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Calibration of GAMMA 2010

The GAMMA model is used to assess the sustainability of Dutch public finances. For this purpose the model is calibrated on a macroeconomic dataset. This dataset is extended with government and pension sector data. Business cycle data are used to make equilibrium corrections. This memorandum reports on this calibration exercise.

[1] Thanks are due to Casper van Ewijk, Albert van der Horst and Ruud de Mooij for their comments

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1 Introduction

The Gamma model (described inDraper and Armstrong (2007)) is used to assess the sustainability of Dutch public finances in 2010 (van der Horst et al. (2010)). For this purpose the model is calibrated on data for the year 2008. This memorandum reports on this calibration exercise.

Section 2 starts with a description of the data used in GAMMA. The macro data for 2008 are based on the national accounts of Statistics Netherlands. For GAMMA the government expenditures categorical classification is transformed into a functional classification; the simplifying assumptions made are explained. The end of section 2 presents business cycle corrections. Section 3 describes how we use the population projection of Statistics Netherlands. Section 4 presents the calibration procedure for the government sector, firms, households and the pension sector, respectively. Section 5 reports how we take into account the most recent mid term projection of CPB. The appendices present technical details.

2 Data 2008

2.1 Macro economic data

The state of the Dutch economy is summarized in table 2.1. The row entries of the total accounts are markets, or subdivisions of a market and the column entries are agents. The aggregated market transactions over agents (row total) sum to zero. The table distinguishes between markets for goods, capital and labour in addition to accounting for income transfers from the government to households. The capital market is subdivided into investment activities, income from capital and profit taxes. GAMMA identifies the following agents: households, pension funds, the government, firms and the foreign sector. Capital is included as an artificial agent to distinguish between total investments and investments of the different sectors. The model subdivides the household sector into one hundred age cohorts, however the table presents only the aggregated household sector. The government sector is subdivided into expenditures, income and production. A cell in the table gives the transactions of agents on a market (+ receipt, − payment). The aggregated budget constraint of agents is obtained by adding up over the columns: the sum of revenues minus expenditures equals savings. That is, the column totals are zero

Table 2.1 Total accounts: circular flow for 2008 (billions of euros)

	Households	Pension sector	Capital	Government Services	Taxes	Production	Firms	Foreign sector	Row total
Goods	− 275.0		− 123.0	− 148.4	66.9	69.0	458.3	− 47.7	0.0
Investment			123.0			− 19.3	− 103.7		0.0
Transfers	55.5			− 55.5					0.0
Labour income	337.5					− 54.2	− 283.3		0.0
Private pensions	33.9	− 33.9							0.0
Non-labour income	16.1	21.6		− 13.4	17.6		− 54.1	12.3	0.0
Income taxes	− 136.6				136.6				0.0
Profit tax					17.2		− 17.2		0.0
Private pension premiums	− 32.2	32.2							0.0
Public transfers to foreigners				− 10.3				10.3	0.0
Savings(-)/ shortage(+)	0.9	− 19.9	0.0		− 6.1			25.1	0.0
Column total	0.0	0.0	0.0		0.0 [a]		0.0	0.0	

[a] Sum of the three columns of the government

These national account figures for the year 2008 come from SAFFIER, CPB's business cycle model[1] (Kranendonk and Verbruggen (2007)). The relations between GAMMA and SAFFIER variables are given in appendix B.

2.2 An update from the government finance department

The accounts of Table 2.1 are changed for two different reasons. First, CPB's government finance department (GF) made an update of the government budget figures, which was not processed in SAFFIER. Second, another classification of the government expenditures will be used. This section presents the incorporation of the update made by the CPB's government finance department (GF). This update is presented in appendix C. A consistent set of circular flow figures based on this update is presented in table 2.2. Comparison of Table 2.2 and 2.1 reveals only small differences.

Table 2.2 Total accounts: circular flow for 2008; update (billions of euros)

	House-holds	Pension sector	Capital	Government Services	Taxes	Production	Firms	Foreign sector	Row total
Goods	− 275.0		− 123.0	− 148.4	66.9	69.0	458.3	− 47.7	0.0
Investment			123.0			− 19.3	− 103.7		0.0
Transfers	55.6			− 55.6					0.0
Labour income	337.6					− 54.2	− 283.3		0.0
Private pensions	33.9	− 33.9							0.0
Non-labour income	16.1	21.6		− 13.4	17.6		− 54.1	12.3	0.0
Income taxes	− 136.5				136.5				0.0
Profit tax					17.2		− 17.2		0.0
Private pension premiums	− 32.2	32.2							0.0
Public transfers to foreigners				− 10.3				10.3	0.0
Savings(-)/ shortage(+)	0.6	− 19.9			− 5.7		0.0	25.0	0.0
Column total	0.0	0.0	0.0		0.0		0.0	0.0	0.0

[1] The figures are from Statistics Netherlands but are collected at CPB for the SAFFIER model. We rely on their dataset.

2.3 The functional classification government expenditures

Table 2.3 presents a functional classification of government expenditures. This functional classification is at the heart of the generational accounting framework of the GAMMA model. The behavioural assumptions of the government are based on this classification. A matrix can describe the relation between the categorical and functional classifications (see appendix D). However, the current GAMMA version makes a more simple assumption by assuming a one-to-one relation between both classifications. More specifically, GAMMA makes the assumptions presented in Table 2.3 for the relation between the categorical and functional classifications

Table 2.3 Classification government budget in the GAMMA model (billions of euros)

Government consumption (a)	147.9
- Defence	6.3
- Education	27.5
- Health	51.4
- Gen. Government	62.7
Debt service (b)	13.4
Indirect taxes minus subsidies	73.2
- Indirect taxes (c)	83.1
- Subsidies (d)	9.8
Production government	69.0
- Wages	54.2
- Depreciation (l)	14.7
Investments (e)	19.3
- Schools	2.6
- Buildings	7.1
- Infrastructure	9.6
Transfers households	65.0
- Social Security (f)	65.7
- Sale ground (g)	0.6
Transfers abroad (h)	13.8
Income taxes (i)	126.4
Profit taxes (j)	20.9
Non-labour income (k)	29.9
- Wealth income	7.2
- Natural gas	14.6
- Other income	8.2
Total expenditures (a+b+d+e+f+h)	269.9
Total income (c+g+i+j+k+l)	275.6
Surplus	5.7

A consistent circular flow table is obtained using assumptions about the contra posts in the system. This brings about Table 2.4.

Table 2.4 Total accounts: circular flow for 2008; using functional classification (billions of euros)

	House-holds	Pension sector	Capital	Government Services	Taxes	Production	Firms	Foreign sector	Row total
Goods	− 281.9		− 123.0	− 147.9	73.2	69.0	458.3	− 47.7	0.0
Investment			123.0			− 19.3	− 103.7		0.0
Transfers	65.0			− 65.0					0.0
Labour income	337.6					− 54.2	− 283.3		0.0
Private pensions	33.9	− 33.9							0.0
Non-labour income	3.5	21.6		− 13.4	29.9		− 50.4	8.8	0.0
Income taxes	− 126.4				126.4				0.0
Profit tax					20.9		− 20.9		0.0
Private pension premiums	− 32.2	32.2							0.0
Public transfers to foreigners				− 13.8				13.8	0.0
Savings(-)/ shortage(+)	0.6	− 19.9	0.0		− 5.7		0.0	25.0	0.0
Col total	0.0	0.0	0.0		0.0		0.0	0.0	0.0

2.4 Equilibrium data set

GAMMA is an equilibrium model that is calibrated on an equilibrium dataset. This section describes the construction of this equilibrium dataset. The assessment of the business cycle situation in 2008, *i.e.* the deviation from equilibrium and the actual situation, is presented in Table 2.5. “The business cycle corrections are given in Table 2.6. Using these corrections a new

Table 2.5 Business cycle situation in 2008

Assumptions	
outputgap	0.029
nairu	0.055
emu saldo structural %GDP	− 0.40
emu saldo structural%GDP	− 2.38
deviations from equilibrium	
government production	0.00
labour income share	0.00
Actual figures	
unemployment	0.04
labour income share	0.6
employment firms	6070.3
employment total	6856.4
replacement rate	0.7
business cycle effect on consumption	0.8
tax rate consumption	0.2
tax rate investments	0.1
tax rate profits	0.3
tax rate labour income	0.3
tax rate benefits	0.2
pension premium in percentages wages	0.1
roll over unemployment benefits to social assistance	0.6
unemployment benefit coverage with premiums	0.0

circular flow Table 2.7 and government budget Table 2.8 are obtained from Table 2.3 and 2.4. This section will further detail on these corrections[2].

The outputgap (g) and the production level in market prices determine the production correction ($\Delta Y_{ge} = g\,(Y_{gg} + Y_{ge} + T_{in}) - \Delta T_{in}$). The indirect taxes move together with investment and consumption ($\Delta T_{in} = 0.2\Delta C_h + 0.1\Delta I$) with 0.2 and 0.1 the relevant tax rates. The labour income share ($\lambda = 0.6$) and production change determine the wage correction ($\Delta Y_{we} = \lambda \Delta Y_{ge}$). The transfers change ($\Delta Y_t = \left(\frac{u_e}{u} - 1\right)(Y_u + \alpha Y_s)$) due to the difference between the NAIRU (u_e)

[2] The symbols can be found in appendix A.

and actual unemployment (u); with Y_s social assistance and Y_u unemployment benefits. The parameter $\alpha(=0.6)$, the fraction long lasting unemployed, is calibrated such that the EMU surplus in Table 2.7 equals the value published in CEP 2009. Other assumptions are: no premium rise due to the unemployment benefit increases; proportional investments with production; pension premiums increase with wage income and profit taxes increase with firms other income. Moreover, the change in other income of firms is proportionally divided over households, pension funds and the foreign sector. Consumption follows the non-capital income change ($\Delta C_h = 0.8\,(0.7\Delta Y_{we} + 0.8\Delta Y_t - \Delta P_p)$).

