rate on current income is dependent on age. This allows us to use the model for age-dependent policy simulations such as financing the first tier of the Dutch pension system. Total taxes (tax_t) consist of a proportional income tax (τ_y) and Social Security contributions (τ_{aow}). The taxable income[20] encompasses labour income (wl) and retirement benefits paid by state (aow) and pension funds (pb). Pension premiums (pp) and Social Security premiums for employees' insurances are tax-deductible. Social Security contributions are imposed until the age of t_{aow}. In sum, this amounts to

$$tax_t = \begin{cases} (\tau_y + \tau_{aow})tax\_base_t & \text{if } t < t_{aow} \\ (\tau_y)tax\_base_t & \text{if } t \geq t_{aow} \end{cases} \tag{3.26}$$

with

$$tax\_base_t = w_t l_t + aow_t + pb_t - ps_t - pp_t \tag{3.27}$$

Social Security premiums for national insurances are part of the tax system. Social Security premiums for employees' insurances are specified separately and, up to age t_{ss}, proportional to labour income minus pension premiums.

$$ps_t = \begin{cases} \tau_s \max\{0, w_t l_t - pp_t\} & \text{if } t < t_{ss} \\ 0 & \text{if } t \geq t_{ss} \end{cases} \tag{3.28}$$

where τ_s is the Social Security premium rate for employees' insurances.

3.4 Key features

The model described in the preceding sections results in a set of key equations that describe the growth of marginal utilities (equations (3.29) and (3.30)), the growth of consumption (equation (3.31), the growth of leisure (equation (3.32)) and the ratio between marginal utilities of consumption and leisure (equation (3.33)).[21]

$$\frac{u_c(c_{t+1}, v_{t+1})}{\mathrm{u}_c(c_t, v_t)} = \Psi_{c,t} \tag{3.29}$$

$$\frac{u_v(c_{t+1}, v_{t+1})}{\mathrm{u}_v(c_t, v_t)} = \Psi_{v,t} \tag{3.30}$$

[19] In Gustman and Steinmeier (2005) taxation is omitted. French (2005) distinguishes only income taxes.

[20] We neglect the impact of institutional differences between employee insurances and Social Security insurances.

[21] See Appendix A, available on request, for a derivation.

$$\frac{c_{t+1}}{c_t} = \Psi_{c,t}{}^{-\gamma} \left(\frac{\Gamma_{c,t+1}}{\Gamma_{c,t}}\right)^{\gamma/\sigma-1} \tag{3.31}$$

$$\frac{v_{t+1}}{v_t} = \Psi_{v,t}{}^{-\gamma} \left(\frac{\Gamma_{v,t+1}}{\Gamma_{v,t}}\right)^{\gamma/\sigma-1} \tag{3.32}$$

$$\frac{\mathrm{u}_v(c_t, v_t)}{\mathrm{u}_c(c_t, v_t)} = \Delta_t \tag{3.33}$$

In this particular case, including the retirement decision, the pension system, variable labour costs and a borrowing constraint, $\Psi_{c,t}$, $\Psi_{v,t}$, $\Gamma_{c,t}$, $\Gamma_{v,t}$ and Δ_t are given by:

$$\Psi_{c,t} = \frac{(1+\rho)/\frac{\xi_{t+1,s}}{\xi_{t,s}}}{(1+r_t^h)/\frac{\tilde{p}_{t+1}}{\tilde{p}_t}} \left[1 - \theta_t - \frac{m_{t,s}\frac{1}{\tilde{p}_t}\mathrm{v}_a\left(\frac{a_t}{\tilde{p}_t}\right)}{\xi_{t,s}\mathrm{u}_c(c_t, v_t)\frac{1}{\tilde{p}_t}}\right] \tag{3.34}$$

$$\Psi_{v,t} = \frac{(1+\rho)/\frac{\xi_{t+1,s}}{\xi_{t,s}}}{(1+r_t^h)/\frac{\tilde{w}_{t+1}}{\tilde{w}_t}} \left[1 - \theta_t - \frac{m_{t,s}\frac{1}{\tilde{p}_t}\mathrm{v}_a\left(\frac{a_t}{\tilde{p}_t}\right)}{\xi_{t,s}\mathrm{u}_v(c_t, v_t)\frac{1}{\tilde{w}_t}}\right] \tag{3.35}$$

$$\Gamma_{c,t} = \left[\mu_c{}^{\frac{1}{\sigma}} + \mu_v \mu_c{}^{\frac{1}{\sigma}-1} \Delta_t{}^{1-\sigma}\right]^{\frac{1}{1-\frac{1}{\sigma}}} \tag{3.36}$$

$$\Gamma_{v,t} = \left[\mu_c \mu_v{}^{\frac{1}{\sigma}-1} \Delta_t{}^{\sigma-1} + \mu_v{}^{\frac{1}{\sigma}}\right]^{\frac{1}{1-\frac{1}{\sigma}}} \tag{3.37}$$

$$\Delta_t = \frac{\tilde{w}_t}{\tilde{p}_t} \tag{3.38}$$

$$\tilde{w}_t = \frac{1}{1+d_t}\left[\left[1 - \tau'_{p,t} - \tau'_{s,t} - \tau'_{y,t}(1 - \tau'_{p,t} - \tau'_{s,t}) + \zeta_t po'\right] w_t + \eta_t \mathrm{I}_t[s, t_{ret} - 1]\right] \tag{3.39}$$

with $\mathrm{I}_t[s, t_{ret} - 1]$ an indicator function reflecting the minimum hours constraint ($l_t \geq l^{min}$) regarding the first job.

The variable $\tilde{w}_t$, as defined by equation (3.39), is the effective (marginal) net wage rate. The marginal net wage rate is equal to the gross wage rate times one minus the (marginal) income tax (τ'_y), marginal Social Security premiums employees' insurances (τ'_s) and (marginal) pension premium (τ'_p). The *effective* marginal net wage rate adjusts the net wage rate by taking care of the (maginal) revenues of the pension system ($po'_{w_t l_t}$) , the minimum hours worked constraint ($\eta_t \mathrm{I}_t[s, t_{ret} - 1]$), and the time surcharge on labour (d_t). Basically, the effective marginal net wage rate is the total compensation of supplying one hour of labour. The variable Δ_t represents the effective marginal net *real* wage rate, the ratio between the effective marginal net wage rate and the (marginal) consumption price including consumption taxes. Below, we clarify these key equations.

The (gross) growth rates of the marginal utilities of consumption and leisure, $\Psi_{c,t}$ and $\Psi_{v,t}$, mainly depend on the ratio between the rate of time preference (ρ) and an appropriate defined real net interest rate. Notice that the deflator of the real interest rate differs between consumption and leisure.[22]

The growth rates of consumption and leisure, in turn, depend on these growth rates of marginal utilities, together with the effective net real wage rates in the two periods (through $\Gamma_{c,t}$ and $\Gamma_{v,t}$). The direction of the impact of the effective net real wage on the growth rates of consumption and leisure depends on the relative magnitudes of the intertemporal rate of substitution (γ) and the intratemporal rate of substitution (σ). If $\sigma > \gamma$ consumption and leisure are substitutes and a rise in the real net wage rate leads to more consumption, less leisure and more labour supply. If $\sigma < \gamma$ consumption and leisure are complements and a rise in the effective net real wage rate leads to less consumption, less leisure and more labour supply.

The presence of a time surcharge on labour, d_t, results in a proportional discount of the effective net wage rate. The pension system results in tax-deductible pension premiums, $(1-\tau'_{y,t})\tau_p$. Money spent on pension premiums is not wasted, but yields pension benefits while retired. The value the agent attaches to pension savings is reflected in the shadow price ζ. As explained in appendix[23], ζ_t measures the relative utility of pension savings compared to private savings. Depending on the distortions of the pension system (absence of a tax on the yields of pension wealth on the one hand, the possible influence of the borrowing constraint on the other hand), ζ will be larger or smaller than $1-\tau'_{y,t}$. As a result, the pension premium may reduce or enhance the effective net wage rate. In addition, as witnessed by the term $D_{t_p,t}$, a DB pension system causes the effective wage rate to increase over time, until retirement is reached (and pension premiums are stopped being paid). This reflects the fact that pension build-up is a fixed fraction of income at the pension pivot age, implying that later paid premiums have higher yields.

The fact that hours worked are bounded below (by l^{min}) yields a shadow price of labour represented by the surcharge η_t.

Finally, in the presence of a borrowing constraint the free-choice optimal dynamic path of consumption and leisure (labour supply) is affected by the surcharge θ_t in order to fulfill the borrowing constraint.

The above equations describe the intertemporal allocation of goods and time (growth paths). The choices of consumption and leisure within a certain period, i.e. the intratemporal decisions (levels), are related according to

$$\frac{c_t}{v_t} = \frac{\mu_c}{\mu_v}{\Delta_t}^{\sigma} \tag{3.40}$$

Together with the lifetime budget constraint, this determines the initial levels of consumption and

[22] This difference in deflator is related to the value of postponing a unit of consumption (consumption price p_t) or leisure (wage rate w_t). In the case consumption is postponed, the additional wealth in the next period is $(1+r)p_t$ and available for $(1+r)\frac{p_t}{p_{t+1}}$ additional consumption goods. If leisure is postponed, the additional wealth in the next period is $(1+r)w_t$ and yields $(1+r)\frac{w_t}{w_{t+1}}$ additional hours of leisure.

[23] This appendix is available on request

leisure. The effect of the level of the wage rate on the (initial, or average) level of labour supply, i.e. hours worked, depends on the relative strenghts of the substitution effect and the income effect. At $\sigma = 1$ both effects exactly cancel, and labour supply is unresponsive of the real wage. The substitution effect dominates if $\sigma > 1$, while the income effect is relatively stronger if $\sigma < 1$.

Finally, the assumed utility function implies a link between the marginal utility of consumption and the marginal utility of bequest. This link is immediately evident at the end of the time horizon (T). Assuming that labour supply is nil at T [24], individuals allocate the available financial wealth at the start of the final period among consumption and bequests. So, in equilibrium marginal utility of consumption is equal to the marginal utility of bequests and an increase in marginal utility of consumption due to a fall in the level of consumption, requires a fall in bequest at T too. That is, in equilibrium, a lower level of consumption is associated with a lower level of bequest. Or considered from an intuitive point of view: individuals with a small consumption (due to small lifetime income) prefer leaving small bequests.

In earlier periods t ($t < T$) an almost similar link exist. Main difference is the influence of consumption at t on all future bequests up to T. After all, reducing consumption at time t with one unit, not only increases end of period financial wealth at t, but also increases financial wealth in all future periods. Taken into account the (real net) interest rate, the effect on financial wealth in future periods will be larger or smaller than the change in consumption at time t. Finally, the survival rates (and mortality rates) and the rate of time preference affect the link between marginal utility of consumption and marginal utility of bequests.[25]

[24] For instance as the variable labour costs (d_t) are very large or the nominal wage rate is almost nil.

[25] Assuming the real net interest rate is equal to the rate of time preference and assuming no effect of the borrowing constraint, the marginal utility of consumption at time t is equal to the sum of the expected marginal utilities of bequests during the residual time span. The conditional mortality rate, conditional on being alive at time t, determines this expected value.

4 Calibration

4.1 Introduction

In order to obtain an applied life-cycle model suitable for policy purposes in the Dutch economy, the aforementioned model has to be estimated or calibrated on Dutch data. However, a full and mutual consistent set of data of consumption, income, wealth, labour supply and retirement is not available. Therefore, the calibration has to be more tentative and limited to the reproduction of some (empirical) stylized facts using plausible values for the structural parameters. Regarding the stylized facts we focus on

1. Empirical retirement patterns
2. Labour supply elasticity
3. Age-profiles of consumption, income and wealth

In the next section, we will describe these stylized facts in more detail. Thereafter, we focus on the applied strategy to explain the variety in retirement ages. Taking into account the economic literature, Section 4.4 presents a survey of the imposed parameter values for utility function, institutions etcetera. After discussing the aggregation of individuals towards macroeconomic key figures, we briefly compare the results of the model with the stylized facts.

4.2 Stylized facts

4.2.1 Participation and retirement behaviour

Dutch data show an increasing participation of man and women until the ages of 25-27 years (see figure 4.1). Between 27 years and 50 years, the participation of man remains stable, while the participation of women gradually falls. After reaching the age 50, the participation of both man and women decreases rapidly, with a sharp fall at the age of 60-61 years.

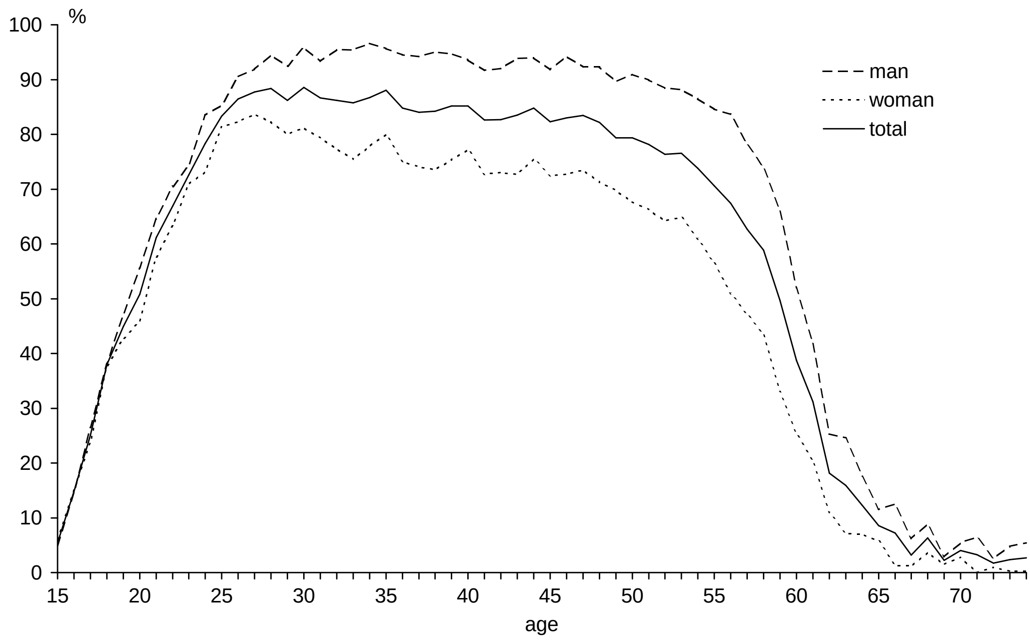
A similar picture arises from Corpeleijn (2007) regarding the outflow of the labour market. Figure 3 (page 33) shows an increasing outflow of labour after 55 years of age, with peaks at the ages of 60-61 and 65.

4.2.2 Empirical labour supply elasticities

The elasticity of labour supply with respect to the wage rate plays a critical role in the response of labour supply on many policy measures. A large number of studies have estimated the (uncompensated) elasticity of labour supply (see, e.g., Blundell and MaCurdy, 1999). [26] These

[26] The uncompensated wage elasticity of labour supply is defined as the percentage change in hours worked as a result of a one percent change in the net hourly wage rate.

Figure 4.1 Participation rate (labour force as % of total population)



Source: Statistics Netherlands, Labour force survey 2007.

studies show a great deal of variation both in results and in approaches to estimate the elasticity. Evers et al. (2008) uses this variation in study characteristics to analyze the systematic impacts of the many factors on reported empirical estimates. In particular, using a sample of 209 uncompensated labour supply elasticities obtained from the literature, they perform a meta analysis, regressing the elasticities on the underlying study characteristics. On the basis of this meta regression, the uncompensated wage elasticity of labour supply for Dutch men is estimated to be around 0.1. The corresponding figure for woman is 0.5.

4.2.3 Age profiles

Using data of the Socio Economic Panel (SEP), Alessie et al. (1997) investigated the wealth and income profiles of Dutch households in 1987-1989. The panel, a representative sample of the Dutch population, contains approximately 5,000 households. On average, the results indicate a hump-shaped profile of both labour income and of total income (consisting of labour income, transfers and capital income). Total income, for example, sharply increases between 20 and 30 years of age and subsequently shows a moderate increase until around the age of 50 - 55. Thereafter, income gradually falls.[27]

Financial wealth (excluding pension wealth and present value of state pensions) also follows a hump-shaped profile. Until the ages 60 - 65 financial wealth increases. Thereafter a mitigated

[27] See Alessie et al. (1997), figure 5a, page 19.

fall appears. However, looking at the individual data of the panel, the profiles of financial wealth show a large variety. For instance, at least 50% of the households does not dissave until the age of 80 years.[28]

Using data of the CBS Budget survey (about 2,000 households per year from 1978 to 2000) De Ree and Alessie (2005) construct life-cycle patterns for consumption and income based on birth cohort averages. Both wealth and household consumption display a hump-shape profile. However, if adjusted for household composition, Dutch consumption seems to be almost constant over the life-cycle.[29]

The observed hump-shaped pattern in Dutch income and wealth profiles also appears in US-studies. For instance Fernandez-Villaverde and Krueger (2001) show a hump-shaped pattern in wealth. In another paper Fernandez-Villaverde and Krueger (2004) looked at consumption profiles and found a hump-shaped pattern for household consumption. If household composition is taken into account, the hump in the consumption profile falls by around 50%.