Table 2.6 Business cycle corrections 2008 (billions of euros)

production firms market prices	− 17.2
production firms base prices	− 16.0
wages firms	− 10.7
unemployment benefits	3.0
unemployment premiums	0.0
investments firms	− 3.5
income taxe wages	− 3.3
income taxes benefits	0.7
net non-capital income households	− 4.1
consumption	− 3.3
indirect taxes on consumption	− 0.8
indirect taxes on investments	− 0.5
pension premiums	− 1.0
profit tax	− 0.9

Lastly, an additional correction is made for the pension data. Table 2.9 presents the observed macro data. The adjustments in the MEV relative to the CEP are rather large. Both premiums and benefits are adjusted with about 10 percent. The MEV data are more reliable. So we use the MEV figures Table 2.7 presents the functional classification of the government budget with business cycle corrections. The circular flow is given in Table 2.8. These tables are used to calibrate GAMMA.

Table 2.7 Equilibrium data for the government budget for 2008 (billions of euros)

Government consumption (a)	147.9
- Defence	6.3
- Education	27.5
- Health	51.4
- Gen. Government	62.7
Debt service (b)	13.4
Indirect taxes minus subsidies	72.0
- Indirect taxes (c)	81.8
- Subsidies (d)	9.8
Production government	69.0
- Wages	54.2
- Depreciation (l)	14.7
Investments (e)	19.3
- Schools	2.6
- Buildings	7.1
- Infrastructure	9.6
Transfers households	68.0
- Social Security (f)	68.6
- Sale ground (g)	0.6
Transfers abroad (h)	13.8
Income taxes (i)	123.9
Profit taxes (j)	20.0
Non-labour income (k)	29.5
- Wealth income	6.8
- Natural gas	14.6
- Other income	8.2
Total expenditures (a+b+e+d+f+h)	272.9
Total income (c+g+i+j+k+l)	270.5
Surplus	− 2.4

Table 2.8 Total accounts: circular flow for 2008; equilibrium data (billions of euros)

	Households	Pension sector	Capital	Government Services	Taxes	Production	Firms	Foreign sector	Row total
goods	− 278.6	0.0	− 119.4	− 147.9	72.0	69.0	442.3	− 37.3	0.0
investment	0.0	0.0	119.4	0.0	0.0	− 19.3	− 100.1	0.0	0.0
transfers	68.0	0.0	0.0	− 68.0	0.0	0.0	0.0	0.0	0.0
labour income	326.9	0.0	0.0	0.0	0.0	− 54.2	− 272.6	0.0	0.0
private pensions	30.7	− 30.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
non-labour income	3.5	21.3	0.0	− 13.4	29.5	0.0	− 49.5	8.7	0.0
income taxes	− 123.9	0.0	0.0	0.0	123.9	0.0	0.0	0.0	0.0
profit tax	0.0	0.0	0.0	0.0	20.0	0.0	− 20.0	0.0	0.0
private pension premiums	− 28.5	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
public transfers to foreigners	0.0	0.0	0.0	− 13.8	0.0	0.0	0.0	13.8	0.0
savings(-)/ shortage(+)	1.9	− 19.1	0.0	0.0	2.4	0.0	0.0	14.8	0.0
column total	0.0	0.0	0.0		0.0		0.0	0.0	0.0

Table 2.9 Pension figures

	2008	2008
Source	CEP2009	MEV2009
Premiums (incl VUT)	36.0	33.1
Benefits (incl VUT)	33.9	30.7
VUT premiums	3.0	2.5
VUT benefits	2.9	2.8
Premiums net of VUT	33.0	30.6
Administration costs	3.8	3.6
Premiums net of VUT and administration costs	29.2	27.0
Benefits net of VUT	31.0	27.9
Pension wealth	875	875
Coverage ratio	140%	140%

3 Projections and assumptions exogenous variables

3.1 Growth, inflation and returns

Table 3.1 presents the growth, inflation and return assumptions. We assume a productivity increase of 1.7% per year just as in the previous study (van Ewijk et al. (2006)) and in the European Commision (2009) study. We have chosen a nominal rate of return of 5% in line with the previous study and the European Commission. Together with 2 percent inflation, *i.e.* the objective of the ECB, this results in a 3 percent real rate of return. This can be split up in a nominal bond rate of 3.5, an excess return on equity of 3 together with a portfolio share of equity of 50 percent.

Table 3.1 Growth, inflation and return assumptions for period 2008-2200

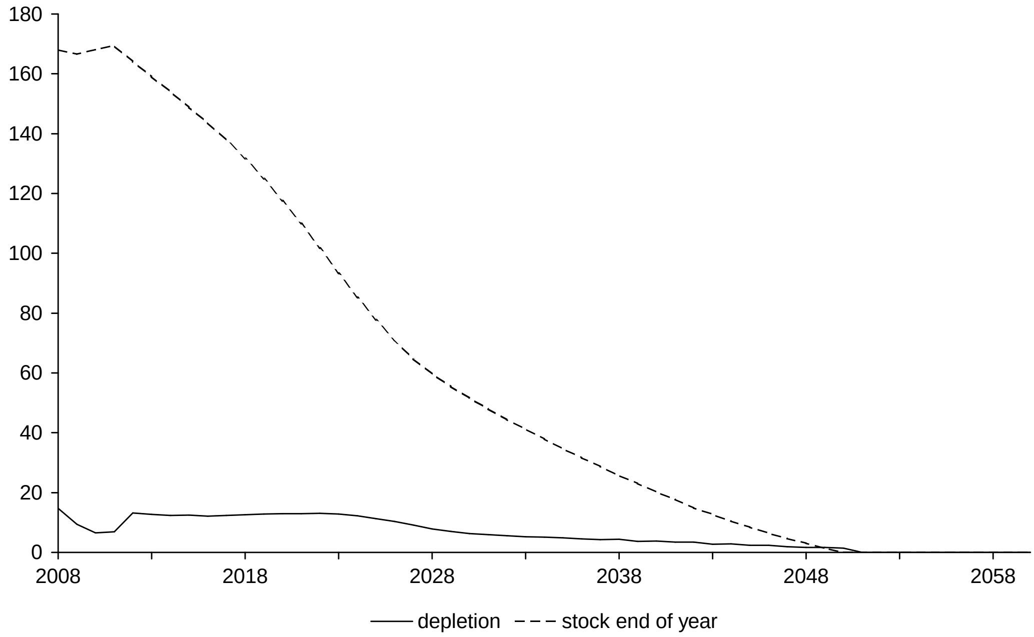
	(%)
Inflation	2
Real return	3
Labour productivity rise	1.7
Bond rate, nominal	3.5
Excess return equity	3.1
Portfolio share equity households	50
Portfolio share equity pension funds	50

.

3.2 Natural gas

Figure 3.1 presents the depletion of the stock of natural gas. The depletion is defined as government income from natural gas. The stock then equals the discounted value of government income form natural gas. The discount factor is set equal the nominal portfolio return.

Figure 3.1 Stock natural gass and depletion (billions of euros)



3.3 Population projection

The 2008 population projection of Statistics Netherlands (CBS) is characterized by a considerable life expectancy increase. The end year of the CBS projection is 2060.

Unlike the GAMMA model CBS distinguishes age cohorts older than hundred. Through an increase of the survival rates of the 90+ cohorts GAMMA mimics the CBS life expectancy values. This correction implies that some more people with an average age of about 95 years are added than the number of people with an average age above hundred. The advantage of this correction is a correct life expectancy. The disadvantage is that the number of persons between 90 and 99 years is a little bit larger, just as the old age dependency ratio. The life expectancy correction in 2050 is 0.1 year for men and 0.2 year for women.

3.3.1 Life expectancy

The development of life expectancy is presented in Figure 3.2 for both men and women. These life expectancy figures are based on cross-section survival rates. The new 2010 (Ageing III) and old projection (used in Ageing II) are compared.

The life expectancy increase is much larger than in the Ageing II projection. The difference in life expectancy between men and women is 3.9 year in 2008. During the projections this decreases to 2.3 year at the end of the projection period

Figure 3.2 Life expectancy men (left) and women (right)

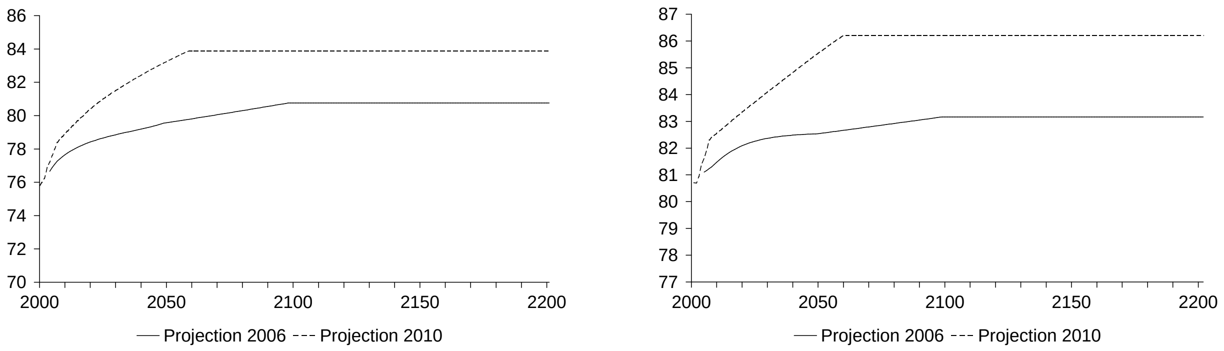


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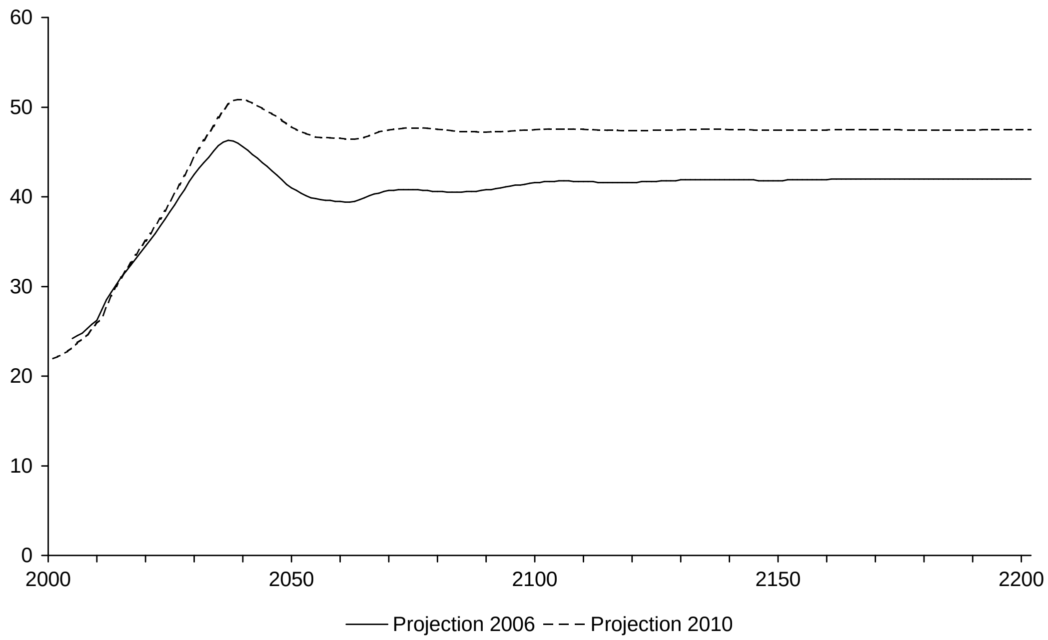
Table 3.2 Life expectancy based on a cross section survival rates

	2008	2050	2060
average at birth	80.4	84.3	85.0
average at age 65	19.7	22.1	22.5
women at birth	82.4	85.5	86.1
women at age 65	21.1	23.1	23.5
men at birth	78.4	83.2	83.8
men at age 65	18.2	21.1	21.5

3.3.2 The dependency ratio

The elderly dependency ratio, the ratio between the number of people above the official retirement age and the other adults, is presented in Figure 3.3. The elderly dependency ratio is defined as the ratio between the number of retirees and workers. This variable is the driving force behind sustainability questions. The increase in life expectancy between Ageing II and III implies a larger sustainability problem.

Figure 3.3 Dependency ratio



3.4 Participation and pa ratio

Figure 3.4 presents the participation projection of men and women. This projection is based on Euwals and Folmer (2009). The participation of older workers increases, which is common sense. However, the participation increase of the youngest is more controversial. In the base year there is a rest group that does not participate at all. The share of this group falls from 7% in 2007 to 0% in 2040. This assumption is based on the introduction of a base education obligation. This will increase participation according to the ministry of OCW[3]. The ratio between persons and labour years does not change very much over time according to the projection (see Figure 3.5)

Figure 3.4 pa-ratio's men (left) and women (right)

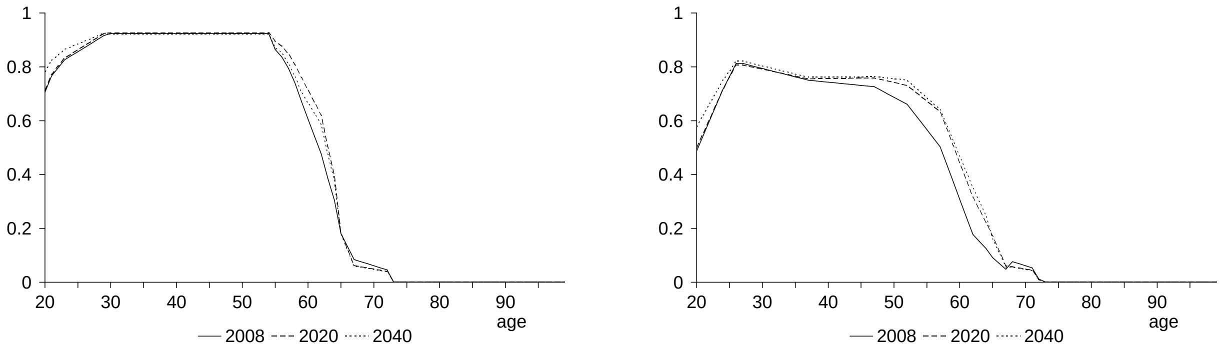
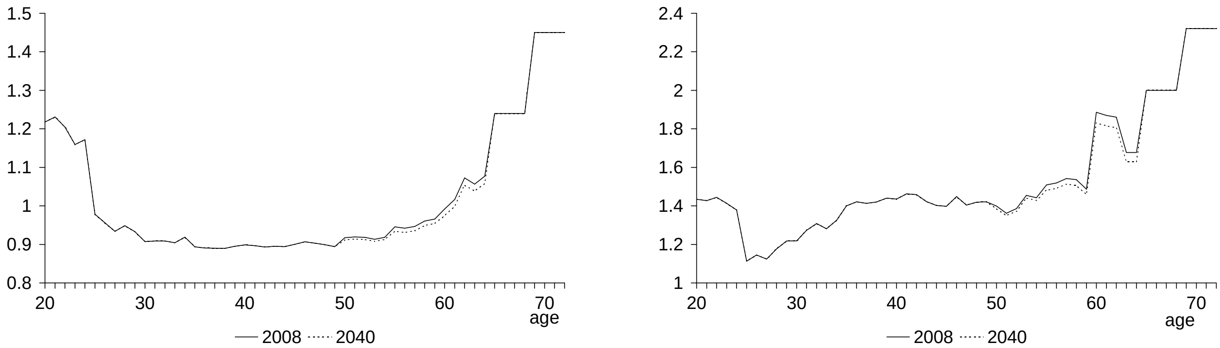


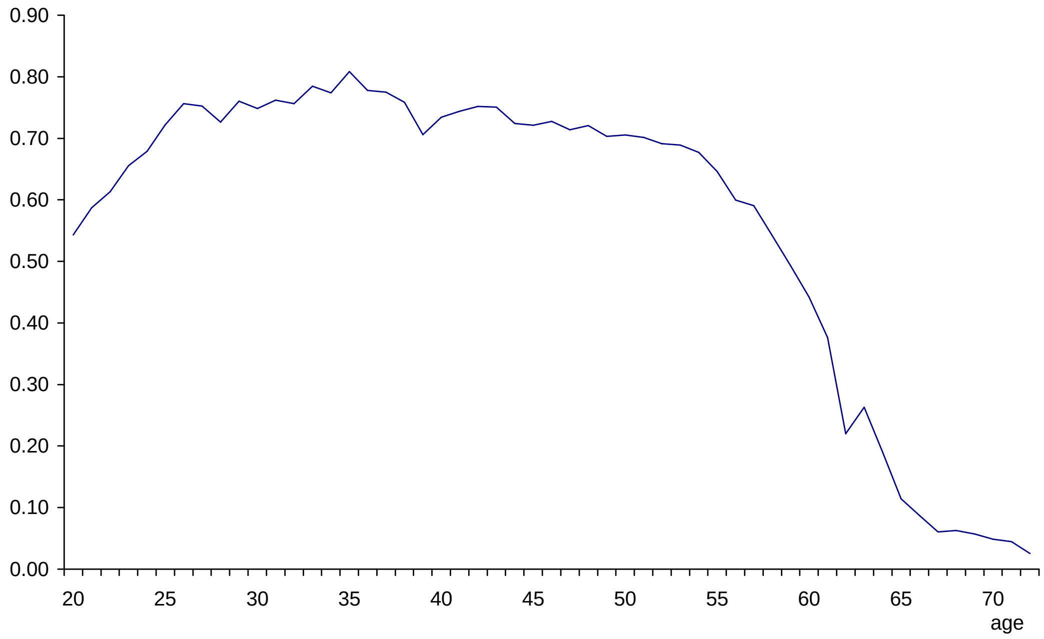
Figure 3.5 pa-ratio's men (left) and women (right)



The employment (labour time) profile in 2008 over age cohorts is presented in Figure 3.6. This profile results from the observed participation profiles and the ratio between persons and labour years.

[3] Folmer details on this subject in his memo 'Partipatie 20 jarigen in Lt raming' (CPB Memo dd 27-11-2009).

Figure 3.6 Employment profile 2008



4 Calibration

4.1 Government

4.1.1 Primary expenditures

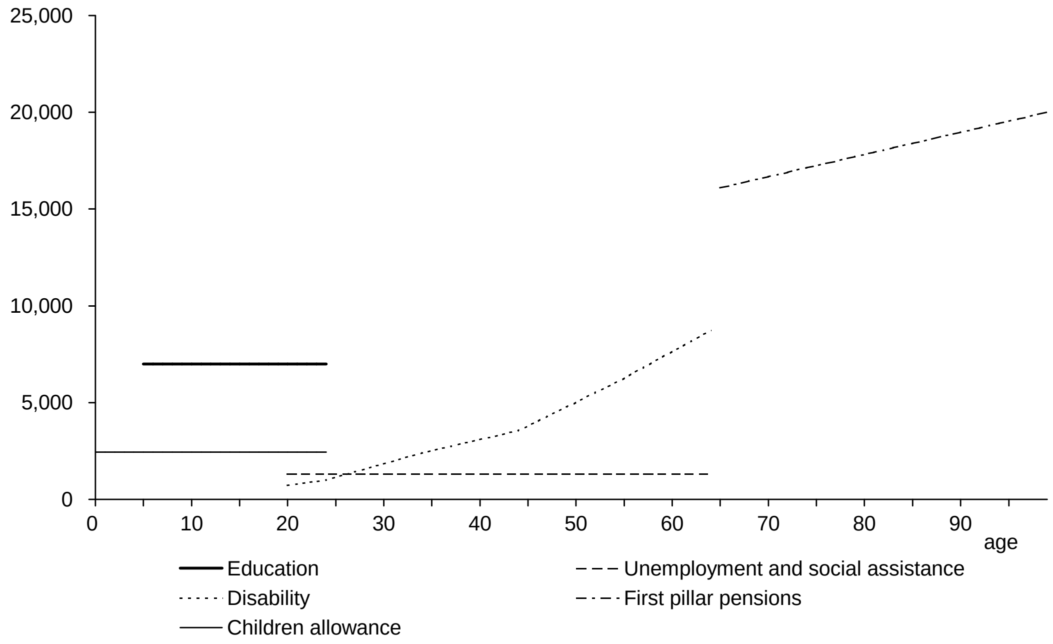
We distinguish two types of primary government expenditures. The first consists of the expenditures of which the benefits can be attributed to beneficiaries. This category consists of expenditures on social security, health care and education, and totals about 26% of GDP. For this category, future expenditures are constructed by assuming that, apart from indexation to productivity in the private sector, age-specific benefits per person from these expenditures remain unchanged (presented in Figure 4.1). The distribution of total expenditures x_i of category i over age cohorts j in base year $(t = 0)$ given a age profile $c(j)$ is[4]