Lambert and Pignatti (2007) compare consumption, income and wealth profiles between Italy and the US. For their analysis the authors use data of the Italian Survey of Household Income and Wealth and of the Consumer Expenditure Survey. Similar to Fernandez-Villaverde and Krueger, Lambert and Pignatti find a hump-shaped profile in the US data for consumption, income and wealth. However, looking at the Italian data, the profiles seem to be much flatter. Institutional differences between the US and Italy, especially concerning the pension systems, seem to be the most important causes of the differences in the observed profiles.

4.3 Strategy to explain variety in retirement ages

To explain the variety in retirement ages we choose one element of the model to differ between individuals. This is the variable d_t, the time surcharge on labour, measuring the variable labour costs, $d_t l_t$. These variable labour costs are measured in terms of time, as witnessed by its appearance in the time constraint (equation (3.5)). As apparent from equation (3.39), increasing d_t over time results in a declining effective real wage profile, inducing the agent to opt for a declining labour supply profile.[30] We assume that continuing increases in d_t are caused by deteriorating health. Health, then, is the job-related physical and/or mental condition that affects the (complete) time needed to do the job. Or, in the alternative interpretation of d_t, it affects the

[28] See Alessie et al. (1997), figure 3b, page 15.

[29] See De Ree and Alessie (2005), figure 2, page 18.

[30] This follows from inserting equation (3.39) in equation (3.35), which feeds in equation (3.32).

preferences with respect to leisure (and, consequently, consumption). The faster d_t rises, the faster the effective real wage falls, and the sooner the agent retires.

In a sense, we describe *desired* hours worked over the life cycle. Of course, we observe that many people do not gradually reduce hours worked before retirement. Traditionally, individuals work full-time or part-time until a given age and then stop working abruptly. From a life-cycle perspective, however, it seems intuitively attractive to have a smooth transition from work to retirement, gradually reducing the number of hours worked.[31] The fact that gradual retirement is not common suggests that workers face restrictions if they want to reduce their work effort. From the demand side, employers are often reluctant to create opportunities for gradual retirement. Reasons for this reluctance include fixed employer costs, team production, and the preservation of job-specific skills. Finally, from the supply side, employees may face fixed costs (eg. travelling time). Finally, institutional arrangements concerning pension- and/or Social Security benefits may also contribute in the discouragement of gradual retirement. In this paper we largely abstract from these restrictions and focus on the preferred smooth transition from work to retirement.[32]

Starting at age T^h, d_t rises quadratically,

$$d_t = \begin{cases} \delta_0 & \text{if } t = 25, \ldots, T^h - 1 \\ \delta_0 + \delta_1 (t - T^h)^2 & \text{if } t = T^h, \ldots, T \end{cases} \tag{4.1}$$

The parameter δ_0 is the same for all individuals. The heterogeneity stems from the parameter δ_1, the rate at which d_t rises. We assume that δ_1 follows a certain probability distribution. This distribution, then, determines the distribution of retirement ages. As the latter is known from the data, we use these data to infer the distribution of δ_1-values. For computational reasons we assume a discrete distribution of δ_1-values. The drawback of this assumption is that groups of individuals are bundled together, making the size of the group the unit of account.[33] Thus, the sizes of the groups are chosen as small as possible (to approach the continuous distribution) to the extent that the associated number of groups is computationally feasible (i.e., calibration and simulation do not take too much time). We use a criterion (see below) to make the distribution sufficiently smooth.

The first step in the calibration procedure involves the determination of δ_1-ranges. Each range of δ_1 values leads to a different retirement age. The parameters of the model are chosen such that the individual chooses to leave the labour force at age 75 if $\delta_1 \geq 0$. Increases in δ_1 will

[31] This is confirmed by Soest et al. (2006), which examines preferences for gradual retirement in the Netherlands.

[32] In future work, to take the restrictions into account, we may restrict the hours worked decision (e.g. between full-time, part-time, and not working, discrete choice model).

[33] That is, in response to a policy measure the whole group decides to adjusts the retirement age or not.

subsequently trigger earlier retirement ages. These δ_1-ranges are determined for each retirement age from 75 until 55, as the vast majority of the people retire between these ages.

Each range, then, is represented by n (one or more) specific δ_1-values.[34] The number of specific values within a range, n, depends on the size of the fraction of people that fall within that range. The higher the fraction of people, the higher n, limiting the amount of people represented by one specific δ_1-value. The criterion we use to determine n, and hence the smoothness of the distribution of δ_1-values, is that the fraction of individuals represented by one δ_1-value is not more than 2.5%. In this way we create many different types of individuals[35], each type characterized by its δ_1-value.

4.4 Values of parameters and exogenous variables

Table 4.1 presents an overview of the parameters and exogenous variables of the life-cycle model, and their values in the base scenario.

4.4.1 Utility parameters

As documented in Frederick et al. (2002), there is considerable disagreement among dozens of studies that all purport to be measuring time preference. The discount rates in these studies range from 0 to almost infinity. The extreme high rates are usually associated with short periods of time, less than one year. The average discount factor pertaining to periods of one year and higher lies around 0.8. This would suggest a rate of time preference, ρ, of 0.25. However, this predominance of high discount rates, and the lack of agreement between the studies likely reflects the fact that the various procedures used to measure time preference consistently fail to isolate time preference, and instead reflect a blend of both pure time preference and other theoretically distinct considerations.[36] Nearly all of these work to bias imputed discount rates upward. Following the life-cycle literature, we choose a value of $\rho = 0.03$, close to the value of the interest rate.

Concerning the existing literature on the elasticity of intertemporal substitution (EIS), on the one hand, empirical studies using aggregate consumption data typically find that the EIS is close to zero (Hall, 1988). On the other hand, calibrated macroeconomic models designed to match

[34] These n points are chosen such that they divide the range in $n+1$ equal-sized subranges. For example, if $n = 1$, we choose the midpoint of the range.

[35] For this paper, the model contains 49 types.

[36] These considerations include (a) intertemporal arbitrage; (b) concave utility; (c) uncertainty that the future reward or penalty will actually obtain; (d) inflation; (e) expectations of changing utility; and (f) considerations of habit formation, anticipatory utility, and visceral influences.

growth and business cycle facts typically require that the EIS be close to one (Weil, 1989; Lucas, 1990, among others). In a recent paper, Vissing-Jørgensen (2002) argues that accounting for limited asset market participation is important for estimating the EIS. She finds estimates of the EIS of around $0.3 - 0.4$ for stockholders and around $0.8 - 1.0$ for bondholders (the estimates are larger for households with larger asset holdings within these two groups). Similarly, Guvenen (2002) studies a dynamic macroeconomic model which incorporates limited asset market participation together with an EIS that increases with wealth to reconcile the conflicting evidence. He finds that the properties of aggregate variables directly linked to wealth, such as investment and output (growth), are almost entirely determined by the (high-elasticity) assetholders. (At the same time, since consumption is much more evenly distributed across households than is wealth, estimation using aggregate consumption uncovers the low EIS of the majority of households, i.e., the non-assetholders.) Mulligan (2002) argues that "the" interest rate in aggregate theory should be measured as the expected return to a representative piece of capital. Using this measure of the interest rate he estimates the aggregate EIS and obtains estimates of 1 and above, roughly consistent with log utility specifications. In conclusion, these studies indicate that the EIS roughly lies between 0 and 1. We take $\gamma = 0.5$.

There is little direct empirical evidence concerning the value of σ, the intratemporal rate of substitution between consumption and leisure. Ghez and Becker (1975) found an aggregate value of $\sigma = 0.83$. Lise and Seitz (2007) estimate this elasticity at 1.58 for men and 1.64 for women. On the contrary, much evidence is available on the labour supply elasticities with respect to the contemporaneous wage of both men and women. So, many studies use σ to attain a target labour supply elasticity. However, the translation of these elasticities into estimates of σ depends on the degree to which the underlying wage changes are permanent or temporary and whether they are anticipated or not. As Auerbach et al. (1983) have shown, a wide range of values of σ is consistent with estimated wage elasticities. For instance Auerbach and Kotlikoff (1987) choose a base case value of σ equal to 0.8, while Bovenberg and Knaap (2005) use an elasticity of substitution of 0.56. To obtain a positive labour supply elasticity (with respect to a permanent change in the wage rate) in our model, σ must exceed 1 (i.e., substitution effect dominates income effect). More precisely: in order to achieve an elasticity of about 0.15, we impose σ at 1.5. This is consistent with Lise and Seitz (2007).

The utility weights on consumption and leisure, μ_c and μ_v, are unobserved parameters. The values of these parameters are chosen to match the shares of consumption and leisure in full income.

Regarding the parameters (ω, α, ϕ) for the bequest motive empirical data hardly exist. In this case the imposed values are mainly based on the shape of the resulting life-cycle profiles of wealth. To correspond with the level of the empirical wealth profile, each individual receives annually a bequest of 2,000 euro.

4.4.2 Time constraint parameters

The time available in each period, l^{max}, is set at $2,250$ hours per year (this is equal to 45 weeks of work, 50 hours per week. The minimum level of hours worked, l^{min}, is imposed at 540 hours per year (i.e., 45 weeks of 12 hours per week).[37] We assume that d_t, measuring the variable labour costs, starts to rise at age 50. This is motivated by studies that estimate the productivity profiles for individual workers using employer-employee matched data sets. Most studies find that workers in their 30s and 40s have the highest productivity levels, while workers above age 50 have lower productivity levels than their younger colleagues (in spite of their higher wage level).[38] Variable labour costs before age 50 are set to 0.

4.4.3 Tax- and pension system parameters

In the calibration we aim to describe the behaviour of an average person in the Netherlands. This average person is supposed to earn the average income of around $33,000$ euro's. His marginal tax rate is approximately 25%, including the Social Security premium paid for national insurances. We set this Social Security premium, τ_{aow}, at 10%, and the tax rate on income, τ_y, at 15%. The Social Security Premium for employees' insurances (τ_s) is imposed at 12%.[39]

The tax rate on the stock of wealth, τ_a, is set at 1.2%. We ignore the tax rate on consumption, as the price of the consumption good is chosen as the numeraire. The level of the pension premium charged on income above a franchise of €11,000, τ_p, is determined at 5.1% in order to obtain an almost balanced budget of pension funds. The pension accrual rate, β, is fixed at 1.25%.[40] This implies that at age 65, after 40 years of work, the gross replacement rate is equal to 50% of average income.[41] The (gross) Social Security benefit is set at €11,000 per year, which amounts to approximately €925 per month.[42]

[37] For technical reasons, we divide the number of hours by 1000, i.e., $l^{max} = 2.25$ and $l^{min} = 0.54$.

[38] See e.g. Skirbekk (2003).

[39] From an institutional point of view these rates seem rather small. However, besides the pension premium, we ignore the institutional franchises in our model. Furthermore, we ignore the institutional distinction between premiums paid by employers and paid by employees. We assume that individuals receive their labour costs and pay all taxes and Social Security premiums.

[40] The value of 1.25% is slightly below the institutional rate, but reflects the gap in pension rights caused by the non-transferability of these rights.

[41] Taken into account Social Security premiums employees insurances, the net replacement rate is approximately 70%.

[42] This is the level of gross Social Security benefits (first-tier pension benefits) of singles in 2005. In the model this coincides with $\delta = 11$.

4.4.4 Exogenous variables

We choose the price of the consumption good, p_t, to be the numeraire. The nominal interest rate is imposed to have a value of 0.04. The applied mortality rates are based on data of the CBS.

Finally, starting from €$17,250$ (per 1000 hours) at age 25 up to the age 50, the nominal wage rate (of the first, main job) increase by 0.925% each year.[43] After age 50, the wage rate is constant. With $1,600$ hours of work per year this amounts to a gross income of €$33,600$ per year.

The wage rate associated with the second job is 45% lower. That is, once the agent decides to take up the second job, his wage rate falls with 45%. After that, the wage rate continues to fall, reflecting the decline in productivity at older ages. We have specified a linear decline in second-job wages, falling to 10% of the wage rate of the first job in 15 years. As hardly any empirical data about post-retirement wage rates are available, the parameters of this part of the wage profile are used to obtain a maximum retirement age of 75 years.

4.5 Aggregation

To aggregate the individual results, such as consumption, labour supply and the like, we need to have the composition of the population *for each type of person*. To construct these numbers we use the following data sources. From the EBB 2004 [44] we have the number of employed and the total population, both according to age. Age runs from 25 until 74. In addition, we construct estimates of percentages of the number of employed, for each age between 55 and 75, that retire in 2004. Combined with the number of employed from the EBB 2004, these percentages translate into the number of persons that retire at each age between 55 and 75. The number of persons that retire at 55, for example, equals the number of persons of type 1 (the ones that retire at 55) of 55 years of age. Likewise, the number of persons that retire at 56 equals the number of persons of type 2 (the ones that retire at 56) of 56 years of age. And so on, until age 75. To extrapolate these numbers to the other ages within each type, we assume that each type consists of a fixed fraction of the population.

[43] This average annual growth of the wage rate is based on Alessie et al. (1997), figure 5(a), page 19. Starting at an amount of (approximately) 30,000 guilders at age 20 and achieving annual earings about 40,000 guilders at age 50 and assuming no differences between the number of hours worked, the average annual growth of the wage rate is approximately 0.925%.

[44] EBB is the "enquête beroepsbevolking", a random sample survey.

Table 4.1 Parameters and exogenous variables

Symbol	Definition	Value	Comment
	Parameters		
ρ	Rate of time preference	0.03	
γ	Elasticity of intertemporal substitution	0.50	
σ	Elasticity of intratemporal substitution	1.50	
μ_c	Utility weight on consumption	0.60	
μ_v	Utility weight on leisure	0.40	
ω	(Relative) weight of bequest motive	9.00	
α	Intertemporal substitution of bequest motive	0.35	
ϕ	Bequests luxury goods or necessary goods	0.10	
l^{min}	Minimum level of hours worked	0.54	
l^{max}	Time available in each period	2.25	representing 2250 hours
δ_0	Variable labour costs, constant	0	
T^h	Age after which labour costs starts to rise	50	
τ_a	Tax rate on stock of wealth	0.012	
τ_y	Tax rate on wage income	0.15	flat rate on income
τ_c	Tax rate on consumption	0	
τ_s	Social Security premium (employees' insurance)	0.12	
τ_p	Pension premium	0.051	
β	Pension accrual rate	0.0125	
t_p	Pension pivot age	65	
f	Pension franchise	11	
τ_{aow}	Social Security premium (national insurance)	0.10	for $t < 65$
δ	Social Security benefit	11	around 30% of gross income
	Exogenous variables		
r_t	Nominal interest rate	0.04	
p_t	Price of the consumption good	1	numeraire

4.6 Results

4.6.1 Introduction

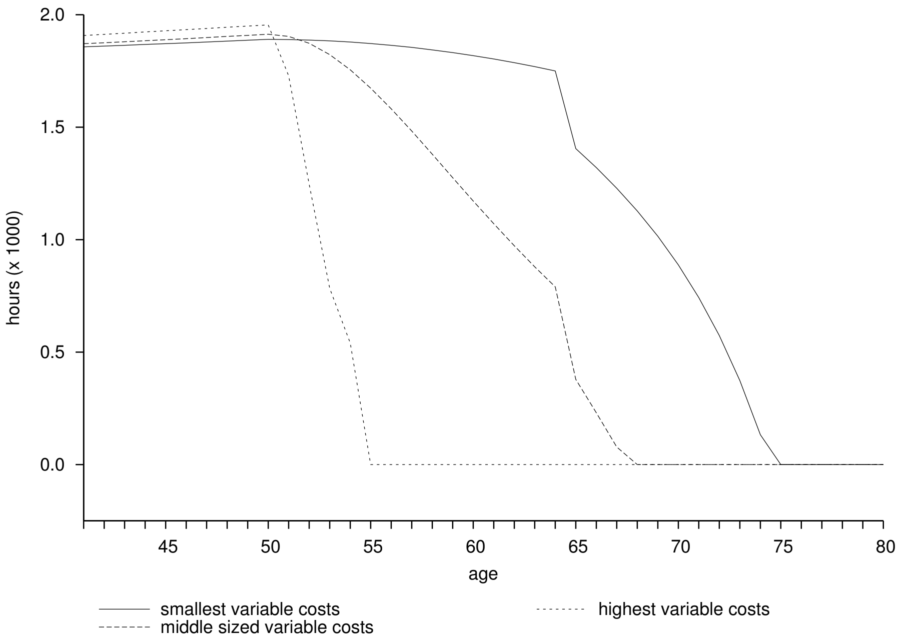
For a given set of parameters and exogenous variables (see Table 4.1), we can depict the different individuals' life-cycle behaviour. In the next section we will discuss the base simulation and the key mechanisms behind these results. Thereafter, to conclude the description of the calibration in this section, we will briefly focus on the resulting labour supply elasticities, age profiles of income, wealth and consumption and the retirement pattern.

4.6.2 Base scenario

For the assumed set of parameters and exogenous variables, Figure 4.2, for example, shows labour supply trajectories over the life cycle concerning three different δ_1-values.[45]

The solid line represents the labour supply of an individual with the smallest variable costs, i.e. the δ_1-value that results in a retirement age of 75. Until age 50 labour supply gradually increases as the effective wage rate goes up due to the increasing value of (defined benefit) pensions and the assumed exogenous wage growth.[46] In principle the increasing mortality rate raises the preference for consumption and leisure in earlier periods, implying a rising labour supply over the life cycle too. However, the increase in the mortality rate does also raise the importance of the bequest motive, which works in the opposite direction: a higher probability to die raises the value of savings. In addition, mortality rates are quite small up to 50 years (less than 0.5% per annum). Hence, this effect on the intertemporal allocation is neglible. After age 50, the increase in the effective wage rate is gradually reversed as the variable labour costs start to rise. At age 65, the age of mandatory retirement, the individual quits her current (main) job, and starts to receive pension income. As her health is still quite good, she decides to take the opportunity to work part time in a second job. At age 65 she experiences a decrease in the net effective real wage rate, and accompanying fall in labour supply. Although Social Security premiums are reduced at age 65, the smaller wage in the second job dominates, resulting in the

Figure 4.2 Labour supply



[45] Note that in this figure, and in the subsequent figures, age runs from 40 to 80 years.