$$x_i(j,0) = \frac{c_i(j)}{\sum c_i(j)n(j,0)} x_i(0)$$

with n population. Public expenditures related to a person of a certain age, e.g. a 30- or 70-year old, will increase each year at a rate that corresponds to the productivity growth in the private sector. This form of extrapolation is considered to be a reasonable approximation of present public arrangements, except for health care. The health care profile is not fixed over time. We

[4] Note, a profile gives information about differences between cohorts. The absolute level does not present information.

Figure 4.1 Expendities Profiles (euros)



assume that above age forty the profile shifts with life expectancy, *i.e.* people get more healthy years. More precisely, the profiles (c) presented in Figure 4.2 will change over time according to

$$c_h(j,t) = \eta \Delta l_e c_h(j-1,t-1) + (1-\eta \Delta l_e) c_h(j,t-1)$$

with l_e life expectancy and $\eta = .5$ a weighting parameter, leading to health care expenditures x_h per cohort

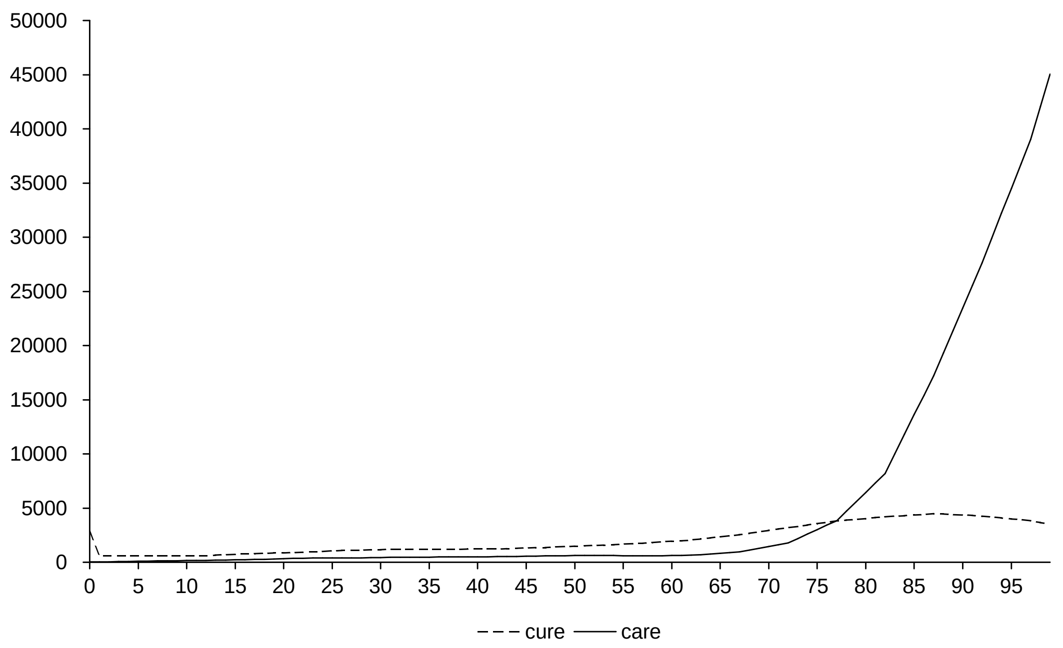
$$x_h(j,t) = x_h(j,t-1))(1+\overset{\circ}{w}(t))\frac{c_h(j,t)}{c_h(j,t-1)}$$

with $\overset{\circ}{w}$ the wage growth.

The second type of expenditures consists of the expenditures which can not be that easily attributed to beneficiaries. This category consists of expenditures on defence, general government, transfers abroad and subsidies. For these expenditure items we assume a 'flat' age profile, entailing an equal benefit for each individual, *i.e.* $c_i(j) = 1$. Obviously, this is an arbitrary assumption, but better alternatives seem to be lacking. The aggregate growth rates of these items are assumed to correspond to that of GDP at base prices. The rationale for this is that expenditures on these items may be closely linked to the size of production in the economy, and GDP at base prices may be considered to be the best measure for this concept.

The age profiles for health care, both cure and care, are provided by the RIVM (see Poos et al. (2008)). The age profile for the first pillar pension is constructed on the basis of

Figure 4.2 Health Profiles (euros)



entitlement. People over 65 years of age are eligible to a benefit. It is a flat rate system. The system only discriminates on the basis of marital status, granting a higher benefit to singles than to married individuals, and this explains the slight rise with age of the profile. The age profiles of the disability arrangements is based on data provided by the Ministry of SZW (the Ministry of Social Affairs) and calculations at the Ministry of SZW and the CPB. The age profile of unemployment and social assistance are assumed flat over the age range at which one is eligible. The age profile of child allowances is also based on eligibility. The age profile of education is flat between the ages of 5 and 24, based on information of annual budget of the Ministry of Education.

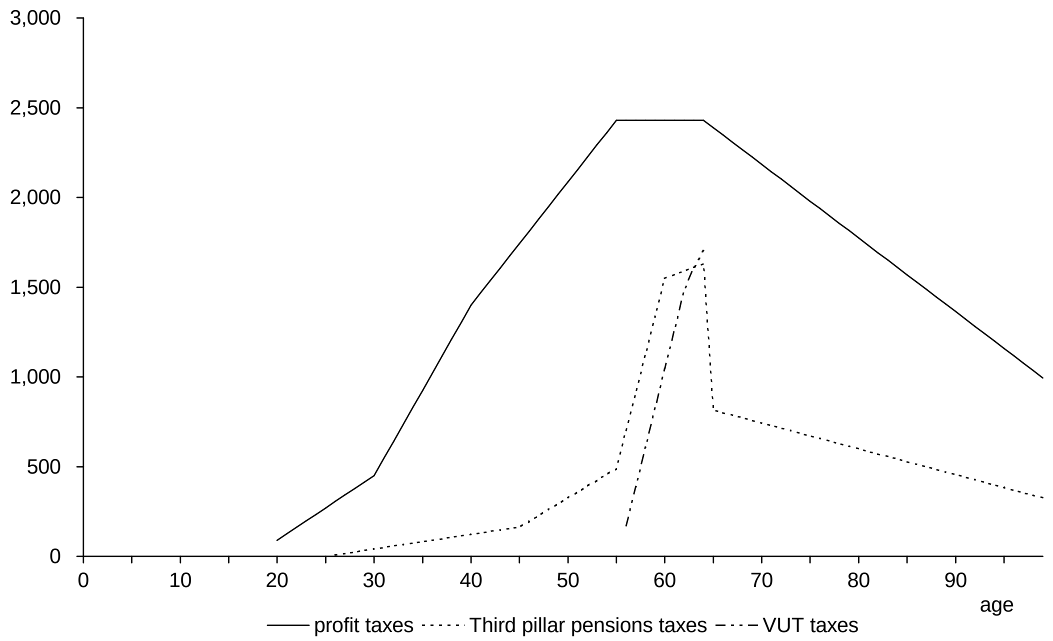
4.1.2 Tax rates

The tax bases (H^i) in GAMMA include: household income (including wages, public and private pensions, transfers, and income from asset wealth), private consumption, private investments and corporate profits as well as a number of miscellaneous tax sources. The tax rates (τ) for each of these bases is calibrated simply by dividing aggregate tax receipts (T) plus tax credit (C) for tax instrument i by the appropriate base in the calibration year:

$$\tau^i(t) = \frac{T^i(t) + C^i(t)}{H^i(t)} \tag{4.1}$$

In the base run progression in tax rates is imputed in this stylized way for wage income and pension income. However, as the tax credit C is indexed to wage growth, progression due to wage growth is eliminated. The tax rate is normally independent of the tax base H. Only in simulations in which pension premiums and benefits are changed, non-constant tax ratex are incorporated (see the following subsection). Progression is ignored completely (the tax credit C is zero) for all other taxes. The shape of the age profile of profit taxes in Figure 4.3 is based on information of Statistics Netherlands (CBS) on household wealth. Ownership of shares are assumed to be in line with this profile. The data on third pillar pensions and the early retirement scheme (VUT) are based on data from Statistics Netherlands and own calculations.

Figure 4.3 Tax profiles



4.1.3 Accurate account of progressive income tax rates in some policy simulations

The progression of income taxes is taken into account accurately, rather than in a stylized way, in policy analyses in which pension premiums and pension benefits are affected.

$$T = \tau_g(Y - P) - C$$

with T the tax receipts, Y gross income and P the pension premiums (zero for pension income) and C the tax credit.

In policy simulations affecting pension premiums and pensions we more accurately take into account the progressiveness of the income tax system by adjusting the actual marginal tax rates that apply to these tax bases. This is done by imputing a progression factor π in the formula. The relation between tax receipts, gross income and pension premiums, is $T = t(Y - P)^{\pi} - C^i$, in which π the progressive factor and C the tax credit. The average tax rate τ_g is defined as

$$\tau_g = \frac{T+C}{(Y-P)} = t(Y-P)^{\pi-1}$$

The influence of a net income change on τ_g is

$$\frac{\tau_{g1}}{\tau_{g0}} = \left[\frac{Y_1-P_1}{Y_0-P_0}\right]^{\pi-1}.$$

The progression factor $\pi = \frac{\tau_m}{\tau_g}$ equals the ratio between the marginal τ_m and average tax rate τ_g, because

$$\tau_m = \frac{\partial T}{\partial(Y-P)} = t\pi(Y-P)^{\pi-1}$$

The tax rates, and the rates of progression, that are used in both the stylized way of modelling household taxation as well as the more accurate way are provided by information from CPB model MIMOSI.

4.2 Firms

We start with summarizing the firm model (see: Bettendorf and Draper (2010) for an extensive discussion). Subsequently, the calibration is presented.

4.2.1 The model

The wage rate, p_{le}, and the compensation for capital, p_{k_e}, equal their marginal products

$$p_{k_e}(t) = p(t)\kappa\left(\frac{y(t)}{k_e^s(t-1)}\right)^{1/\sigma} \tag{4.2}$$

$$p_{le}(t) = p(t)\theta\left(\frac{y(t)}{l_e(t)}\right)^{1/\sigma} \tag{4.3}$$

with y production, k_e capital, l_e employment in efficiency units and p the price level. Different age cohorts j have different productivity levels, which can be represented by their productivity

Table 4.1 Tax parameters

	wage income	pension income
π	0.18	0.73
C	31.2	3.8
T	100.3	9.7
τ_g	0.39	0.25

profile $e_f(j,t)$. This assumption links age j's wages $p_l(t)$ to the macro wage in efficiency units p_{le}

$$p_l(j,t) = p_{le}(t)e_f(t)e_f(j,t) \tag{4.4}$$

with e_f the general productivity index. Employment in efficiency units, l_e, is the aggregate over the different cohorts

$$l_e(t) = \sum_j l_e(j,t) = \sum_j l_d(j,t)e_f(j,t)e_f(t) \tag{4.5}$$

with $l_d(j,t)$ employment of age j in period t. Investments are necessary for capital growth and for replacement of scrapped capital

$$i_e(t) = \Delta k_e^s(t) + \phi\, k_e^s(t-1) \tag{4.6}$$

The adjustment cost function reads as

$$\Gamma(t) = \frac{1}{2}\gamma_{e1}\left[\frac{i_e(t)}{k_e^s(t-1)} - \gamma_{e0}\right]^2 k_e^s(t-1) \tag{4.7}$$

Investments, i_e, are above the steady state level if the additional investment contributes to the value of the firm

$$\frac{i_e(s)}{k_e^s(s-1)} = \gamma_{e0} + \frac{1}{\gamma_{e1}(1-\tau_p)}\left\{\frac{q(s)}{p(s)} - 1 + \frac{\tau_p \nu}{r+\nu-\overset{\circ}{p}}\right\} \tag{4.8}$$

with q the marginal contribution of capital to the value of the firm (Tobin's q), τ_p the profit tax rate, r the nominal rate of return on the capital market, ν the fiscal depreciation rate and $\overset{\circ}{p}$ inflation. Tobin's q equation reads as

$$q(s) = \frac{(1-\tau_p)\left\{p_{k_e}(s+1) + p(s+1)\frac{\gamma_e}{2}\left[\left(\frac{i_e(s+1)}{k_e(s)}\right)^2 - \gamma_{e0}^2\right]\right\} + \tau_p\rho_2\left(r-\overset{\circ}{p}\right)\, p(s+1) + q(s+1)(1-\phi)}{(1+r)} \tag{4.9}$$

Production takes place according to a CES technology

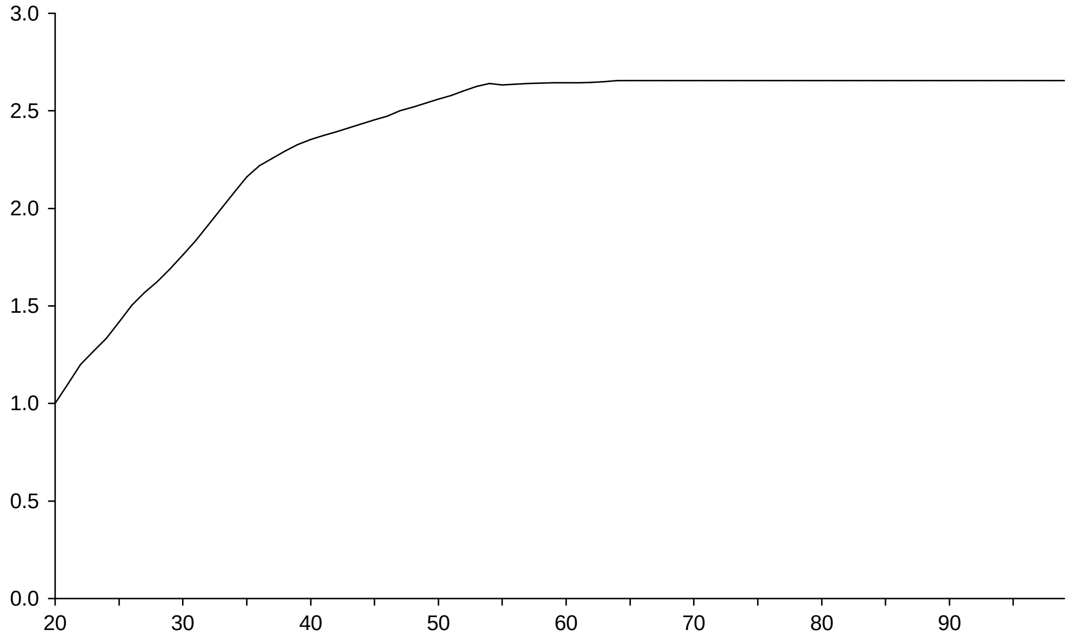
$$y_{ge}(t) = \left(\kappa k_e^s(t-1)^{\frac{\sigma-1}{\sigma}} + \theta l_e(t)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{4.10}$$

with $k_e^s(t-1)$ the relevant capital stock and σ the absolute value of the substitution elasticity between capital and labour.

4.2.2 Calibration

The capital stock k_e^s ultimate 2007 is taken from the sectorial capital stock statistics published by Statistics Netherlands and is 1469 billion euro. The depreciation rate $\phi = 0.046$ is set according to this statistics. The fiscal depreciation rate exceeds by one percent the economic depreciation rate ($v = \phi + 0.01$). Assume, for convenience, investments are at the steady state level in the base year, *i.e.* adjustment costs play no role in the calibration procedure. The efficiency profile $e_f(j,t)$, which is presented in Figure 4.4 is based on the wage structure review of Statistics Netherlands. The production function parameters κ and θ are obtained by inverting the marginal

Figure 4.4 Efficiency profile



product equations

$$\kappa = \frac{p_{k_e^s}(s)}{p(s)} \left(\frac{y_{ge}(s)}{k_e^s(s-1)} \right)^{-1/\sigma} \tag{4.11}$$

$$\theta = \frac{p_{le}(s)}{p(s)} \left(\frac{y_{ge}(s)}{l_e(s)} \right)^{-1/\sigma} \tag{4.12}$$

The elasticity of substitution between labour and capital is fixed at 0.5, which falls within the range estimated in Broer et al. (2000). Zero adjustment costs ($\frac{i_e(t)}{k_e^s(t-1)} = \gamma_{e0}$) imply exogenous user costs of capital ($p_{k_e^s}$), which can be derived from equation (4.8) and (4.9). In the GAMMA model $\gamma_{e1} = 2$ while γ_{e0} is fixed at the steady state investment share. Hassett and Hubbard (2002) provide an excellent overview of the empirical work on adjustment costs. Early studies found estimated values of γ_{e1} ranging from 20 to 100, implying large marginal adjustment costs between one and five dollars per dollar of investment. Subsequent research has corrected for two problems: (1) measurement error in fundamental variables and (2) misspecification. of convex adjustment costs. The application of improved methods yielded much lower values for γ_{e1} of 2 or lower, implying more plausible marginal adjustment costs in the range of 10 cents per dollar of additional investment. In a more recent study, Hall (2004) reports that adjustment cost parameters are not much above zero for most industries. The tax deductible finance costs parameter $\rho_2 = 0.2$.

4.2.3 Rest sector

Calibrated production equals $y_{ge}p = k_e^s(-1)p_{k_e^s} + l_e p_{le}$ the sum of the capital costs and the labour costs. The capital costs deviate from non-labour income of firms as presented in Table 2.8 due to the made rate of return assumption. For the same reason the calibrated production will deviate from the observed production of the enterprise sector. The differences are modelled in a restsector which growth with GDP.