[46] See section 3.4 for an explanation why the effective wage rate increases as a result of the pension system.

decrease in the net effective wage rate. Subsequently each year, as her costs of working continue to rise, she supplies less labour. Until age 75, she decides to fully retire.

The dotted line represents the labour supply of an individual with the highest variable costs, which result in retirement at age 55. After age 50, the positive δ_1-value raises the variable labour costs, reduces the effective wage rate and leads to a decline in labour supply. The high costs of labour induce this person to reduce his hours of labour from full time to zero within five years. The kink at age 54 reflects the minimum amount of hours that a person is required to work in his main job, if not retired. At age 54 this restriction is binding, implying that working one year at the minimum amount, and then retiring at 55, is preferred over quitting the labour force at 54. For these individuals it does not pay to take a second job, after retiring from the first job.

The dashed line, finally, represents the labour supply of an individual with middle-sized variable costs. In this particular case these costs result in a continuous decrease of hours worked from age 50, leading to a retirement from the main job at age 65. Thereafter, he works three more years in a small second job before leaving the labour force completely.

Figures 4.3 and 4.4 show the consumption and private financial wealth trajectories belonging to the same type of individuals. The dotted lines, for example, describe consumption and wealth over the life cycle when variable costs are at their highest level. Wealth is accumulated for two reasons: (i) to smooth consumption in response to a future decrease in hours of work and/or in sufficient and (ii) to leave a bequest. The fact that these persons are restricted in their choice concerning hours worked – they are forced to choose between either working at the minimum

Figure 4.3 Consumption

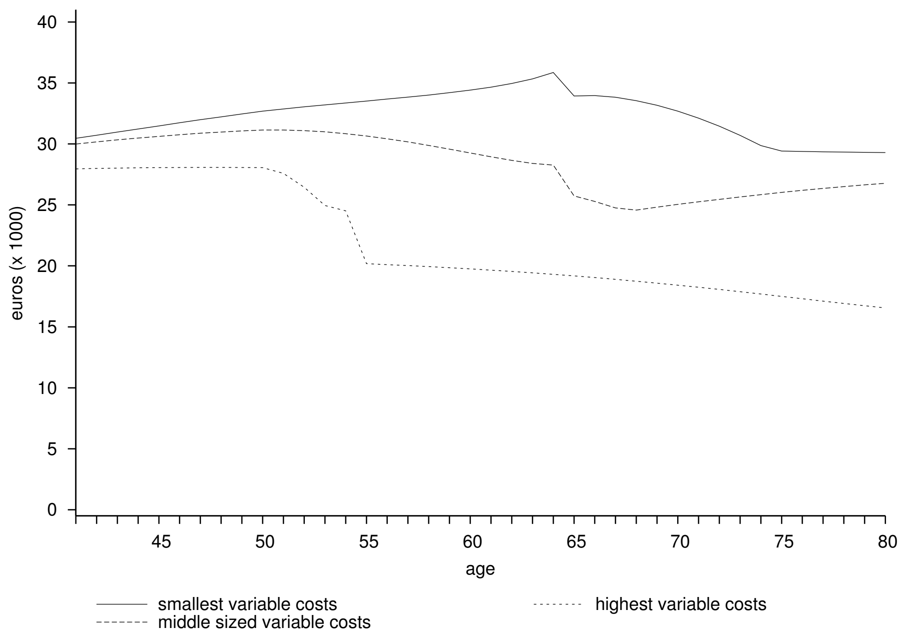
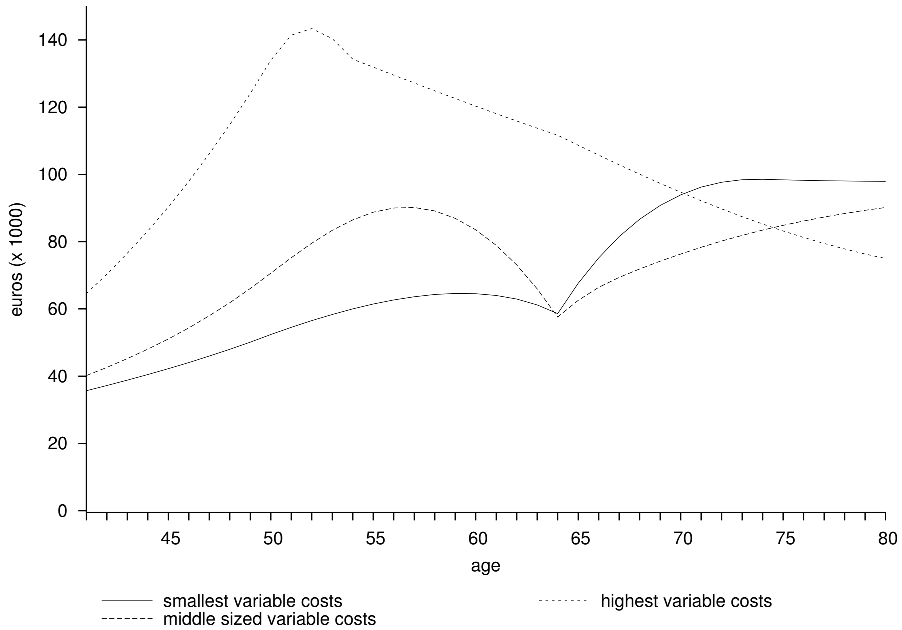


Figure 4.4 Private financial wealth



amount of hours or not work at all – produces the pronounced kink in consumption at age 54. Basically, the higher than optimal level of hours worked is compensated by a higher level of consumption at that age.[47]

In the period before 50, the age at which health starts to decline, mortality rates have hardly any influence. As a result, the time-path of consumption in that period is mainly influenced by 1) the gap between the real net interest rate ($r - \tau_a$) and the rate of time preference (ρ) and 2) the relative price of consumption (inverse of Δ). The gap between the real net interest rate and the rate of time preference leads to a slightly falling consumption profile as the net real interest rate is below the rate of time preference. Simultaneously the increase in the effective wage rate due to the impact of DB pensions and the assumed wage profile, imply an increasing consumption level until age 50 (intratemporal substitution effect).

After full retirement, mortality rates start to be numerically relevant, making the time-path of consumption also a function of wealth through the bequest motive. As the relative price of consumption is fixed, the slope of the consumption profile in this period is determined by the difference between the real net interest rate and the rate of time preference and the (slope of the) wealth trajectory. A declining level of wealth, for example, implies that the marginal utility of leaving a bequest is increasing. This requires that the marginal utility of consumption (remember that leisure is fixed) is increasing, implying declining levels of consumption. This is what happens in the consumption and wealth profiles of the individual with the highest variable costs:

[47] In terms of the model, the shadow price of leisure rises (inducing the higher level of hours worked), making consumption relatively cheaper (intratemporal substitution).

declining levels of wealth after full retirement are associated with declining levels of consumption. In addition, the rate of time preference is higher than the interest rate, reinforcing the decrease in consumption.

The solid lines, in turn, describe consumption and wealth over the life cycle of an individual with the smallest variable costs. Until age 65, she slowly builds up wealth, mainly for bequest purposes. A small part of her wealth is used for smoothing purposes. After age 65, net income, consisting of both pension benefits and income from work, increases. At the same time the need for consumption reduces as a result of the reduction in labour supply and the accompanying increase in leisure, as consumption and leisure are substitutes. Furthermore, the increased mortality rates raise the interest of the bequest motive affecting the allocation of annual funds among consumption and savings. Therefore, after 65 – the age at which the ample pension benefits become available – savings are high, as reflected by the fastly increasing wealth levels. In this stage wealth is largely accumulated for bequest motives. After full retirement at age 75 consumption marginally declines – for two reasons. The first reason concerns the difference between the real interest rate and the rate of time preference (the latter is higher). The second reason concerns the resulting (marginal) decline in wealth, which, as described above, implies a decline in consumption.

The consumption and wealth profiles of an individual with middle-sized labour costs are given by the dashed lines. Due to the rise in labour costs and the accompanying decline in labour supply and income, consumption starts to decline around the age of 50 years. This decline of consumption is less pronounced than the decline in income as the individual has accumulated some wealth in anticipation. Basically, the individual saves to finance part-time work in his late 50s and early 60s. Consumption features a kink at age 65 due to the sudden increase in leisure at that time. Until age 65 wealth follows the same pattern as for the individual with the smallest variable costs. Due to the higher labour costs and accompanying steeper decline in hours worked, this individual accumulates higher levels of wealth in this period. A sizable fraction of this wealth is used to set off the declining levels of income. Then, from the moment of the first pension receipt on, this individual starts to accumulate wealth holdings to provide for his needs to leave a bequest. This implies that both wealth holdings and consumption, the latter after full retirement, increase over time.

The combination of relatively high incomes later in life with a bequest motive implies that in times of relatively low incomes the individual is still compelled – by her own motive – to save. This leads to lower levels of consumption at earlier phases in the life cycle and higher levels later on. That is, the consumption profile rotates anticlockwise. This is shown in figure 4.3, in which the consumption trajectories of the individuals with highest and middle-sized variable costs – the ones with relatively high incomes later in life – are steeper than the consumption trajectory of the individuals with the smallest costs.

4.6.3 Resulting key figures and profiles

Aggregate effects

The macroeconomic implications of this base scenario are depicted in figures 4.5 to 4.8. The aggregation of the individual results is based on the composition of the population in 2004, as described in section 4.5.[48] Individuals start to withdraw from the labour market at age 55, implying that the participation rate is 100% until age 55, and then starts to fall, first rapidly, then more slowly, until at age 75 everybody is retired. The same pattern is visible in the graph displaying total labour supply, which also reflects the decline in hours worked after age 50 and the decline in population starting in the late 50s. Total private financial wealth accumulates during the first periods of the life cycle and reaches the top around the early to late fifties, and is quickly decumulated thereafter. This reflects both the decline in population and the fact that many agents at these ages decumulate assets to finance their declining levels of hours worked. The amounts of private financial wealth after 65 are largely hold to leave bequests.

Figure 4.5 Total labour supply

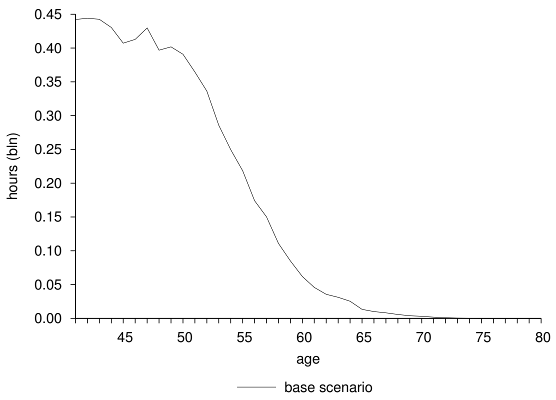


Figure 4.6 Participation rate

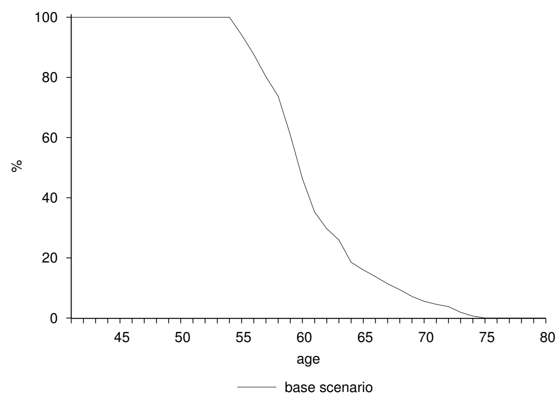


Figure 4.7 Total consumption

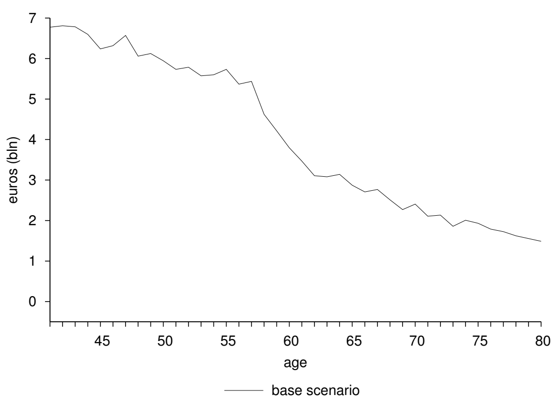
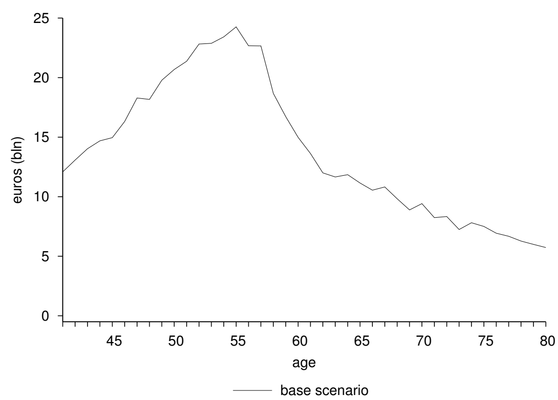


Figure 4.8 Total private financial wealth



[48] This explains the irregular behaviour of the macroeconomic variables, as age groups have different sizes.

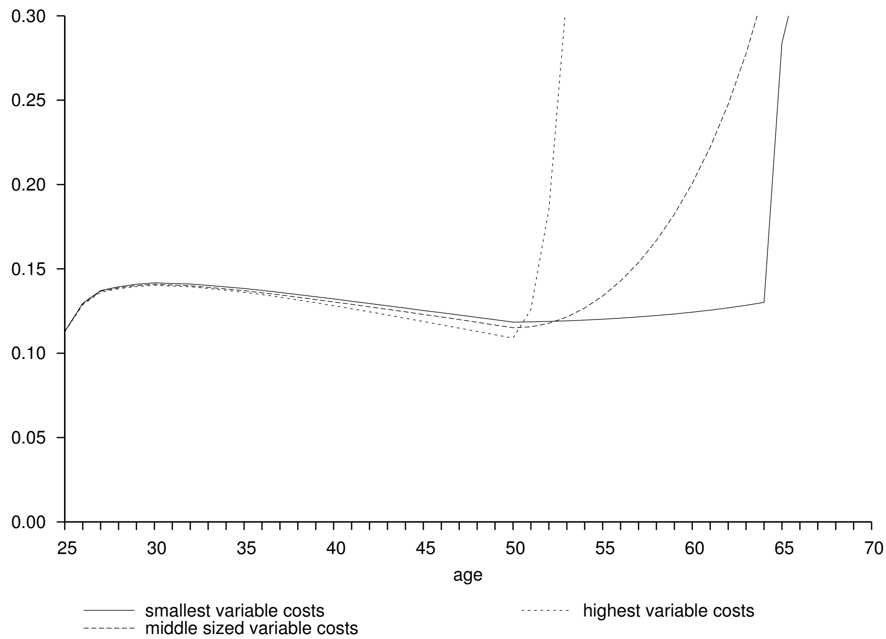
Elasticities

Looking at the labour supply elasticities the average elasticity is about .13 (see Figure 4.9). Among the distinghuished groups (different d_1-values) only small differences exist. The age-profile of the elasticity is quite flat. Only at ages close to the retirement age sharp increases occur. Euwals et al. (2006) estimate that (on average) individuals will postpone their retirement age by 5 months if pension wealth falls by 100,000 euro's. In order to compare the simulation properties of our model with this empirical result, we investigated the labour supply effect of a fall in lifetime income of 30,000 euros. In contrast to Euwals et al. (2006) our model results do not show an increase in the retirement age, but an increase in annual labour supply during the entire life cycle (hours worked). As our model has an annual frequency, the step size of the retirement age is equal to full years. So, in the case of small shocks an adjustment of labour supply at the intensive margin might be more appropriate. Converting this rise of labour supply into full-time equivalents over the life cycle, which encompasses the effects of a change in the extensive margin as well as a change in the intensive margin, yields an increase of labour supply about 0.12 (fte) years. Or in other words: an increase of approximately 1.4 months. Taken into account the different size of the impulse, this outcome is in line with Euwals et al. (2006).

Age profiles

Figures 4.10, 4.11 and 4.12 show the (average) age profiles of labour income, consumption and financial wealth. In agreement with the earlier described literature the model generates a hump-shaped age profile of labour income. Consumption shows a small hump-shape as all

Figure 4.9 Labour supply elasticities (model results)



agents are single person households. Finally, the model generates a hump-shaped (financial) wealth profile. However, as already mentioned in the literature, the age profiles of wealth are quite heterogeneous. As shown by figure 4.13 the age profile of wealth is hump-shaped for some groups (groups 26 and 36), while for other groups (6 and 16) the age profile shows saving at older ages.