4.3 Households

4.3.1 The model

The leisure demand relation, v, reads as

$$v(s) = \widetilde{v}(s) \text{ if } \widetilde{v}(s) \leq 1$$
$$v(s) = 1 \text{ if } \widetilde{v}(s) > 1 \text{ and}$$
$$\widetilde{v}(s) = \left(\frac{1}{\eta_v(s)} \frac{p_c(s)}{p_v(s)} \right)^{\frac{1}{\beta}}.$$

with p_c the consumption price and p_v the leisure price (*i.e.* net wages plus the discounted value of new pension rights). Given the optimal levels of leisure $v(s)$ commodity consumption c_h is given by

$$c_h(s)p_c(s) = c_l(s)p_c(s) + \left[W^s(j-1) - \sum_{i=j}^{j_e} d_o(i)\left(v(i)p_v(i) + c_l(i)p_c(i)\right) \right] \times \left(\frac{d_o(s)}{d_s(s)} \right)^{-\frac{1}{\gamma}} \left(\frac{\eta_c(s)p_c(s)}{p_W(j-1)} \right)^{\frac{\gamma-1}{\gamma}}, \qquad s \in \{j, \ldots, j_e\}$$

with

$$p_W(j-1) = \left[\sum_{i=j}^{j_e} \left(\eta_c(i)p_c(i)\right)^{\frac{\gamma-1}{\gamma}} d_o(i)^{\frac{\gamma-1}{\gamma}} d_s(i)^{\frac{1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}.$$

$$c_l(i) = -\frac{1}{\eta_v(i)} \frac{v(i)^{1-\beta}}{1-\beta}$$

In these equations p_W is the price index of total wealth, *i.e.* the composite price of future consumption, W^s total wealth, c_l the labour induced commodity consumption, d_o and d_s

discount factors. The euler equation for total consumption x_f

$$x_f = \frac{1}{\eta_c} c + \frac{1}{\eta_c} \frac{1}{\eta_v} \frac{v^{1-\beta}}{1-\beta}$$

can be derived from these equations and reads as

$$x_f(i) = \left(\frac{p_x(i)}{p_x(i+1)} \right)^{-\frac{1}{\gamma}} \left(\frac{1+r_h(i+1)}{1+\delta} \right)^{-\frac{1}{\gamma}} x_f(i+1)$$

with $p_x = \eta_c p_c$.

4.3.2 Parameters from the literature

The values of the parameters β and γ are based on evidence produced by national and international research. One of the crucial parameters is the price elasticity of leisure. This has a value of 0.25 ($\beta = 4$) and implies that on average the wage elasticity of labour supply equals 0.14.[5] A meta-analysis on this elasticity was used to update the MIMIC model (Evers et al. (2005)). Our value of 0.14 is a little smaller than the corresponding value in the MIMIC model, but corresponds fairly well with the results from the meta-analysis.

The elasticity of intertemporal substitution equals 0.5 ($\gamma = 2$). Estimates of this elasticity typically vary widely in the range between zero and one. Research by Epstein and Zin (1991), which properly distinguishes between the aversion to risk and the aversion to intertemporal substitution, confirms this result. Our value of 0.5 is well within their range of estimated values. The rate of time preference takes a value of 1.3%. This is somewhat higher than in Altig et al. (2001), and somewhat lower than in Bovenberg and Knaap (2005).

4.3.3 Consumption and wealth

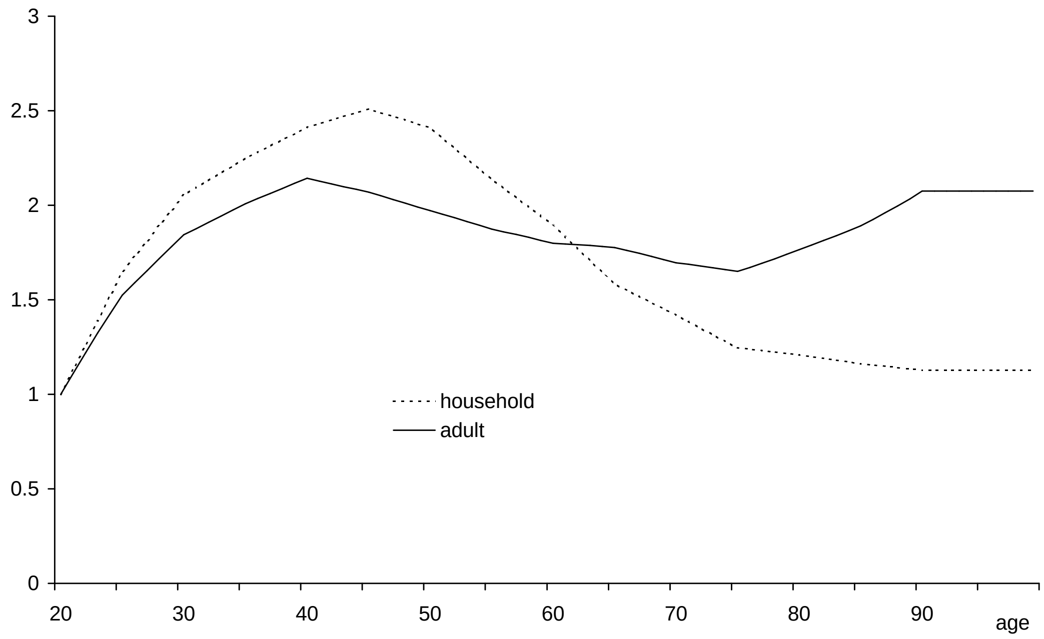
Estimates for consumption and income profiles of households are presented in de Ree and Alessie (2009). Figure 4.5 shows the income profile per household. However, GAMMA does not distinguish households. Each adult is modelled separately. De Ree and Alessie present the number of adults per household over the life cycle, too. We assume, that this profile[6] can be used to calculate the income profile per adult out of the profile per household. This leads to the dotted line in Figure 4.5.

The consumption profile can not be derived from the article because of a distinction between durables and non-durables. Aggregation is not possible because the multiplicative constants

[5] In the labour supply function of GAMMA there is no income effect so the uncompensated and compensated labour supply elasticities are equivalent.

[6] A level correction for the number of adults per household is obtained by assuming that at the age of 90 the number of adults per households is one.

Figure 4.5 Estimated income profile

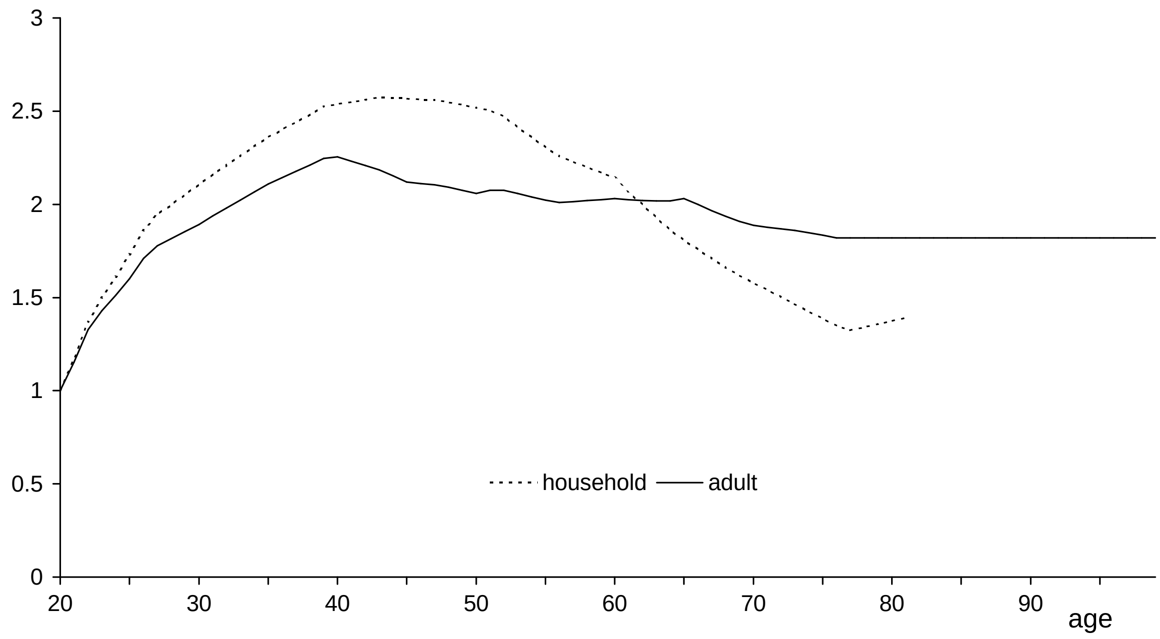


(related to cohort effects) of the estimated equations are not available. So, we have to rely on old estimates of Alessie used in Draper and Armstrong (2007). This estimated profile for households is presented in Figure 4.6 together with the profile per adult which is obtained in the same way as the income profile per adult. In Ageing II the consumption profile was not corrected for the number of adults per household. The correction seems an important improvement.

The income and consumption profiles are confronted in Figure 4.7. The estimated profiles (per adult) are indicated with underscore-e. The similarity of the consumption and income profile is striking. Due to the used Deaton Paxson method all trending is interpreted as cohort effect. This implies that the wage development over the life cycle does not contain the yearly increase due to general productivity rises, *i.e.* the profile is a cross section profile. Interpretation of the consumption profile as a life cycle profile results in an implausible wealth profile. Indeed, individuals should finance consumption early in life with debt, *i.e.* the profiles should result in negative wealth. This indicates that the consumption profile is a cross section profile which has to be corrected for productivity increases to obtain the life cycle profile.

The cross section income and consumption profile of GAMMA are indicated in Figure 4.7 with underscore-m. The income profile is composed of several income sources. The income profile deviates in the years before retirement from the Alessie and de Ree profile. Moreover, the GAMMA income profile is more hump-shaped in the working years. Note the GAMMA consumption profile is a little bit turned around relative to the estimated profile, *i.e.* the time

Figure 4.6 Estimated consumption profile



preference parameter is decreased to get more savings early in life. This correction is made to make total consumption consistent with the observed macro value (276.1) of Table 2.8. We did not fine-tune macro consumption fully.