4.7 Concluding remarks

The preceding sections describe the parameters and exogenous variables of the model and the key features of the resulting base scenario. The values of the parameters and exogenous variables in the base scenario are determined on the basis of studies in the (international) literature and (roughly) on average characteristics of the Dutch economy. In addition, to be able to explain the variety in retirement ages, the agents in the model are distinguished with respect to

Figure 4.10 Average profile of labour income (model results)

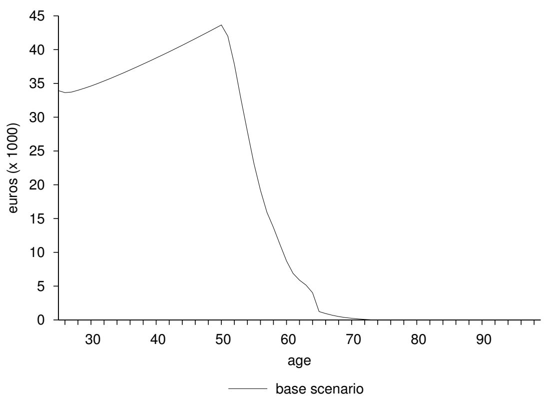


Figure 4.11 Average profile of consumption (model results)

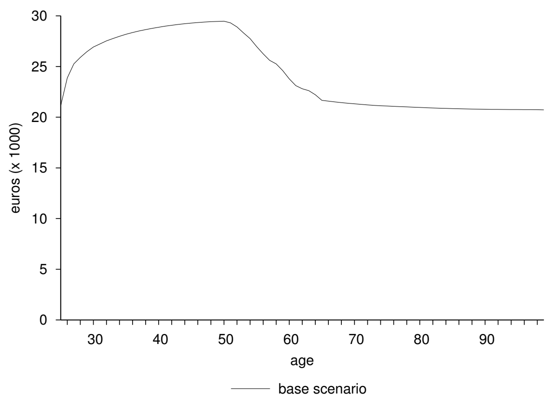


Figure 4.12 Average profile of private financial wealth (model results)

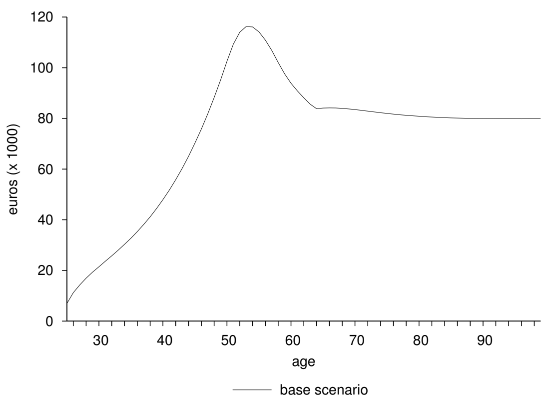
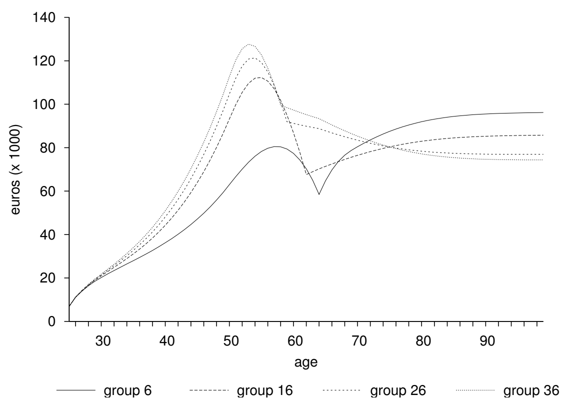


Figure 4.13 Profile of private financial wealth of different groups (model results)



their (variable) costs of labour supply. Agents with high costs experience fast reductions in their effective wage rates, leading to lower retirement ages. The model is calibrated to span retirement ages from 55 to 75. This implies the presence of 21 groups, where each group has its own retirement age. The sizes of these groups are based on Dutch retirement data in 2004. To limit the number of identical agents, these groups are divided into subgroups that have the same retirement age (in the base scenario), but have different labour costs. The resulting key features, such as elasticities and age-profiles of consumption and private financial wealth correspond to the results found in the economic literature.

5 Simulations

5.1 Introduction

Six policy simulations are conducted. The first simulation consists of elimination of the exemption of Social Security premiums for national insurances after achieving age 65. In the second simulation we shift the age of access to the first-tier pensions from 65 to 67 years. Third, we consider the introduction of an early retirement scheme. The fourth simulation concerns an alternative pension scheme characterized by a fixed commencing date and no labour supply constraint. Next (fifth simulation), we focus on the effects of a more flexible pension scheme. The sixth simulation discusses the introduction of a delayed retirement credit associated with a prolonged participation in the labour market. Finally, we look at the budgetary effects. In particular of government and pension funds. For several reasons the simulations so far are open budget exercises. In order to assess the closed budget effects, we conduct two additional simulations. First a reduction in the tax rate on income. Next, the effects of a cut in the pension premium are analysed. Finally, an adequate approximation of the closed budget effects can be obtained by an suitable combination of the discussed partial simulations. Each of these simulations is described in relation to the base projection. The contents of this projection is described in the section 4.6.2. Sections 5.2 to 5.8 describe the policy simulations.

5.2 Eliminating Social Security premium exemption of the elderly

Both ageing of the population and increases in life expectancy will raise government expenditures for Social Security benefits. One policy measure that may keep these expenditures affordable is to lower (or eliminate) the Social Security premium exemption of the elderly. In the base scenario, reflecting the current situation in the Netherlands, individuals are exempted from Social Security premiums once they reach the age of 65 years. The current simulation fully eliminates this exemption, effectively making the Social Security premium constant over the life cycle.[49]

In the remaining part of this section we will first focus on the incentives of this policy change, then explain the aggregate responses of all individuals, and finally examine the robustness of the results.

[49] For the sake of simplicity we do not adjust the gross first-tier pension benefits and the tax system. Furthermore, we abstract from transitional measures and periods. In this respect the contents of this simulation deviates from Dutch institutions and current policy proposals.

Incentives

The introduction of positive Social Security premiums from age 65 onwards reduces net income, from work and/or from state pension and/or from second-tier pension benefits.

The reduction in the net state pension causes a wealth effect, as this pension is independent from an individual's labour supply. As a result the lower net state pension induces agents to raise their work effort, both at the intensive margin (the hours decision) as well as the extensive margin (the retirement decision).

Whereas changes in non-labour income only yield a wealth effect, changes in labour income also yield intratemporal substitution effects. In the current setting, because $\sigma > 1$, the (intratemporal) substitution effect dominates the income effect. This implies that a lower effective wage rate induces individuals to reduce labour supply, both at the intensive as well as the extensive margin. The current policy measure changes labour income in two ways, (i) a reduction in second-tier pension income, and (ii) a reduction in the net effective wage rate after age 65.

The reduction in second-tier pension income, which is actually deferred wage income, means a reduction in the reward to labour supply (concerning the first job), yielding a lower net effective wage rate.[50] This lower net effective wage rate applies to the period in which the agents accumulate second-tier pensions.

In addition, as a direct consequence of the Social Security premium exemption, the net effective wage rate also falls after (and including) age 65. The intratemporal substitution effect being the stronger force, labour supply also falls at these ages. Of course, these incentives only apply to those individuals who actually receive wage income in that period.

Besides the aforementioned wealth effect of the cut in net state pension benefits and income and intratemporal substitution effect of changes in the effective wage rate, there are two intertemporal substitution effects caused by the altered profile of the effective wage rate. The first effect results from the fact that the fall in the net effective wage rate after 65 is larger than the fall occurring before 65. This brings about an intertemporal reallocation, shifting labour supply from the period after 65 – again displayed both in hours worked and retirement age – to the period before 65. Again, this effect is only relevant for the agents that do actually work beyond age 64 in the base scenario. The second intertemporal substitution effect induces a reallocation of labour within the working period up to the age of (second tier) pension receipt. In contrast to an actuarial fair pension scheme and ignoring the impact of the variable labour costs, the assumed defined benefit pension scheme with a common pension premium results in a rising net effective

[50] In the model, this effect is reflected in a change in ζ_t, the shadow value associated with the accumulation of second-tier pensions. The presence of the exemption in the base scenario favours pension savings relative to private savings. This induces agents to save more through pension funds. As these savings are mandatory and consist of a fixed fraction of income from work, this provides an incentive to work more. Elimination of this exemption, then, will imply a fall in labour supply. As shown in equation (3.39), a fall in ζ_t, reflecting a worsening of the relative utility of pension savings compared to private savings, causes the net effective wage rate to fall.

wage rate up to the age of pension receipt. This pension system, therefore, shifts labour supply from younger to older ages. Elimination of the Social Security premium exemption reduces these advantages and, thus, induces a reallocation of labour supply in favour of younger ages.

Aggregate effects

In reaction to the elimination of the Social Security premium exemption, individuals supply less labour over their lifetime – see table 5.1. This holds for nearly all types of individuals. As shown by figure 5.1, which describes the change in (million) hours between simulation and base scenario, and figure 5.2, the reduction in labour supply and the participation rate is widespread across the different ages. Furthermore, these figures show a strong correlation between changes in labour supply and changes in participation rate. In other words: changes in labour supply at the extensive margin. As might be expected, the largest changes in the participation rate and labour supply occur at age cohorts above 65 years. The fall in labour supply is largely caused by an earlier withdrawal from the labour market as influenced by the minimum hours constraint. In the baseline scenario the labour supply (hours worked) of many types is, just before retirement from their main job, equal to the minimum hours level. Without this minimum hours constraint

Table 5.1 Eliminating Social Security premium exemption of the elderly

Macroeconomic results	
Average age of quitting the labour force	− 0.2
Labour supply (%)	− 0.2
Consumption (%)	− 1.1
Average lifetime labour supply (fte, abs dif)	− 0.1
Government budget (bln, abs dif)	5.6
Cash flow of pension funds (bln, abs dif)	− 0.1
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	− 0.1
Participation rate (%-point)	0.0
Age group 55 - 59 years	
Labour supply (%)	− 0.3
Participation rate (%-point)	− 0.4
Age group 60 - 64 years	
Labour supply (%)	− 2.2
Participation rate (%-point)	− 1.2
Age group 65 - 69 years	
Labour supply (%)	− 16.6
Participation rate (%-point)	− 2.1
Age group 70 - 74 years	
Labour supply (%)	− 31.6
Participation rate (%-point)	− 1.1

Figure 5.1 Total labour supply

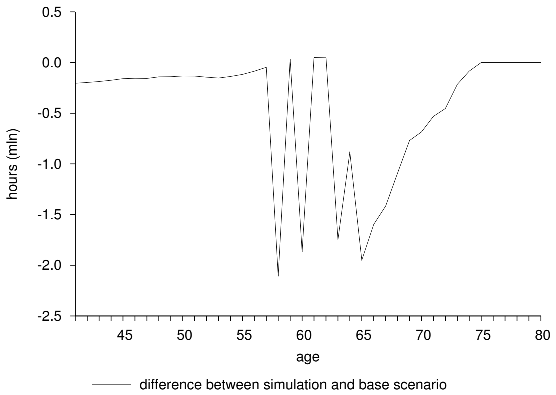


Figure 5.2 Participation rate (absolute differences)

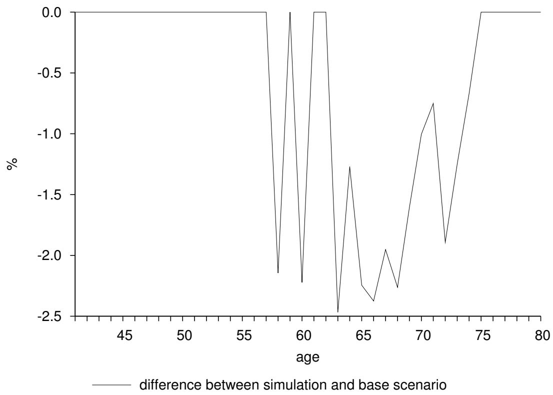


Figure 5.3 Total consumption

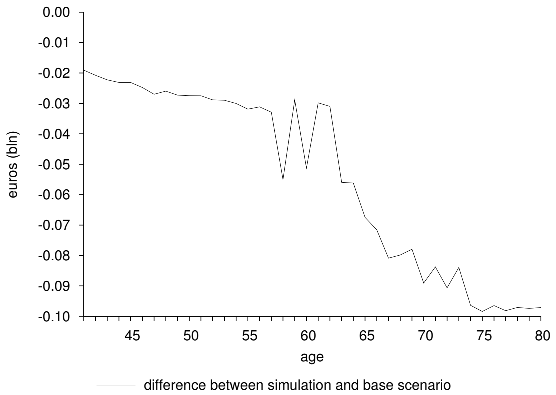
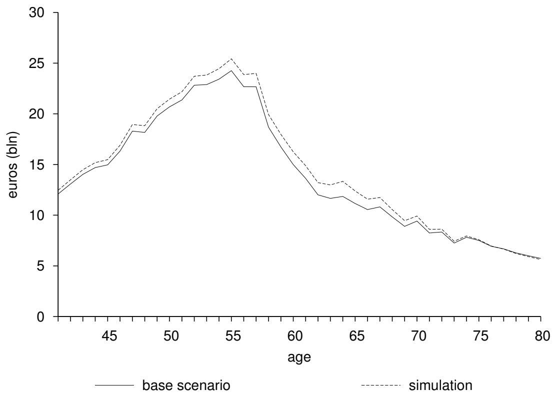


Figure 5.4 Total private financial wealth



(i.e., in the interior solution) agents of these groups would like to work less than this level. However, facing the choice between retirement (from main job) and working at the minimum level, these individuals prefer the minimum level in the baseline scenario. As elimination of the exemption of Social Security premiums within an actuarial unfair pension scheme reduces the effective wage rate and shifts the intertemporal allocation towards labour supply at younger ages, these agents shift from hours worked at the minimum level towards either full time retirement or a small part-time second job. Due to the assumed decline in wages in these second jobs, an earlier transition from main to second job is accompanied by lower wages, which often leads to an earlier withdrawal from the labour force.

The decreases in labour supply and participation beyond age 65 are additionally due to the direct impact of the higher premium on the wages in that period. The individuals that work in this period face lower wages in their second job and decrease both hours worked and participation in response.[51]

[51] The peaks in figures 5.1 and 5.2 are caused by the (discrete) shifts in retirement age of some of the discerned groups. More groups, for instance as the result of a monthly model, will show a more fluent pattern.

The associated decline in lifetime consumption is more concentrated in the after-65 period, see figure 5.3, which describes the change in (billion) euro's of (real) consumption between simulation and base scenario. There are two reasons for this intertemporal reallocation of consumption. First, consumption is lower at older ages because hours worked are also lower at these ages (consumption and leisure are substitutes). The second reason concerns the bequest motive. The reduction of total income over the life cycle reduces both consumption and the level of the bequest. [52] The lower bequest allows the individuals to consume more in their earlier phases of life and, consequently, less in later phases.

The changes in consumption around age 60 occur as agents face the minimum labour constraint. In general facing this constraint implies an increase in consumption, as consumption and leisure are substitutes. Individuals who were restricted in the base simulation and retire earlier in response to the higher Social Security premiums, will therefore reduce consumption.

Looking at the budgetary effects (table 5.1), the additional tax receipts result in an improved government budget of about 5.6 bln euros.[53] Regarding the total cash flow of pension funds the fall in labour supply reduces both the premium base and the promised pension benefits. The net effect in this simulation of these two opposite forces is almost nil.

Reallocations of individuals with smallest variable costs in response to eliminating Social Security premium exemption

Individuals with the smallest variable costs, slightly increase hours worked in their main job. This increase in hours worked is the result of some opposing incentives, consisting of wealth, income and (intra- and intertemporal) substitution effects. Hours worked in their second job are adjusted downwards, as a result of the lower wages, in turn caused by the increased Social Security premiums. The resulting higher levels of leisure are accompanied by lower levels of consumption. These lower levels of consumption are reinforced by the lowered need for bequests and the reduction in income after 65. Both factors tend to reduce consumption later in life, while the lower bequests also tend to raise consumption early in life. As a consequence, the reduction of consumption following the reduction in lifetime income is concentrated in the last phases of the life cycle. As a result of the more evenly distributed income over time, wealth accumulation is likewise more evenly distributed, i.e. more savings in the working period (main job) and less savings in the retirement period (resulting in lower levels of wealth later in life).

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[52] The fall in consumption raises the marginal utility of consumption which calls for an increase in the marginal utility of the bequest too. Or in other words: a reduced level of the bequest.

[53] This amount exceeds the amount mentioned in CPB (2008) (page 18). However, in our simulation we neglect the simultaneous increase in gross state pensions (additional government expenses) and adjustments in the tax system (less government receipts). Please note. The mentioned budgetary effect should not be confused with the concept of fiscal sustainability as the partial life-cycle model is not suitable to assess these effects.

Reallocations of individuals with highest variable costs in response to eliminating Social Security premium exemption

The impact of eliminating the premium exemption on the individuals with the highest variable costs is different, because these individuals are retired long before age 65, and because they have relatively lower incomes after retirement. Consequently, their labour supply trajectory hardly changes at all (the income and substitution effects roughly cancel). To counterbalance the loss of pension income, these agents increase their wealth holdings and reduce their consumption level evenly over their whole life cycle.

5.3 Raising statutory retirement age

Nowadays, and also assumed in the base projection, the 65th anniversary implies entry to the first-tier pension scheme and, if still at work at that age, a compulsory dismissal from the current job.[54] Furthermore, after age 65 individuals are exempted from Social Security premiums. In this simulation we shift the statutory retirement age, the exemption of Social Security premiums and the compulsory dismissal to age 67. The pivot age of the second-tier pension scheme remains unaltered.[55] Again, we will look at the changes in labour supply, consumption and savings.