4.3.4 Calibration utility parameters

The utility parameters are calibrated in two steps. First, consumption and leisure are calculated for the whole calibration period using the consumption and employment profiles. In the second step the utility parameters are obtained by inverting the behavioural equations. This revealed preference procedure is now described in more detail. The budget equation reads as

$$W^s(j-1) = \sum_{i=j}^{j_e} d_o(i)\left[c_h(i)p_c(i) + v(i)p_v(i)\right]$$

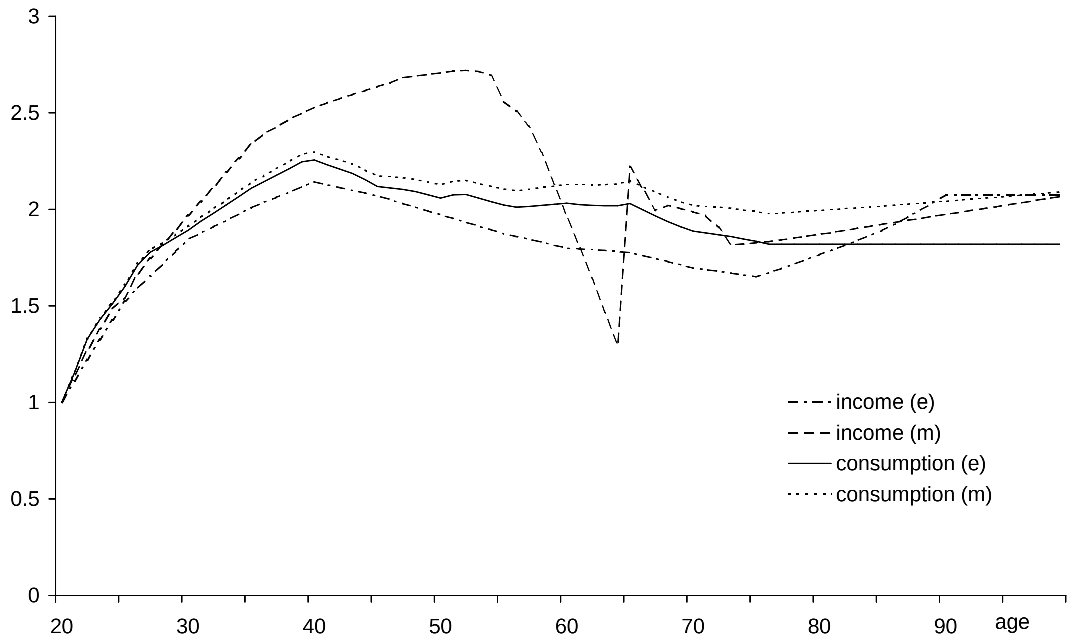
The total available time is scaled at one. Leisure is the complement of labour time, which is given in the base path (see section 3.4). Bring leisure consumption to the left hand side

$$W^s(j-1) - \sum_{i=j}^{j_e} d_o(i)v(i)p_v(i) = \sum_{i=j}^{j_e} d_o(i)c_h(i)p_c(i)$$

Use the exogenous consumption profile c_p and the productivity increase assumption ρ

$$\frac{c_h(i+1)}{c_h(i)} = \frac{c_p(i+1)(1+\rho)}{c_p(i)}$$

Figure 4.7 Estimated and used profiles in GAMMA



Substitution leads to

$$W^s(j-1) - \sum_{i=j}^{j_e} d_o(i)v(i)p_v(i) = \frac{c_h(j)}{c_p(j)} \sum_{i=j}^{j_e} d_o(i)c_p(i)p_c(i)(1+\rho)^{i-j}$$

which implies for consumption

$$c_h(j) = \left[W^s(j-1) - \sum_{i=j}^{j_e} d_o(i)v(i)p_v(i)\right] \left[\frac{1}{c_p(j)} \sum_{i=j}^{j_e} d_o(i)c_p(i)p_c(i)(1+\rho)^{i-j}\right]^{-1}$$

Leisure is calculated using the leisure profile.

In the second step of the calibration procedure the utility parameters are calculated by inverting the behavioural equations. Inverting the leisure equation gives

$$\eta_v = \frac{p_c}{p_v} v^{-\beta}$$

The leisure utility parameter for retirees is set equal to that of the last participation year. Total consumption is defined as

$$x_f = \frac{1}{\eta_c} c + \frac{1}{\eta_c} \frac{1}{\eta_v} \frac{v^{1-\beta}}{1-\beta} \equiv \frac{x_z}{\eta_c}$$

Substitution into the Euler equation

$$x_f(i) = \left(\frac{p_x(i)}{p_x(i+1)}\right)^{-\frac{1}{\gamma}} \left(\frac{1+r_h(i+1)}{1+\delta}\right)^{-\frac{1}{\gamma}} x_f(i+1)$$

and inverting leads to the calibration equation

$$\eta_c(i) = \left(\frac{x_z(i)}{x_z(i+1)}\right)^{\frac{\gamma}{\gamma-1}} \left(\frac{p_c(i)}{p_c(i+1)}\frac{1+r_h(i+1)}{1+\delta}\right)^{\frac{1}{\gamma-1}} \eta_c(i+1)$$

The consumption utility parameter for age 99 is set equal to one.

4.4 Pension sector

We use as default an average-pay pension scheme. Because building up pension rights is linear, namely 2% (a_p) of the pension wage per year worked, our pension scheme aims at a replacement rate of 80% of average pay after 40 years of service. Not all workers build up occupational pensions in the Netherlands. Most of the self-employed workers do not participate in collective pension arrangements. We assume that 90% of the workers have occupational pensions (ε). The existence of the flat-rate public pension, the AOW, is taken into account by the pension fund through a franchise. Only workers with a wage above this franchise build up an occupational pension. In the base year (2008) the franchise (f_p) is set at 10,600 euro.

Most pension funds in the Netherlands aim at wage- or price indexation. This is not guaranteed, however, but is conditional on the financial position of the fund (funding ratio). Many pension funds have recently introduced more explicit indexation rules, providing for example no indexation at all if the funding ratio is below a certain lower bound, full indexation if the funding ratio is above an upper bound, and a linear cut in indexation for ratios in-between. Our average pension fund aims at a mixture of wage- and price indexation, and gives full indexation at a funding ratio of 135% of the nominal liabilities (equivalent to about 95% of the indexed liabilities) or more. No indexation is given if the funding ratio is below 100% of nominal liabilities (70% of indexed liabilities).

The next section describes how we approximate the pension rights distribution over age cohorts in the base year.

4.4.1 Assumptions

The pension rights are calibrated in such a way that the pension assets, the funding ratio (i.e. the ratio between pension assets and pension rights) and the pension benefits are consistent with their observed macro economic equivalents. This calibration of the pension rights is done in the following way.

Assume that the employment profile $l(j) = 1 - v(j)$, which is presented in Figure 3.6 did hold in the past and shall also hold in the future. The number of participation years a_l in the pension fund at age j then equals[7]

$$\begin{aligned} a_l(t+j,j) &= a_l(t+j-1,j-1)+\varepsilon\, l(t+j,j)-m(t+j,j) \\ a_l(t-1,-1) &= 0 \end{aligned}$$

with $\varepsilon = 0.9$ the fraction of workers with a supplementary pension arrangement and $m = -0.025$ a maturity correction which is the same for all current retirees (*i.e.* $j > j_r$). The pension accrual B_l in an average wage system evolves over the life cycle according to:

$$\begin{aligned} B_l(t+j,j) &= B_l(t+j-1,j-1)\psi + [a_l(t+j,j)-a_l(t+j-1,j-1)] \\ &\quad \times \left[(p_{\text{lg}}(t+j,j)-f_p(t+j,j)\right] a_p \\ B_l(t-1,-1) &= 0 \end{aligned}$$

with indexation factor ψ, gross wage p_{lg}, franchise f_p and accrual rate $a_p = 0.02$. Assume that 65% of the pension rights are wage indexed and 35% only inflation indexed:[8]

$$\psi = 0.65(1+\pi)(1+\rho)+0.35(1+\pi)$$

with $\pi = 0.02$ inflation and $\rho = 0.017$ the productivity increase. Wages follow an age profile and further grow with inflation and productivity, just as the franchise:

$$p_{\text{lg}}(t+j,j)-f_p(t+j,j) = \left[p_{\text{lg}}(t+j-1,j)-f_p(t+j-1,j)\right](1+\pi)(1+\rho)$$

A cross-section of the pension accrual (for $j < j_r$) and actual pension benefits (for $j \geq j_r$) in the base year reads as,

$$B_p(t,j) = B_l(t+j,j)\,[(1+\pi)(1+\rho)]^{-j-1}$$

The value of the guaranteed pension liabilities R to a participant of age j then equals:

$$R(t,j) = B_p(t,j)\sum_{i=\max\{j,j_r\}}^{j_e} d(i,j)$$

with d the discount factor, $j_r = 65$ the age of retirement and $j_e = 99$ the maximum attainable age. The discount factor,

$$d(i,j) = (1+r_w)^{-(i-j)}\prod_{l=j}^{i-1}\zeta(l)$$

[7] For convenience the age index starts here at zero which represents the start of the working life.