Incentives

The policy package of this simulation contains several, sometimes opposite, incentives to labour supply. First, the delay of access to first-tier pension benefits reduces lifetime income and leads to an incentive to increase lifetime labour supply, by a rise in annual labour supply (i.d. more hours per year) and/or deferred retirement (more years).

Second, compared to the base scenario the shift in the exemption of Social Security premiums reduces the net effective wage during the ages 65 and 66. This will reduce the opportunity costs of leisure and will induce an intratemporal substitution between consumption and leisure and an intertemporal substitution between leisure in different periods. Furthermore, it reduces net pension benefits of already retired individuals.

Third, the shift in the age of compulsory dismissal implies better job opportunities for the still employed individuals at the age of 65 years. Instead of being fired and perhaps looking for a less well paid job, they are able to keep their – better paid – current job. This implies higher opportunity costs of leisure and therefore an increase in labour supply at the ages of 65 and 66. In contrast to the influence of increased Social Security premiums, the shift in the age of the

[54] In the Netherlands almost all collective labour agreements are (temporarily) elevated at a particular age, often 65. Although dismissal at that particular age is not obliged, in practice the majority of employers lays off its employees at this age. Therefore, from the perspective of employees, this age acts as an age of compulsory dismissal.

[55] This simulation differs from CPB (2008). For instance the shift in the retirement age is only two years. Furthermore, CPB (2008) also assumes adjustments in second-tier pension schemes, while we ignore these adjustments. Next, the labour supply effects in CPB (2008) are based on assumed changes in participation rates (including ‘framing effects’), while the labour supply effects of the life-cycle model are fully based on optimal reallocations of lifetime consumption and labour supply in response to the altered policy and so the model ignores some insights of behavioural economics.

compulsory age of retirement increases the real net wage in the range between old and new age of statutory retirement and will induce an (opposite) intratemporal substitution between consumption and leisure and an (opposite) intertemporal reallocation of lifetime leisure.

Aggregate effects

Concerning the macroeconomic effects of this policy change a small increase in labour supply (hours) about 0.3% and a small fall in consumpion about 0.5% occurs. The average age of quitting the labour force shifts about 0.1 year[56], while the participation rate only significantly changes after age 65.[57]

Table 5.2 Economic effects of raising statutory retirement age

Macroeconomic results	
Average age of quitting the labour force	0.1
Labour supply (%)	0.3
Consumption (%)	− 0.5
Average lifetime labour supply (fte, abs dif)	0.1
Government budget (bln, abs dif)	6.4
Cash flow of pension funds (bln, abs dif)	− 1.3
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	0.1
Participation rate (%-point)	0.0
Age group 55 - 59 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 60 - 64 years	
Labour supply (%)	0.0
Participation rate (%-point)	0.0
Age group 65 - 69 years	
Labour supply (%)	46.5
Participation rate (%-point)	1.3
Age group 70 - 74 years	
Labour supply (%)	60.1
Participation rate (%-point)	1.3

[56] This result is slightly lower than empirical studies like Gustman and Steinmeier (1985), Gustman and Steinmeier (2006) and Fields and Mitchell (1984). These authors find approximately a delay of two months if the statutory retirement age is shifted from 65 to 67 year. Furthermore, our results are smaller than the results of Mastrobuoni (2006) and of the DNB household survey (De Nederlandsche Bank (2008)). Mastrobuoni (2006) estimates the effect on the retirement age of a shift in the statutory retirement age at 50%. The responses in the DNB household survey indicate an effect of 40%.

[57] As in the base scenario the number of people working above the age of 75 years is nil, a shift towards these ages leads to a strong increase in the participation rate at these ages. However, the amount of people involved is quite small.

Figure 5.5 Total labour supply

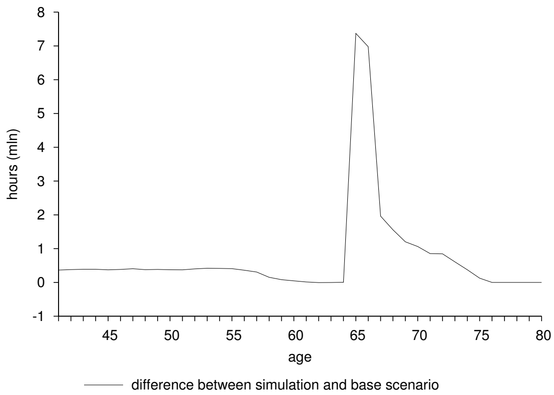


Figure 5.6 Participation rate (absolute differences)

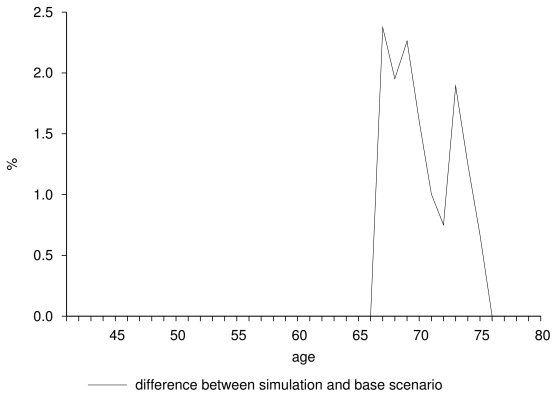


Figure 5.7 Total consumption

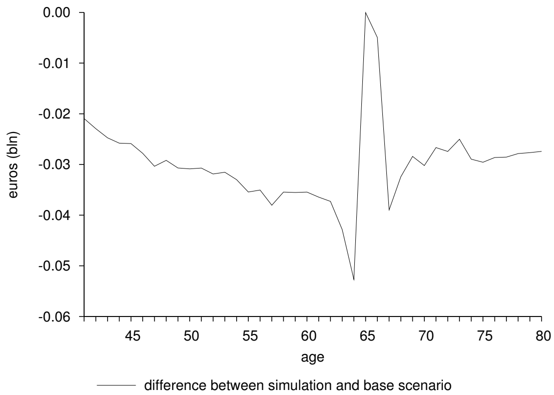
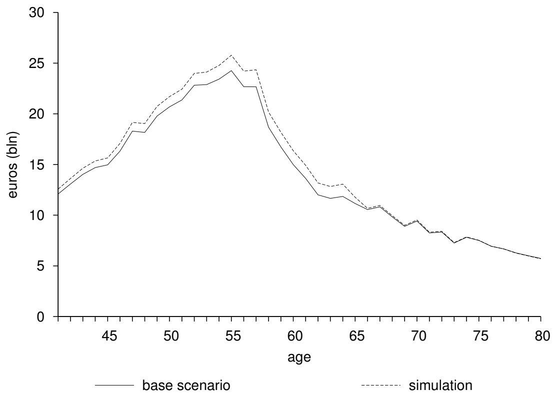


Figure 5.8 Total private financial wealth



Focusing on economic behaviour at the ages 41-80, the described policy changes result in a moderate increase in labour supply until the early 60's, and a simultaneous fall in consumption (see figures 5.5 and 5.7 which describe the changes in million hours of work and in billion euro's of (real) consumption between simulation and base scenario).

Up to the old age of statutory retirement, age 65, the reallocation of consumption, leisure and labour supply is determined by the wealth effect, intertemporal substitution effect and, possibly, the bequest motive and restrictions on the ability to work. First, ignoring the bequest motive and restrictions on the ability to work, the shift of the statutory retirement age reduces first-tier pensions and net second-tier pension benefits of individuals already retired before age 65. These changes reduce net lifetime income and lead to a fall in consumption, leisure and, consequently, an increase in labour supply over the life cycle.

Because up to the age 54 full participation is assumed, the increase in labour supply in that period is equal to the rise in hours worked. Thereafter, participation starts to increase. As a consequence, the rise in total labour supply after age 54 might be caused by an increase in the participation rate (due to delayed retirement) and/or an increase in hours worked. Figure 5.6

(depicting differences between simulation and base scenario) shows however that until age 67 participation is unaffected, implying that all changes in labour supply before age 67 are due to changes in hours worked. Only from age 67 the increase in the participation rate explains a significant part of the increase in labour supply.
In addition to reallocation due to the wealth effect, time allocation in the period up to the old age of statutory retirement is affected by the intertemporal substitution effect of leisure.[58] The shift of the statutory retirement age changes the opportunity costs of leisure during the time period between old and new age of retirement in two ways. First, the shift of the exemption of Social Security premiums reduces net wages. Second, but only relevant to individuals affected by the compulsory dismissal, the delay of compulsory dismissal offers the opportunity to stay at the current, better paid, job. In this simulation the net effect of both changes is an increase in net wages in that period.[59] This will lead to intertemporal substitution: for those individuals whose wage increases, time spent on leisure increases in advance of the old age of statutory retirement and decreases in the period between old and new period of retirement.

Summarizing, in advance of the old age of statutory retirement (age 65) the wealth effect reduces consumption and leisure, while the (intertemporal) substitution effect increases leisure.

In the period between old and new age of retirement, reallocations are again induced by the aforementioned wealth and intertemporal substitution effects, but also by an intratemporal substitution effect. As described above and ignoring the impact of a bequest motive, the income effect results in less consumption and leisure in this period.[60]

On the one hand, regarding individuals who already exchanged their first job for a less paid but more flexible new job (including the receipt of pension benefits), the intertemporal substitution effect will lead to a reduction in labour supply between the old and new age of statutory retirement and an increase in labour supply in advance as net wages fall in this period. However, as shown by figure 5.6, the reduction in labour supply is not accompanied by a reduction in the participation rate at ages 65 and 66. On the other hand, regarding individuals who experienced a compulsory dismissal in the base scenario, the shift in the age of compulsory dismissal results in a higher net wage rate at 65 and 66, notwithstanding the increase in premiums paid, as the first job has a significantly higher wage. These individuals will increase their labour supply between the old and new age of retirement.

A similar divide applies to the intratemporal substitution effect. If net wages increase, individuals choose to reduce time spent on leisure activities and increase consumption and labour supply in this period. Individuals facing a reduction in net effective wage rate in this

[58] This substitution effect is only relevant for individuals who are able to work after the old age of retirement.

[59] Social Security premiums are raised by 10%-points, while nominal wages increase by 30%.

[60] The latter applies if individuals are still able to work.

Reallocations of individuals with highest variable costs in response to raising statutory retirement age

In the base scenario, the individuals with highest variable costs retire at age 55, and consequently are not affected by changes in the wage rate at 65 and beyond. For them, the rise in the statutory retirement age means a reduction, i.e. a two-year delay, in Social Security benefits and a cut in net pension benefits as a result of the shift in the premium exemption. The former reduction produces a wealth effect: the loss of income prompts individuals to increase labour supply and reduce consumption. As the loss of income occurs at ages 65 and 66, this leads to increases in wealth. The latter reduction is actually a reduction in the effective wage rate, which produces both an income and a substitution effect. Due to the dominance of the substitution effect this reduction causes the individual to lower his labour supply. Because the reduction in net pension benefits (10% over two years of benefits) is much smaller than the reduction in Social Security benefits, the wealth effect dominates the results. For these individuals, the increase in labour supply is fully manifested in increases in hours worked. The high variable costs actually precludes them from extending their working lifes.[a]

[a] Beyond a certain age, in this case 54, the high variable costs in combination with the minimum size of hours worked are incompatible with the total available time.

Reallocations of individuals with smallest variable costs in response to raising statutory retirement age

The individuals with smallest variable costs continue working far beyond the old (and new) statutory retirement age. Therefore, in addition to the effects impacting on the individuals with highest variable costs as described in the accompanying textbox, these individuals are affected by the changes in the wage rate at 65 and beyond. The shift in the exemption of Social Security premiums reduces the wage rate at ages 65 and 66. However, the shift in the compulsary dismissal allows them to work two years longer in their main job. The higher wages that prevail in these main jobs, as compared with the wages in second jobs, dominate the presence of the Social Security premiums, resulting in higher wages at 65 and 66. In addition, the delay of retirement from their main job implies a simultaneous delay of human capital depreciation, causing net wages (prevailing in their second job) to be higher than before. Thus, wages after (and including) 65 are higher, while wages before 65 are (marginally) lower than in the baseline scenario. This induces the individuals to supply less labour before 65 and more thereafter. The lower levels of leisure after 65 are accompanied, or compensated, by higher levels of consumption, and vice versa before 65. The postponement of pension payments extends the first period of consumption smoothing, and delays the accumulation of assets for bequest purposes.

period, conversely, will increase leisure and reduce consumption and labour supply.

Summarizing, for some agents the wealth effect, the intratemporal substitution effect and the intertemporal substitution effect all point to a fall in leisure and an increase in labour supply in this period. This increase in labour supply reveals itself both in increases in the number of hours worked per year and in delayed retirement. Other agents reduce labour supply in this period. As witnessed by figure 5.5, the former type of individuals dominate the aggregate effects. This is also apparent from aggregate consumption at ages 65 and 66, although the impact on total consumption at these ages is still negative, due to the lower consumption levels of the majority of individuals that are already retired at these ages. As we assume a gradual depreciation of human capital after retirement from the first job, reflected in diminishing wages, in the current simulation this path of depreciation is, for those who choose to work longer in their main job, postponed by one or two years. That is, after the new age of statutory retirement net wages (in second jobs) are higher than before and cause an (intratemporal) substitution effect between

consumption and leisure. As a result, labour supply increases (see figure 5.5), both in terms of hours worked and in an increase in the participation rate (see figure 5.6). The accompanying lower levels of leisure, in turn, imply an increase in consumption, which, in the aggregate, translates to a smaller negative effect on consumption.
Finally, the shift in the age of pension receipt for some types of individuals in combination with the bequest motive induces them to consume their higher lifetime pension benefits in a shorter period. The presence of the bequest motive limits their possibility, or more accurately, their desire to lower their wealth levels earlier in life in order to raise consumption. On the contrary, the higher level of lifetime income induces these individuals to raise their target level of bequest, increasing the value of wealth. This pushes up consumption of the retirees.

As shown in table 5.2, the reduction in government transfers improves the government budget. The total cash flow of pension funds deteriorates. The increase in labour supply increases both received premiums and paid benefits. As the change in paid benefits exceeds the change in received premiums, the total cash flow of pension funds falls.

5.4 Introduction of an early retirement scheme

In this simulation we introduce an actuarial unfair early retirement scheme (ERS). If an individual voluntarily leaves the labour force at an age between 60 and 64 years, he receives a (lump sum) ERS income transfer in advance of the receipt of pension benefits at age 65.The size of this transfer is 80% of the average labour income during the preceding 10 years.

The introduction of ERS leads to a double-peaked decision problem. This is true because, as the use of this scheme is voluntarily, the optimal allocation and associated lifetime utility of the base scenario remains an option. The second option, then, is to take part in the ERS. The second option consists of a different optimal allocation of lifetime consumption and leisure as taking part in the ERS changes the lifetime budget constraint and imposes a constraint on labour supply after entering this scheme (that is, to be eligible for the ERS income transfer, you have to retire fully within a specified time period and are not allowed to resume work any time in the future). The ratio between the amount of the income transfer and the amount of missed labour income and associated pension benefits is the crucial factor in determining which of the two locally optimal allocations is the global optimum.

Incentives

Focusing on the allocation associated with participation in the ERS, the lifetime allocation of consumption and leisure is affected by (i) the change in the lifetime budget constraint and (ii) the imposed labour supply constraint. The changed lifetime budget causes an income effect, while the imposed labour supply constraint causes an intertemporal and intratemporal substitution effect.[61]

Aggregate effects

As the ERS is a subsidy to quit the labour market at a particular age or age-range, the intuitive result is an extended participation and labour supply of individuals with retirement ages just before the entrance date of the scheme, while individuals with retirement ages after this entrance date will reduce their participation and labour supply. Furthermore, the link between the ERS income transfer and average labour income in the preceding 10 years will stimulate labour supply at ages 50 and 59 years. This intuitive result also follows from our model (see figure 5.10 in which the dashed line describes the results of the simulation), but as the net effect of different behavioural responses of the distinguished groups. Some groups, in particular groups with larger variable costs, prefer a prolonged period of labour force participation until 60 years. Other groups, in particular groups with smaller variable costs, reduce their working period. Finally

Table 5.3 Economic effects of early retirement scheme

Macroeconomic results	
Average age of quitting the labour force	− 2.2
Labour supply (%)	− 1.2
Consumption (%)	3.2
Average lifetime labour supply (fte, abs dif)	− 0.7
Government budget (bln, abs dif)	− 22.6
Cash flow of pension funds (bln, abs dif)	− 8.8
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 55 - 59 years	
Labour supply (%)	9.5
Participation rate (%-point)	2.2
Age group 60 - 64 years	
Labour supply (%)	− 100.0
Participation rate (%-point)	− 31.6
Age group 65 - 69 years	
Labour supply (%)	− 100.0
Participation rate (%-point)	− 11.8
Age group 70 - 74 years	
Labour supply (%)	− 100.0
Participation rate (%-point)	− 3.4

[61] As the associated shadow price (η) alters the effective wage rate.

Figure 5.9 Total labour supply

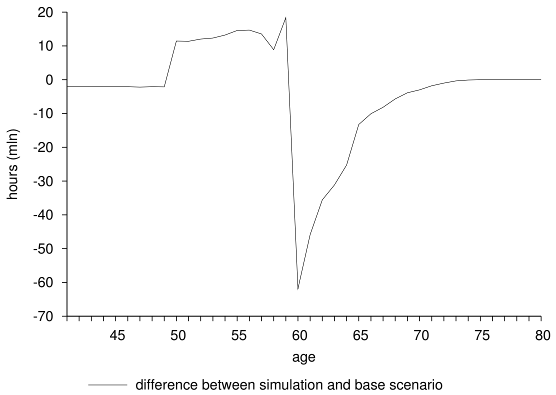


Figure 5.10 Participation rate

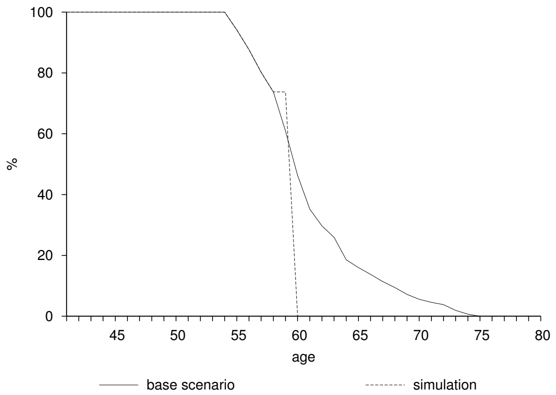


Figure 5.11 Total consumption

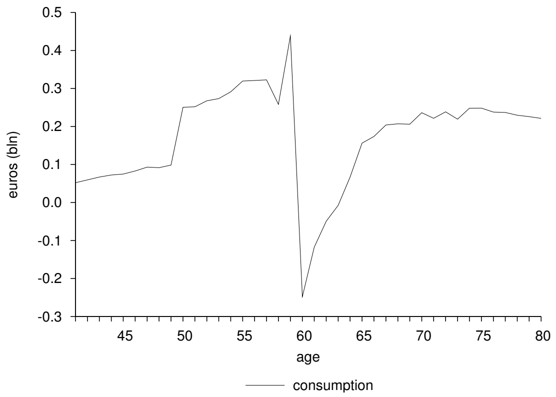
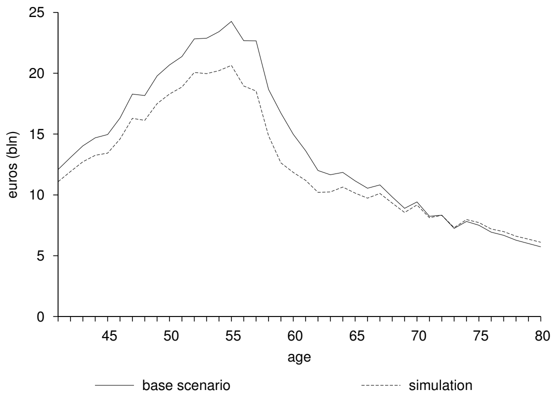


Figure 5.12 Total private financial wealth



there are some groups, in particular groups with extremely large and extremely small variable costs, who do not alter their consumption and leisure over the life cycle. In order to increase their ERS income transfers, individuals of these groups raise their labour supply between 50 and 59 years. In the case of extremely large variable costs individuals retire before the age of 60 years due to the infeasibility of the size of the variable costs, imposed minimum amount of working hours and maximum available time. This constraint prevents reallocations of lifetime consumption and lifetime leisure in response to the introduction of an early retirement scheme. In this simulation individuals with extremely small variable cost also enter the ERS. However, in a simulation with an ERS income transfer of significantly less than 80% of the average labour income, these individuals could decide not to enter the ERS as lifetime utility of working until age 75 do not exceed lifetime utility of using the ERS (where the latter leads to less lifetime income and more leisure). In the textboxes we focus on the reallocations of the first (larger variable costs) and second category (smaller variable costs). Looking at the aggregate results, in our simulation almost everyone enter the ERS and so the participation rate and labour supply become nil after age 60 (see figures 5.9 and 5.10). In this simulation the average age of

Reallocations of individuals with large variable costs in response to ERS

In the base scenario individuals with large variable costs retire before the entrance date of the ERS as the effective wage rate becomes to small due to the variable costs. In this simulation these individuals face a positive effect on lifetime income if they postpone their retirement for a few years. First, they receive the ERS income tranfer. Second, they receive additional labour income during the years up to the entrance date of the ERS and associated higher (lifetime) pension benefits after age 65. This increase in lifetime income results in a higher consumption. Compared to the base scenario, the increase in lifetime income also results in more leisure and less labour supply up to the age 50. Up to the retirement age in the base scenario, the link between the ERS income transfer and average labour income in the period 50-59 years results in an increase in the effective wage rate and so labour supply goes up as the substitution effect exceeds the income effect. Next, the imposed minimum labour supply constraint implies an increase in the participation rate and a higher effective wage rate in the period between the retirement age (in the base scenario) and entrance date of the ERS. This increase in the effective wage rate also causes an intratemporal and an intertemporal substitution. The intratemporal substitution effect leads to more consumption and less leisure. The intertemporal substitution effect results in more leisure in advance of the retirement age (in the base scenario) as leisure just before the entrance date of the ERS becomes more expensive. So, individuals with large variable costs increase consumption up to the entrance date of the scheme (income effect and intratemporal substitution effect), while they reduce labour supply in advance of their (baseline) retirement age (intertemporal substitution effect dominates income effect) and increase labour supply between this age and the entrance date of the ERS. Up to the baseline retirement age, the increase in consumption and fall in labour supply reduces savings and private financial wealth. Compared to the baseline, during the period of prolonged labour market participation savings increase due to received labour income which exceeds the increased consumption.

After the age 60 the reallocation is influenced by the increase in lifetime income as, in the base scenario, the effective wage rate in this period is already small due to high variable costs. So, after age 60 (relative) prices are almost similar to the base scenario and do not result in a (significant) reallocation by a substitution effect. Furthermore, the replacement of second-tier pension benefits by the ERS income transfer reduces current income between 60 and 65 years of age. Therefore, consumption falls between 60 and 65 years as current income falls and a full compensation by dissaving would reduce the utility of bequests. After age 65 the increased pension benefits offer the opportunity to raise simultaneously consumption and bequests.

withdrawal from the labour market reduces with 2.2 years and total labour supply falls with 1.2% (see table 5.3). Induced by the income and the substitution effects consumption simultaneously changes between the ages 50 - 65 years (see figure 5.11). Regarding consumption opposite effects appears for different groups. Groups facing large variable costs will increase their consumption due to an increased lifetime income. Groups facing small variable costs reduce their consumption as lifetime income falls. The net effect of opposite changes in consumption behaviour is an increase of about 3.2%. Finally, savings and private financial wealth fall as the ERS implies an income transfer after leaving the labour market which reduces the necessity of private wealth in order to consume after retirement (see figure 5.12).

The ERS reduces the government budget. First, as the ERS income transfer is paid by the government. Second, as the base of income taxes and Social Security premiums falls as the decrease in labour income (due to less labour supply) is only partly offset by the received ERS income transfer. The cash flow of pension funds also falls. In this case the fall in received pension premiums exceeds the fall in paid pension benefits as the accrual of pension rights just before the pivot age of the pension scheme falls.

5.5 Fixed benefit commencement date

This simulation analyses the effects on labour supply, consumption and wealth of a change in the commencement date of the second-tier pension benefit. In the base scenario the agents start to draw pension benefits after they have stopped working in their main job, i.e., the date of pension receipt is linked to their labour supply behaviour. The new scenario provides for a fixed commencement date at which the pension fund starts to pay benefits, independent from the agents' labour supply behaviour. In this simulation, agents begin to receive second-tier pension benefits at age 60.[62] From that age onwards agents stop paying pension premiums and stop building up pension rights.

Incentives

Given that the fixed age at which agents start to receive pension benefits is 60 years, some agents start to receive benefits later than in the base scenario (especially groups with large variable costs), while others start to receive benefits at an earlier age (groups with small variable costs). These changes in the pension scheme imply several changes in the effective wage rate since features of the pension scheme (for instance, pension premiums, promised benefits, relative yield on pension wealth) are part of this wage rate. Furthermore, this new pension scheme implies the removal of the labour supply constraint, that is, the obligation to quit your main job in order to receive pension benefits.

The first and most obvious change in the effective wage rate is caused by the forward or backward shift in the commencement date which affects the amount of pension rights and corresponding pension benefits. Such a shift, for example, changes the time span in which pension rights are built up.

Second, age related tax rates cause of a change in the effective wage rate. After all, due to different tax rates before and after age 65, a shift of the commencement date may affect net pension benefits. That is, (gross) pension benefits that are received between 60 and 65 are taxed more heavily than benefits received after 65.

A third, quite hidden, cause of a change in the effective wage rate is the change in the relative utility of pension savings compared to private savings. This relative utility depends, among other things, on the difference between the (tax-free) net yield on pension wealth and (taxed) net yield on private financial wealth. A change in the commencement date, then, reduces or extends the

[62] First tier pension benefits start at age 65.

period of tax-free pension wealth accumulation. Moreover, in contrast to pension rights, paid pension benefits are available to allocate among consumption, leisure and bequests. In this respect the fixed commencement date changes the relative utility of pension savings with respect to private savings too. Independent of the reasons behind the changes in the effective wage rate, changes in the effective wage rate result in both an income effect and a substitution effect.

The removal of the link between labour supply behaviour and the benefit commencement date on the one hand offers the possibility to continue to supply labour in the main job. In the baseline pension scheme one of the incentives to retire from the main job is that retirement gives access to your pension income. The removal of this incentive logically may result in later retirement. On the other hand, the removal of the link between labour supply behaviour and the benefit commencement date also offers the possibility to delay the commencement date, and benefit from the tax advantages, without having to extend labour supply.

Aggregate effects

The pension scheme with a fixed commencement date at age 60 leads to a fall in labour supply, in particular at the extensive margin (see table 5.4 and figure 5.14 before age 65). The average

Table 5.4 Economic effects of a fixed commencement date

Macroeconomic results	
Average age of quitting the labour force	− 0.7
Labour supply (%)	− 0.6
Consumption (%)	− 0.1
Average lifetime labour supply (fte, abs dif)	− 0.3
Government budget (bln, abs dif)	− 2.1
Cash flow of pension funds (bln, abs dif)	5.8
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	− 0.1
Participation rate (%-point)	− 0.1
Age group 55 - 59 years	
Labour supply (%)	− 6.0
Participation rate (%-point)	− 8.3
Age group 60 - 64 years	
Labour supply (%)	− 15.7
Participation rate (%-point)	− 6.2
Age group 65 - 69 years	
Labour supply (%)	4.7
Participation rate (%-point)	0.0
Age group 70 - 74 years	
Labour supply (%)	24.8
Participation rate (%-point)	0.6

Figure 5.13 Total labour supply

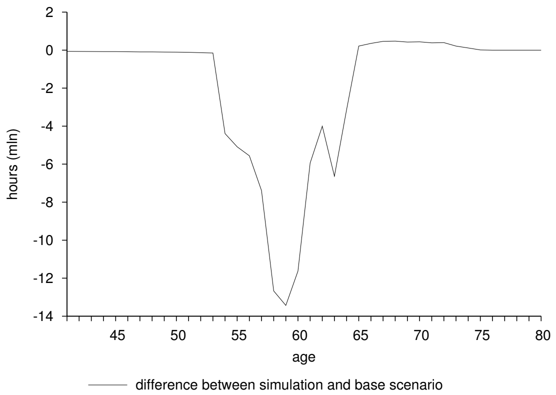


Figure 5.14 Participation rate (absolute differences)

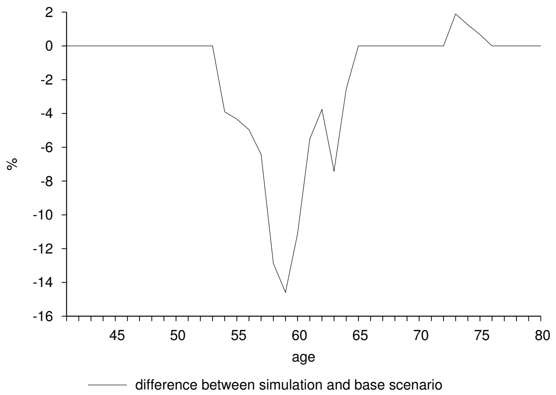


Figure 5.15 Total consumption

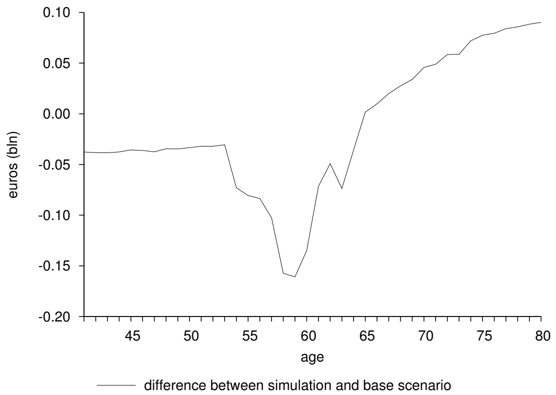
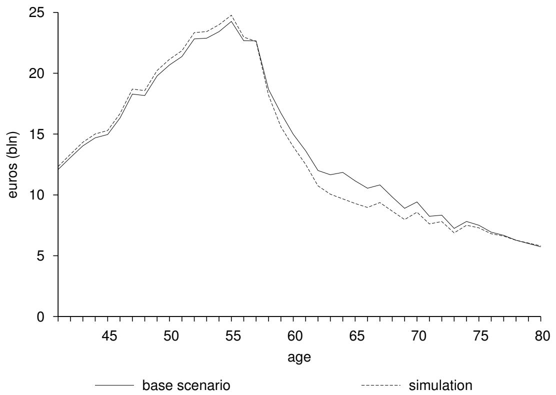


Figure 5.16 Total private financial wealth



retirement age drops by almost eight months (see table 5.4). Especially labour supply between 55 and 65 falls, while a small increase occurs after age 65 (see figure 5.13). Total consumption is almost stable as the increase in post-65 consumption offsets the fall in pre-65 consumption. Like the simulations in the previous sections, these outcomes are the net result of different behavioural responses of different groups and at different stages during the life cycle.

Up to the commencement date of second-tier pension benefits, the macroeconomic effect on labour supply, consumption and private financial wealth is the result of opposite effects at underlying groups. For instance, individuals with very large variable costs retire at around 55-57 years of age due to the infeasibility of the minimum hours requirement and the size of the variable costs, given the total available time. Because the fixed commencement date does not relieve this infeasibility, these individuals face a delay of pension benefits without the possibility to extend their working life. Consequently, they have to finance the time span between retirement and receipt of pension benefits by own savings (higher private financial wealth). In this respect the shift of the commencement date of second-tier pension benefits deteriorates the allocation of funds. Compared to the baseline pension scheme, forced pension savings become

Reallocations of individuals with small variable costs in response to fixed commencement date

Compared to the baseline, the new pension scheme implies a forward shift in the commencement date (mostly from 65 to 60), which implies a reduction in the accrual of pension rights. This lowers the net effective wage rate before age 60. On the other hand, this forward shift makes pension benefits available earlier in time to be used for consumption, leisure and bequests. This improves the relative utility of pension savings with respect to private savings, increasing the net effective wage rate. In this case the latter effect dominates the results: the effective wage rate increases. This gives rise to an income effect and an intratemporal substitution effect. As the substitution effect dominates, leisure falls, while consumption and labour supply increase.

Furthermore, the forward shift in the receipt of pension payments implies less private savings in order to smooth consumption in times of lower income (due to annual increases in variable costs after age 50).

Depending on the baseline retirement age, the effective wage rate also changes after the commencement date as the building up of pension rights ends. In most cases this results in a fall in the effective wage rate and a corresponding reduction in labour supply. However, in the baseline some individuals with small variable costs retire somewhere between 60 and 65 in order to attain their pension benefits. As this labour constraint is now removed, some of these individuals choose to delay retirement from their main job. This results in a higher lifetime income and a corresponding upward shift in consumption. This opposes the aforementioned downward effect of the real wage rate.

In addition to these two effects, the fact that the effective wage rate falls during ages 60-65 and rises between 25 and 60 implies the existence of an intertemporal substitution effect. This amounts to (slightly) more labour supply in advance of the new commencement date and less labour supply thereafter (ages 60-65).

Finally, in order to smooth consumption after age 60, a part of the received pension benefits and additional labour earnings is saved, implying that private financial wealth increases from 60 till 64 years of age.

After the statutory retirement age of 65 and compared to the baseline scenario, the annual amount of pension benefits is reduced due to the prolongend period of pension payments and the reduced period of building up the pension rights. Compared to the baseline in which income after retirement is significantly higher than income before retirement, this results - despite of some additional savings between 60 and 65 years - in less consumption and leisure after retirement.

less attractive and so the effective wage rate is lower up to the age of withdrawal from the labour market. The delay in the benefit commencement date without an associated extension of working life (as in the baseline scenario), in addition, raises net pension benefits due to the tax advantages. This gives rise to an income effect, raising consumption and leisure. Overall, in this period, consumption and labour supply (intensive and extensive margin) fall. On the other hand, individuals that retire from their first job between 60 and 65, increase their labour supply in reaction to a rise in their effective wage rate as the early start of second-tier pension benefits implies additional funds to allocate among consumption and bequest. In this respect the new pension scheme is more favourable than the baseline scheme. The forced early commencement date reduces the accrual of pension rights and yields a negative income effect. Furthermore, private savings are reduced as additional pension funds will be available at age 60 to compensate the expected drop in labour supply after the gradual increase of variable labour costs. The net effect of increased labour supply and less savings is a small rise in consumption up to age 60.

The macroeconomic effects on labour supply during the time span 60 - 65 years are entirely

Reallocations of individuals with large variable costs in response to fixed commencement date

Individuals with the largest variable costs retire due to the infeasibility of time constraint, minimum hours constraint and variable costs. To continue working beyond the current retirement age is no option. The new commencement date, therefore, requires additional savings to bridge the time span between retirement and new commencement date. In this way the pension scheme distorts an optimal allocation of consumption and leisure over the life cycle. This results in a small fall in the effective wage rate and so a fall in labour supply (hours worked) and less consumption in advance of the withdrawal from the labour market.

After retirement, labour supply is nil and consumption is funded by private financial wealth until the commencement date of the pension scheme. Thereafter, pension benefits are also used to consume. However, as the altered pension scheme distorts the optimal life-cycle allocation of consumption, consumption increases after the retirement age. Until age 65, the rise in consumption is accompanied by a fall in private financial wealth. At the age 64, private financial wealth is below its baseline value. After age 65 and the start of first-tier pension benefits, savings increase in order to restore the amount of private financial wealth almost to its baseline value.

caused by groups with smaller variable costs. In this period the net effect on the effective wage rate of the new pension scheme is negative. The loss of the accrual of pension rights is larger than the impact of the reduction of the pension benefits and the more favourable availability of funds. In response to the fall in the effective wage rate, labour supply drops at the extensive and intensive margin. Simultaneously, consumption falls and savings increase. On the other hand, consumption of individuals with large variable costs start to increase after age 60, while savings fall between ages 60-54. The increase in consumption is caused by the rise in lifetime income after age 60. Compared to the baseline, this income increases as second-tier pension benefits are paid during a shorter period. The fall in private savings is caused by an unbalance in the annual flows within the post-60 period. As the baseline pension scheme incorporates first-tier pension benefits and results in a fixed amount of total pension benefits after retirement, the new pension scheme raises total annual pension benefits after the commencement date of first-tier pensions.

At age 65 individuals start to receive their first-tier pension benefits. As just described, individuals with large variable costs increase their private savings in this period in order to restore private financial wealth to its baseline value at age 99. Individuals with small variable costs face a fall in total post-65 income as a part of second-tier pension benefits is already received. The drop in (residual) lifetime income results in less consumption and less leisure, and so an increase in labour supply at the intensive and extensive margin.

Looking at the effects on the government budget and the total cash flow of pension funds, the government budget deteriorates as the tax base falls. The shift forward of the payment of second-tier pension benefits improves the total cash flow of pension funds. The reduced accrual of pension rights is exceeded by the yield on pension wealth.

5.6 Free choice

The default pension scheme relates the commencement of pension benefits to quitting the first job, while pension funds impose the amount of these benefits – consisting of a fixed yearly annuity. In order to assess the impact on labour market participation of a more flexible pension scheme, we introduce a pension scheme without the link between quitting the main job and receiving pension benefits and with the opportunity for the individual to choose the amount of pension benefits between 60 and 65 years. It is not allowed to receive pension benefits before age 60. In agreement with Dutch institutions, the chosen levels of pension benefits are limited to 70% of average labour income, and the sum of current labour income and current pension benefits is not allowed to exceed the average labour income until age 60. After age 65 the assumed pension scheme returns an actuarial-fair fixed annuity.[63]

Incentives

Compared to the baseline, the new pension scheme gives the opportunity to simultaneously supply labour in the main job and receive pension benefits between 60 and 65 years, to cope with the increasing variable costs. This combination allows people to acquire lower private financial wealth to smooth consumption and, consequently, raise their consumption level and reduce labour supply, prior to age 60. However, within the new pension scheme, one may also choose to first quit the main job and postpone the receipt of pension benefits. Such a delay would be beneficial for two reasons. First, compared to private savings, the yield of pension savings is higher due to the fiscal exemption of interest income and the reallocation of wealth of deceased participants among the survivors.[64] The second reason concerns the difference in tax rates before and after age 65, resulting in higher net pension benefits if received after age 65. Such a strategy requires additional savings before age 60 in order to smooth consumption in the period between quitting the labour force and receiving pension benefits. Or in other words: less consumption and more labour supply. Whichever choice they make concerning their pension commencement date, before or after the moment of quitting their main job, individuals who in the baseline started to receive pensions before age 60 are now forced to delay pension receipt to at least age 60.

[63] In order to conduct this simulation the model described in chapter 3 is slightly altered. Equation (3.25) is replaced by the constraints

$$pb_t \begin{cases} = 0 & \text{if } t < 60 \\ \leq \overline{wl}_t - \mathrm{w}_t(\overline{R}_{ret})l_t & \text{if } t \geq 60 \text{ and } < 65 \\ \leq 0.7\mathrm{w}_t(\overline{R}_{ret})l_t & \text{if } t \geq 60 \text{ and } < 65 \\ = \Gamma_{t_{65}}^{-1} ap_{t_{65}-1} & \text{if } t \geq 65 \end{cases} \tag{5.1}$$

[64] This gap between yield on pension wealth and private wealth implies higher pension benefits if the commencement date is postponed.

Aggregate effects

Looking at the results for labour supply figure 5.17 and figure 5.18 show a drop in labour supply, especially at the extensive margin before age 65. Total labour supply falls about 0.7% and in full time equivalents about 0.3% (see table 5.5). Like previous simulations, these figures describe the total effect of responses of different groups. In this simulation reallocations of individuals with large variable costs largely explain the macroeconomic results.[65] These individuals face a shift of the commencement date of their pensions up to at least age 60 and have to consider an expensive (in terms of lifetime income) early start of the benefits at age 60 and an expensive (in terms of reduced bequests up to age 65) of a postponement of the benefits up to age 65. In this simulation, these individuals prefer to postpone their pension benefits to age 65 (with an exception at age 63, see below).

Table 5.5 Economic effects of pension scheme including free choice between 60 and 65 years

Macroeconomic results	
Average age of quitting the labour force	− 0.8
Labour supply (%)	− 0.7
Consumption (%)	1.0
Average lifetime labour supply (fte, abs dif)	− 0.3
Government budget (bln, abs dif)	− 2.8
Cash flow of pension funds (bln, abs dif)	6.0
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	− 0.2
Participation rate (%-point)	− 0.1
Age group 55 - 59 years	
Labour supply (%)	− 6.1
Participation rate (%-point)	− 8.3
Age group 60 - 64 years	
Labour supply (%)	− 12.1
Participation rate (%-point)	− 6.2
Age group 65 - 69 years	
Labour supply (%)	0.0
Participation rate (%-point)	0.0
Age group 70 - 74 years	
Labour supply (%)	0.0
Participation rate (%-point)	0.0

[65] Groups with small variable costs do not alter their life-cycle allocation of consumption and leisure as – in the baseline – they quit their main job and start to receive pension benefits at age 65. A shift forward of pension funds would reduce their lifetime income as 1) the tax rate on pre-65 income exceeds the tax rate of post-65 income and 2) the yield on pension wealth exceeds the yield on private financial wealth due to the tax exemption and the redistribution of pension wealth of deceased participants.

Figure 5.17 Total labour supply

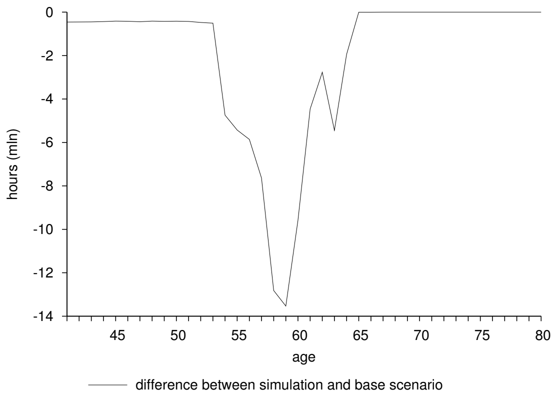


Figure 5.18 Participation rate

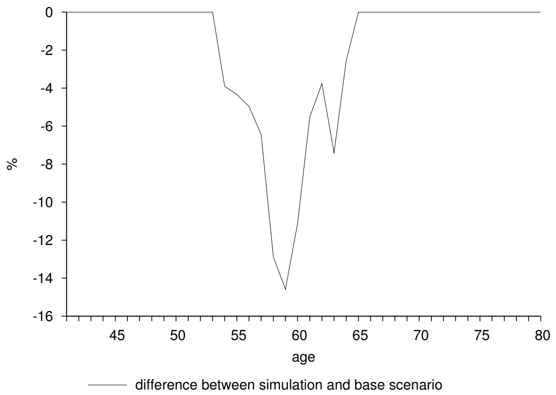


Figure 5.19 Total consumption

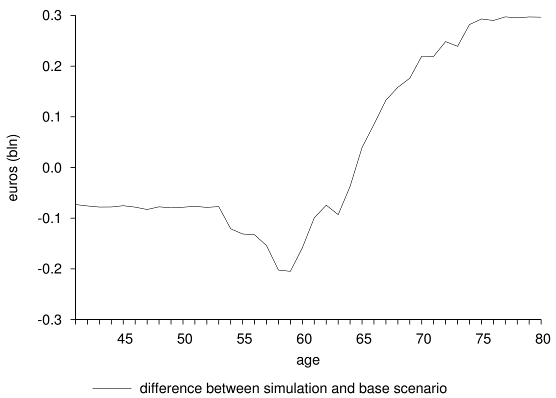
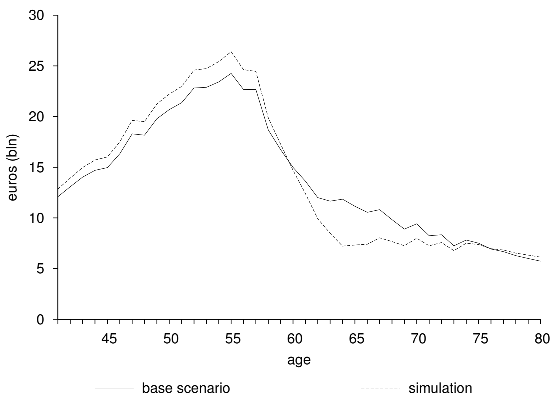


Figure 5.20 Total private financial wealth



Between ages 55 and 65, current income is below its value in the baseline due to postponed pension benefits. So, savings are used for consumption, resulting in a lower level of private financial wealth at the end of this period.

Up to age 55, the lower levels of private financial wealth at later ages and associated higher levels of marginal utility of bequests reduce the effective wage rate up to the retirement age and lead to a fall in both labour supply and consumption. The reduction in the effective wage rate shifts the optimum of working at the minimum hours constraint towards an earlier retirement, lowering the participation rate. The decline in consumption exceeds the decline in labour income to realize a higher level of private financial wealth at age 55.

After age 65, current income rises (caused by higher pension benefits), implying that consumption and savings exceed their baseline values. The additional savings ultimately result in a slightly higher level of private financial wealth, expressing the increased lifetime income caused by higher (net) pension benefits.

Figures 5.17-5.19 show a spike at age 63. Only at that age, many types of individuals ask for some pension benefits. In our data, the mortality rates – which are based on CBS data – show a sharp increase at age 63 and so alter significantly the return on pension wealth and – compared to other years – the weight of bequests in lifetime utility. If a fixed and constant mortality rate is assumed, this spike disappears.

Above results are dominated by the structure of the tax system. In particular, if post-65 and pre-65 income taxes are equalized and the tax exemption on the yield on pension wealth is abolished, almost all individuals (also individuals with small variable costs) will choose to receive pension benefits at ages 60 or 61, and retire one year earlier. Again, labour supply falls. But in contrast to the preceding results, consumption falls due to a reduced net lifetime income caused by lower pension benefits and income taxation.

The drop in labour supply and therefore in labour income reduces tax receipts of the government. This leads to a fall in the government deficit. The total cash flow of pension funds improves as some groups extend their labour supply (at the extensive margin) in order to tide over the period between the ’old’ age of receiving pension benefits in the baseline and the current age.

5.7 Delayed retirement credit

In this section, we focus on the effects of a more flexible first-tier pension scheme. In the baseline, first-tier pension benefits start at the imposed age of 65 years independent from retirement. In current simulation the commencement date of these first-tier pensions is equal to the retirement age if the retirement age exceeds 65 years. As the baseline simulation contains a statutory retirement age of 65 years, we have to shift the statutory retirement age in the simlation too.[66] We assume a new statutory retirement age at 70 years. Furthermore, we introduce a premium for each year of participation in the first job after 65 year. First, and inspired by the Dutch policy debate, we impose a premium of 5% and show that - compared to the effects of a shift in the statutory retirement age, negative effects on labour supply of this premium will appear.[67]

Incentives

A simulation including a premium on participation above 65 years must contain a shift in the statutory retirement age too. So, compared to the baseline, this simulation consists of two impulses. First, a shift in the statutory retirement age. In this simulation we shift this age towards 70 years. Second, a premium for extended labour force participation.

[66] Otherwise, nobody is able to use the delayed first-tier pension benefits.

[67] In contrast to the policy proposals this simulation assumes a link between receiving the premium and the prolonged participation in the labour market.

As more extensively described in section 5.3, the shift in the statutory retirement age increases labour supply as better paid (first) jobs are longer available. Furthermore, the decline in the wage rate of the second job starts a few years later and so, after quitting the first job, the wage rate of the second job exceeds its baseline value in the next 15 years. So, a rise of the effective wage rate after age 65 appears.

The premium on the delayed first-tier pension benefit affects the lifetime income and life-cycle pattern of private financial wealth. The change in lifetime income depends on the size of the premium, the interest rate and tax rates. A rough estimate of the actuarial fair premium is about 9%. Next, postponement of the first-tier pension benefit reduces private financial wealth after the age of 64 years for a long period and so reduces lifetime utility associated to the bequest motive. This will result in a downward effect on the effective wage rate.

Aggregate effects

In order to describe and understand the aggregate effects of delayed retirement credit, we will start with a briefly description of the effects of a shift in the statutory retirement age (first column of table 5.6). As already described in section 5.3, this shift encourages labour supply of

Table 5.6 Economic effects of delayed retirement credit

	(1)	(2)
Macroeconomic results		
Average age of quitting the labour force	0.2	0.1
Labour supply (%)	0.2	0.2
Consumption (%)	0.6	0.3
Average lifetime labour supply (fte, abs dif)	0.2	0.1
Government budget (bln, abs dif)	0.2	0.5
Cash flow of pension funds (bln, abs dif)	− 1.0	− 1.3
Age cohort results		
Age group 25 - 54 years		
Labour supply (%)	− 0.1	0.0
Participation rate (%-point)	0.0	0.0
Age group 55 - 59 years		
Labour supply (%)	− 0.2	− 0.1
Participation rate (%-point)	0.0	0.0
Age group 60 - 64 years		
Labour supply (%)	− 0.8	− 0.5
Participation rate (%-point)	0.0	0.0
Age group 65 - 69 years		
Labour supply (%)	76.7	54.3
Participation rate (%-point)	0.8	0.0
Age group 70 - 74 years		
Labour supply (%)	97.4	109.6
Participation rate (%-point)	1.8	1.8

Figure 5.21 Total labour supply

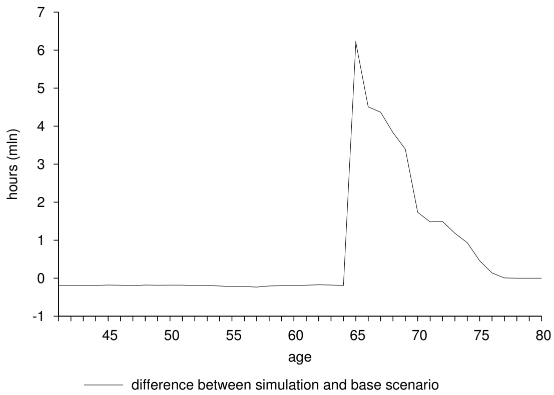


Figure 5.22 Participation rate

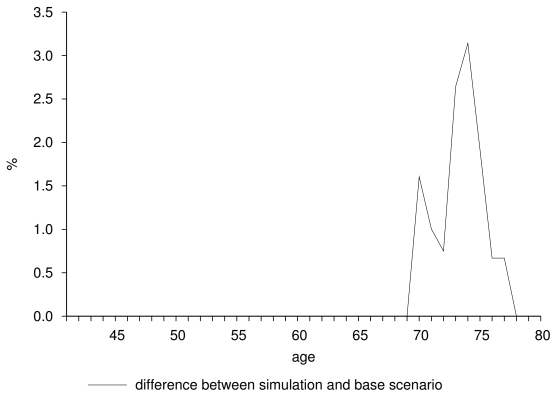


Figure 5.23 Total consumption

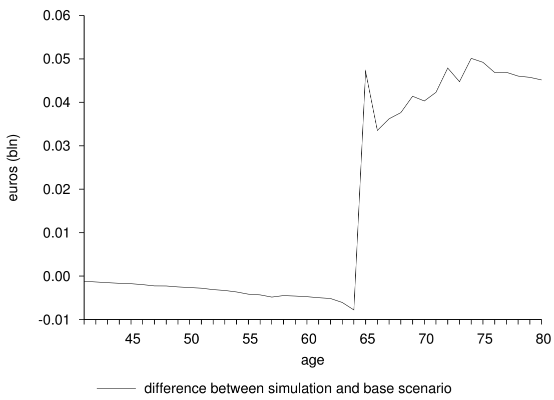
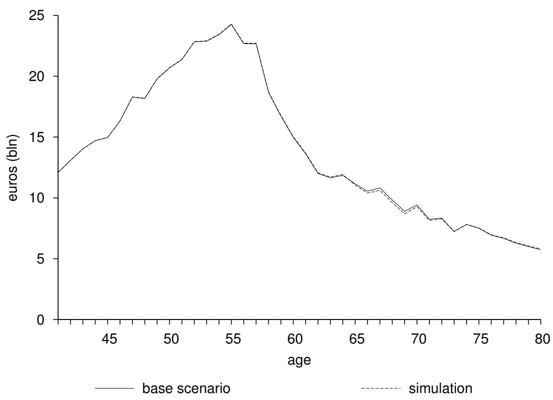


Figure 5.24 Total private financial wealth



the groups with small variable costs after 65 years. In contrast to groups with large variable costs, they are not yet restricted by the time constraint, minimum hours constraint and the size of their variabele costs. The opportunity to keep their better paid first job after achieving their 65th anniversary results in a larger labour supply in hours during 65 - 70 years. Thereafter, the wage rate of the second job exceeds its baseline value as the depreciation is related to the wage rate in last year at the first job. This leads to an increase in hours worked and finally in an increase in the participation rate at older ages. The increased labour income (and so lifetime income) results in a rise in consumption, an improvement of the government balance and financial wealth of pension funds. In advance of 65 years intertemporal substitution caused by increase in the wage rate after 65 years, leads to a decline in labour supply before 65 years.

Compared to the effects of the shift in the statutory retirement age, the combination of a shift in the statutory retirement age and a premium on postponed first-tier pension benefits results in an almost identical increase in labour supply (see second column of table 5.6). Looking at the average lifetime labour supply, the introduced premium results in a smaller increase. In the case of a 5% premium, the premium does not compensate the loss in lifetime utility by a cut in private financial wealth at and after 65 years. For some groups, the fall in private financial wealth caused by postponed first-tier benefits results in an increase in the marginal utility of private financial wealth and so a lower effective wage rate.[68]. The lower effective wage rate leads to an intertemporal and an intratemporal substitution effect. The intertemporal results in a reallocation to more work after 65 years and less labour supply in advance. The intratemporal substitution effect results in more leisure and less consumption before 65 years. The, compared to only a shift in the statutory retirement age, reduced labour supply results in a smaller increase in consumption and a slightly lower total cash flow of pension funds. Looking at the government balance, the fall in paid first-tier pension benefits reduces the government transfers and that exceeds the negative impact on government (tax) income of the reduced labour supply.

5.8 Balanced budget simulations

Introduction

All simulations presented in the previous sections are open budget analyses, *i.e.* (financial) effects on the government budget and/or the total cash flow of pension funds are not redistributed among households through changes in tax rates or pension premiums. For some issues, however, balanced budget simulations may be more relevant. But from the perspective of a model with heterogeneous households it is not evident how a balanced budget simulation should be defined. One approach is to aim at a balanced budget for a particular group. This approach will neutralize the income effects, but will necessarily result in different tax rates and/or pension premiums for different groups. From an institutional point of view a rather odd result.

The other approach is to balance the budgets at a macroeconomic level. This will guarantee uniform tax rates and pension premiums, but will not neutralize income effects as this approach contains redistribution of income between groups.

In this section, we limit our analysis to providing the tools to manage the second approach of balanced-budget simulations. Tools, as in this model the outcomes in case of a balanced budget simulation are nearly equal to the sum of the outcomes of an open budget simulation and a separate income tax and/or pension premium simulation. This finding leads us to limit our balanced budget discussion to the presentation of these two additional simulations.

[68] In particular groups with middle sized variable costs. Groups with large variable costs are not able to extend their period of labour force participation and so do not alter their labour supply in response to the shift in the statutory retirement age and the premium. Moreover, groups with small variable costs hardly reallocate their life-cycle labour supply in response to the premium. If they quit at age 65, the loss of labour income and so private financial wealth at that and successive ages exceeds the value of the first-tier pension in these years.

A cut in the tax rate on income

A cut of 1%-point in the (proportional) tax rate increases the net effective wage rate. This induces both an income effect and an (intratemporal) substitution effect. According to the substitution effect both labour supply and consumption increase. The income effect, as lifetime income is higher, causes higher levels of consumption and leisure, and hence a lower level of labour supply. Without the presence of age-dependent taxes, non-labour taxable income and borrowing constraints, these two effects imply that consumption increases, while the net effect on labour supply depends on the relative strenths of the income and substitution effects.

Because the model contains age-dependent tax rates[69], the relative effect of the cut in the tax rate on the effective wage rate differs between age-groups. This difference leads to a small intertemporal substitution effect. Moreover, the model contains non-labour taxable income, giving rise to an additional income effect. Finally, the presence of a bequest motive reduces the reallocation over time.

Table 5.7 Economic effects of a cut in the tax rate on labour income

Macroeconomic results	
Average age of quitting the labour force	0.0
Labour supply (%)	0.2
Consumption (%)	1.2
Average lifetime labour supply (fte, abs dif)	0.1
Government budget (bln, abs dif)	− 8.7
Cash flow of pension funds (bln, abs dif)	0.0
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 55 - 59 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 60 - 64 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 65 - 69 years	
Labour supply (%)	0.7
Participation rate (%-point)	0.0
Age group 70 - 74 years	
Labour supply (%)	1.8
Participation rate (%-point)	0.0

[69] The turning point is 65 years.

Figure 5.25 Total labour supply

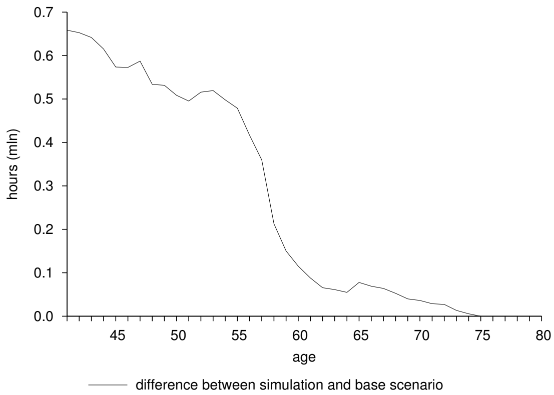


Figure 5.26 Participation rate (absolute differences)

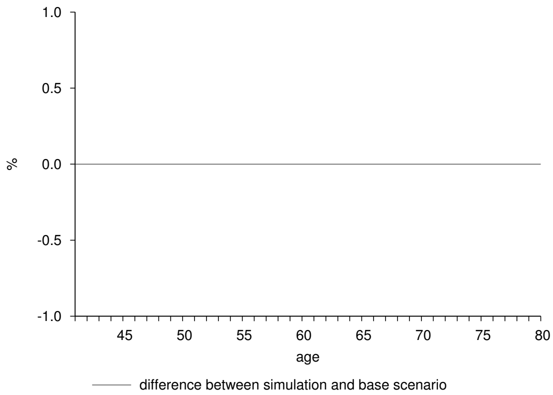


Figure 5.27 Total consumption

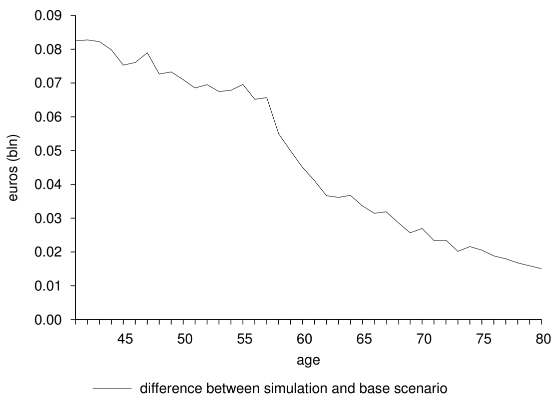
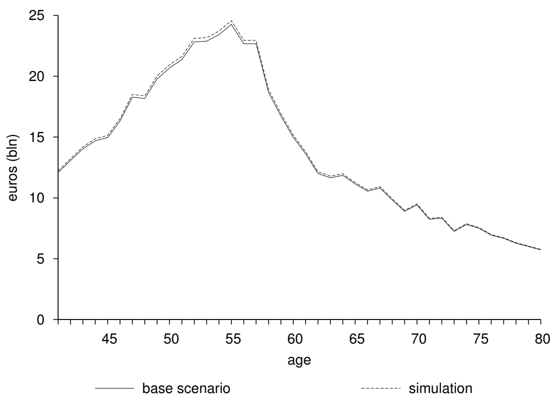


Figure 5.28 Total private financial wealth



As shown in table 5.7, the cut in the tax rate induces a small increase in labour supply and an increase in consumption of more than 1%. Both the average age of quitting the labour force and the participation rate (see figure 5.26) are unaffected. This is mainly the result of the largely age-independent nature of this policy change and the relatively small impulse.

As figures 5.25 and 5.27 show, the largest effects of the tax reduction occur at those stages in the life cycle in which all agents work. This reflects both the decline in the population and the fact that the impact of the change in the tax rate on both labour supply and consumption is lower after (full) retirement (on labour supply the impact after retirement is actually zero). For all types of individuals the income effect translates in more consumption, more leisure and less hours worked, while the substitution effect leads to more consumption, less leisure and more hours worked. Finally, the intertemporal substitution effect results in less time spent on leisure before age 65, and more time spent on leisure thereafter. As the elasticity of intratemporal substitution (σ) is larger than 1, the substitution effect dominates the income effect, implying increases in consumption, a reduced demand for leisure and higher levels of labour supply.

Individuals who retire before 65 face an increase in their net wage rate and consequently raise their labour supply by way of raising their hours worked. Participation remains unaltered. The corresponding increase in lifetime income is used to raise their level of consumption over the whole life cycle. To compensate the lower levels of leisure during their working life, however, consumption during working life is raised more than consumption during retirement. These individuals increase their level of wealth (see figure 5.28) for two purposes. One is to finance their higher levels of consumption later in life. The other purpose is to leave a higher amount of wealth as bequest. The higher bequest is driven by their higher lifetime income.

Individuals who continue to work after age 65 face a similar increase in net wages before 65, but in addition experience a relatively higher increase in their net wage rate after 65.[70] This induces them to raise their hours worked more than in the pre-65 period – induced both by a higher impulse and by an intertemporal reallocation, which consists of a shift of hours worked from the pre-65 period to the post-65 period. Again, consumption is raised over the whole life cycle and more so during working life. All these individuals raise their wealth level in response of the tax cut. This extra wealth is primarily used for bequest purposes, though some of it is used for smoothing purposes to finance part-time work. Income after 65 is used to finance consumption after 65 and additionally accumulate wealth for bequest purpose. These higher bequest needs tend to lower the increase in consumption after 65.

A cut in the pension premium rate

Naturally, responses to a decrease in the pension premium 1%-point are close to the responses to the fall in the income tax as descibed above. The main differences are that

1. A change in the pension premium has no effect on transfer income
2. Pension premiums are only paid until retirement from the main job

Taken into account these differences, the income effects of a change in the tax rate are not present here, while the gap between the net effective wage rate before and after retirement falls if the pension premium is reduced. Compared to the results of the cut in the tax rate, the different development of labour supply (compare figures 5.25 and 5.29) is largely the result of the smaller gap, giving rise to a (stronger) intertemporal dimension. Compared to the baseline, the cut in the pension premium labour supply induces an intertemporal substitution, shifting labour supply from the second to the first job. [71]

Comparing the macroeconomic outcomes between the cut in the income tax and the cut in the pension premium, the simulations show hardly any differences (compare tables 5.7 and 5.8).

[70] The effect on the net wage rate is relatively higher after (and including) age 65, because the 1%-point reduction of the tax rate concerns a lower tax rate after 65. This constitutes a higher relative change.

[71] See figure 5.29 where the change in labour supply gradually falls and labour supply is below its baseline value at age 65. Thereafter, the gap between simulation and baseline reduces as labour supply converges to nil.

Table 5.8 Economic effects of a cut in the pension premium

Macroeconomic results	
Average age of quitting the labour force	0.0
Labour supply (%)	0.2
Consumption (%)	0.6
Average lifetime labour supply (fte, abs dif)	0.1
Government budget (bln, abs dif)	3.1
Cash flow of pension funds (bln, abs dif)	− 77.2
Age cohort results	
Age group 25 - 54 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 55 - 59 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 60 - 64 years	
Labour supply (%)	0.2
Participation rate (%-point)	0.0
Age group 65 - 69 years	
Labour supply (%)	− 0.5
Participation rate (%-point)	0.0
Age group 70 - 74 years	
Labour supply (%)	− 0.7
Participation rate (%-point)	0.0

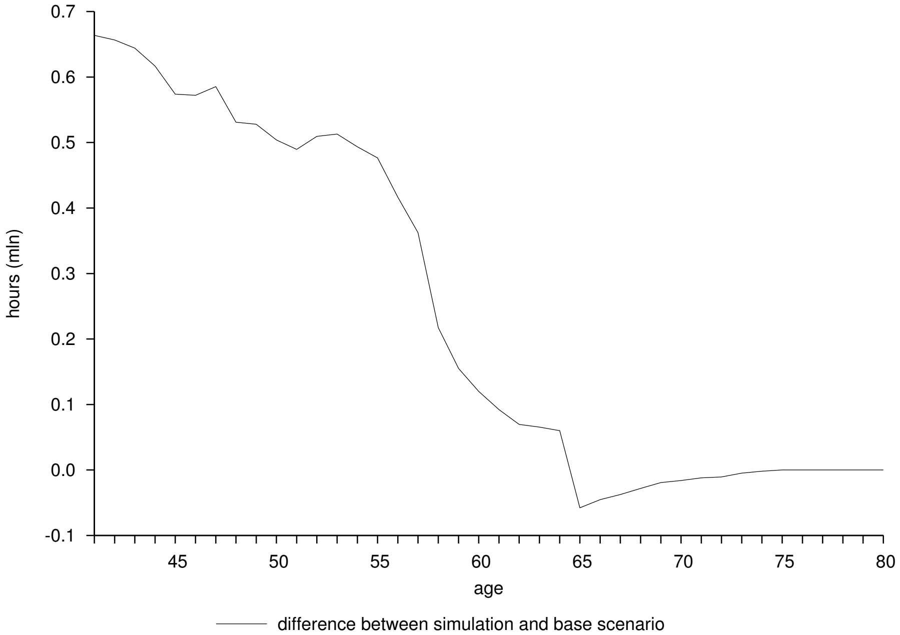
The macroeconomic effects on labour supply are very similar. The increase in consumption is smaller due to smaller income effects. In contrast to the cut in the income tax, the government budget improves because of smaller expenditure for tax-deductable pension premiums. The total cash flow of pension funds deteriorates significantly as the assigned pension benefits hardly change in the defined benefits scheme, while the received pension premiums substantially fall.

5.9 Concluding remarks

The preceding sections describe a number of policy simulations. The policy simulations show how the different (sub)groups behave, both individually and in the aggregate, in response to a change in policy. For example, if the Social Security premium exemption of the elderly would be eliminated, the model predicts that the average age of quitting the labour force would decrease with almost four months. Likewise, total labour supply would fall with 0.2%, while total consumption would fall with well over 1%. To properly assess these results, we have to keep in mind the partial nature of the model, and the set of simplifying assumptions.

Compared to the version of November 2007 we extended the model with a government

Figure 5.29 Total labour supply



budget constraint and a budget constraint for the pension funds. This enables us to conduct balanced-budget exercises. An additional advantage of this, as mentioned before, is that a balanced budget effectively removes the income effects, which are empirically hard to quantify. We also improved upon the empirical foundation of the model. Unfortunately, as the retirement data of 2005 were not yet available (in March 2008), we are still using the 2004 data.

The current results give an indication of the desired change in behaviour of households in the economy, in which the employers do not play an active role – for instance, apart from a minimum amount, the employees are free to choose any amount of hours they wish to supply. Moreover, there is still a fair amount of uncertainty about many parameters of the model. Finally, at this stage of constructing and analysing the properties of the model, we also simplified the model. For instance, at this stage we ignored the influence of empirically-founded wage profiles, unemployment, and the like.

6 Agenda for future research

At this point, we identify several avenues to improve the life-cycle model in the future. In order to refine the policies' impact on the retirement date, we may shorten the length of a period in the model to one month. Additionally, to take account of the restrictions that workers face if they want to reduce work effort, we may further restrict the hours worked decision.

Further, we may extend the degree of heterogeneity of the model. We can think of several directions in which it may be worthwile to extend the model. One direction concerns the level of the wage rate, or education level. In the current setting, all individuals earn the same gross wage rate. This may potentially overstate the income effect (e.g. of changes in Social Security). Moreover, having agents of different income levels, for example high and low income, allows us to differentiate the policies' impacts with respect to income levels. Another dimension of heterogeneity is to include family labour supply. The current population of the model consists of one-person households only. Extending the household to include two persons (possibly with children) may bring in important interactions between family members. This may be particularly important to describe female labour supply. Another approach to capture the different retirement patterns of women compared to men is to separately calibrate the model for men and women. A third potential direction of heterogeneity that may significantly influence the results is the pension system. In particular, we think of access to the early retirement scheme. As shown in the simulation concerning the introduction of an early retirement scheme, if such a scheme is available for everyone, almost everyone will consequently take it. Therefore, to capture both groups of people, the one that retires through the early retirement scheme and the one that does not, we need to differentiate with respect to (the eligibility of) the early retirement scheme. Finally, we may consider heterogeneity with respect to the past, i.e. to realized levels of wealth.

Last but not least, the ongoing development of behavioural economics provides challenges to incorporate these insights in a proper description of labour supply, retirement and consumption.

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