[8] This assumption is used to determine the pension right distribution in the calibration year. In the ultimate baseline scenario, we have used a different weight to wage indexation for workers and retirees. Based on recent evidence, for workers we take a weight of 50% wage indexation and for retirees we take 35%.

is determined by the 15-years swap interest rate $r_w = 0.045$ and the survival rates ζ.[9] The swap rate is assumed to be one percent-point larger than the bond rate. Discounting with the lower bond rate should lead to too large pension liabilities given the observed values of the pension assets and the funding ratio. The total benefits are:

$$B_p(t) = \sum_{i=j_r}^{j_e} n(i-1,t-1) B_p(t,i)$$

and total pension rights:

$$R(t) = \sum_{i=j_w}^{j_e} n(i-1,t-1) R(t,i)$$

4.4.2 Corrections

The aggregate benefits $B_p(t)$ calculated in the last section lead are 0.2% smaller than the observed aggregate pension benefits $B_o(t)$. The corrected benefit level per age group $\widetilde{B}_p$ is consistent with the aggregate observation:

$$\widetilde{B}_p(t,j) = B_p(t,j) \frac{B_o(t)}{B_p(t)}$$

The corrected value of the guaranteed pension liabilities $\widetilde{R}$ for the retirees ($j > j_r$) equals:

$$\widetilde{R}(t,j) = \widetilde{B}_p(t,j) \sum_{i=j}^{j_e} d(i,j)$$

The pension rights of the current working population ($j \leq j_r$) are scaled in such a way that the total pension rights are consistent with the observed financial wealth W_{fp} and funding ratio q_f of the pension funds:

$$\widetilde{R}(t,j) = R(t,j) \frac{W_{fp}(t-1)/q_f(t) - \sum_{i=j_r}^{j_e} n(i-1,t-1)\widetilde{R}(t,i)}{\sum_{i=j_w}^{j_r-1} n(i-1,t-1) B_p(t,i) \sum_{l=j_r}^{j_e} d(l,i)}$$

This correction factor for the guaranteed liabilities is also small (1.0004). The corrected cross-section of the pension accrual thus equals:

$$\widetilde{B}_p(t,j) = \widetilde{R}(t,j) \left(\sum_{i=j}^{j_e} d(i,j) \right)^{-1}$$

Hence, the life-cycle profile of the pension accrual is:

$$\widetilde{B}_l(t+j,j) = \widetilde{B}_p(t,j) \left[(1+\pi)(1+\rho)\right]^{j+1}$$

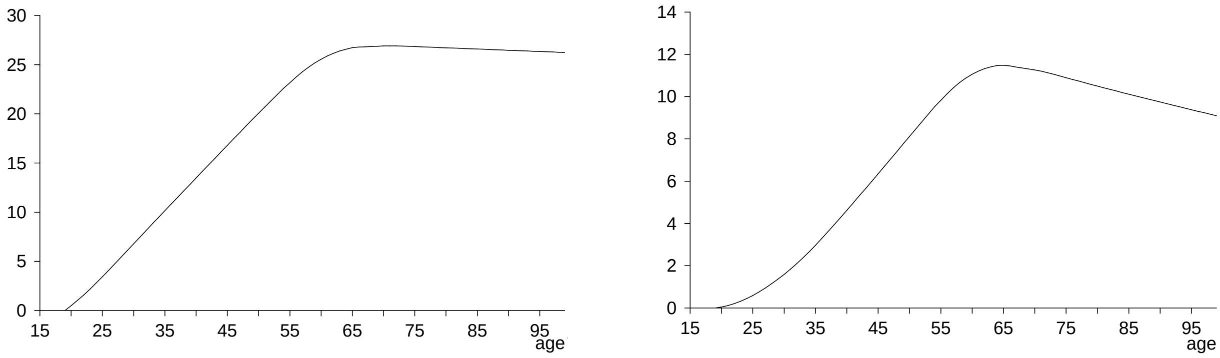
[9] The swap rate of 4.5% is used for the calibration. In the ultimate baseline scenario we have used a swap interest rate of 4%, which better fits to the actual recent development of the 15-years swap rate.

Finally, we can retrieve the corrected participation profile from the the adjusted pension accrual, giving:

$$\widetilde{a}_l(t+j,j) = \widetilde{a}_l(t+j-1,j-1) + \frac{\widetilde{B}_l(t+j,j) - \widetilde{B}_l(t+j-1,j-1)\psi}{\left[(p_{\text{lg}}(t+j,j) - f_p(t+j,j)\right] a_p}$$

Figure 4.8 presents the results: the starting values for the number of participation years and for the pension rights per year

Figure 4.8 Participation years (left) and pension rights a year (right)



5 Results

Table 5.1 presents the macro economic calibration results for base year 2008. Comparison with Table 2.8 shows that most variables are reproduced rather good. An exception is other income of both households and pension funds and their savings. The latter is due to the rate of return assumption (discount rate). We did not finetune consumption, which explains the deviation of the indirect taxes from the equilibrium values.

6 Period 2008-2015

For the period 2008-2015 the projection ’Centraal Economisch Plan 2010’ and ’Economische Verkenning 2011-2015’ (together called MLT projection) is adopted. This implies that up to 2011 planned policies are taken into account and for period 2012-2015 no new policies are included. From period 2016 onwards we assume constant arrangements, *i.e.* expenditures per age cohort that growth with productivity of with GDP. We detail here to the methods used for the adaptation of the years 2008-2015.

Normally the primary government expenditures grow with productivity or with GDP. However, we adopt the predicted government expenditures from the MLT projection. This

Table 5.1 Calibration result for 2008 (in billions of euros)

	House-holds	Pension sector	Capital	Government Services	Taxes	Production	Firms	Foreign sector	Row total
goods	− 271.5		− 119.4	− 147.9	70.3	68.9	442.3	− 42.7	0.0
investment			119.4			− 19.3	− 100.1		0.0
transfers	68.0			− 68.0					0.0
labour income	326.9					− 54.2	− 272.6		0.0
private pensions	30.4	− 30.4							0.0
non-labour income	19.5	26.4		− 13.4	30.1		− 49.5	− 13.2	0.0
income taxes	− 123.9				123.9				0.0
profit tax					20.0		− 20.0		0.0
private pension premiums	− 28.5	28.5							0.0
public transfers to foreigners				− 13.8				13.8	0.0
savings(-)/ shortage(+)	− 20.9	− 24.5			3.4			42.0	0.0
column total	0.0	0.0	0.0		0.0		0.0	0.0	

implies that the expenditure growth rates are rescaled over this period to make policy simulations also possible for these years.

The profit tax revenues are made consistent by a temporally adjustment of the tax base. The tax rates for direct taxes paid by households and all indirect taxes are adjusted over the period 2010-2015 to reproduce the tax receipts according to the MLT projection. After this period the tax rates remain at the 2015 level.

The MLT projection distinguish a categorical and functional projection of the government budget. For the years 2010-2015 we adopt both divisions by including separate factors.

Employment and consumption are modelled at the disaggregated level in GAMMA and incorporates optimal behaviour. This makes business cycle corrections difficult. Firstly because corrections imply deviations from optimal behaviour. Secondly, because it is impossible to make corrections for all age cohorts. In particular, we adjust the leisure decision only for the age cohorts 25-55 to avoid implausible leisure levels. Consumption is corrected only for the age cohorts 25-80, to prevent problems with the life time budget constraint.

Appendix A Bookkeeping system GAMMA

Table A.1 presents the total accounts of the Dutch economy as a circular flow, describing the macro-economic relations identified in the GAMMA model. The row entries of the total accounts are markets, or subdivisions of a market into transactions and the column entries are agents. The aggregated market transactions over agents (row total) sum to zero. The table distinguishes between markets for goods, capital and labour in addition to accounting for income transfers from the government to households. The capital market is subdivided into investment activities, income from capital and profit taxes. GAMMA identifies the following agents: households, pension funds, the government, firms and the foreign sector. Capital is included as an artificial agent, distinguished to make total investments and investments of the different sectors explicit. The model subdivides the household sector into one hundred age cohorts, however the table presents only the aggregated household sector. The government sector is subdivided into expenditures, income and production. A cell in the table gives the transactions of agents on a market (+ receipt, − payment). The aggregated budget constraint of agents is obtained by adding up over the column: the sum of revenues minus expenditures equals savings. That is, the column totals are zero.

Table A.1 Total accounts: circular flows

	house-holds	pension funds	capital	government			firms	foreign sector	Σ
				expenditures	income	production			
Goods	$-C_h$		$-I$	$-C_g$	T_{in}	Y_{gg}	Y_{ge}	$-E_x$	0
Investments			I			$-I_g$	$-I_e$		0
Income transfers	Y_t			$-Y_t$					0
Labour income	Y_{wh}					$-Y_{wg}$	$-Y_{we}$		0
Private pensions	B_p	$-B_p$							0
Non-labour income	Y_{zh}	Y_{zp}		$-X_r$	Y_{zg}		$-Y_{ze}$	Y_{zf}	0
Income taxes	$-T_y$				T_y				0
Profit tax					T_p		$-T_p$		0
Private pension premiums	$-P_p$	P_p							0
Transfers to foreigners				$-X_{fo}$				X_{fo}	0
Savings(-)/shortage(+)	$-S_{vh}$	$-S_{vp}$			S_{vg}			$-S_{vf}$	0
Σ	0	0	0		0		0	0	

There is one good in GAMMA used for consumption, investment and exports. Imported goods are perfectly substitutable with domestic goods. The difference between domestically produced goods (by the government Y_{gg} and by firms Y_{ge}) and the domestic demand (private consumption C_h plus investments I plus government consumption C_g) minus indirect taxes plus subsidies T_{in} is sold abroad E_x. Households finance their consumption and pay tax and pension premiums (C_h,

T_y and P_p respectively) with income from labour, transfers, pensions and asset wealth (Y_{wh}, Y_t, B_p and Y_{zh} respectively). In addition, they save privately for retirement S_{vh}.

Pension funds finance their payments B_p out of premium receipts P_p and income from wealth Y_{zp}. Wealth of pension funds grows with their savings S_{vp}. Government expenditures consist of government consumption C_g (defence, schooling, health care and public administration), income transfers Y_t (social assistance, children's assistance, public old-age-, disability-, unemployment-benefits and other social transfers), transfers to foreigners X_{fo} and debt services X_r. The government levies indirect taxes T_{in} (exclusive of subsidies), income taxes T_y, profit taxes T_p and other income taxes Y_{zg} (presented as non-labour income). The government produces services Y_{gg} using labour (income Y_{wg}) and capital which is created with public investments I_g. The EMU deficit of the government is S_{vg}. Firms also produce Y_{ge} with labour (income Y_{we}) and capital. Private capital formation takes place through investments I_e. The capital costs of firms consist of depreciation, profit taxes T_p and finance costs Y_{ze}. The difference between income and expenditures of firms is zero, *i.e.* firms does not issue bonds and pay out all profits.

Table A.2 The total accounts: changes in total assets

	households	pension sector	government	firms	foreign sector	Σ
Savings	S_{vh}	S_{vp}	$-S_{vg}$		S_{vf}	0
Asset changes by emigration	$-W_{eh}$	$-W_{ep}$			W_{ef}	0
Asset changes by immigration	W_{ih}	W_{ip}			$-W_{if}$	0
Revaluation of assets	W_{rh}	W_{rp}	W_{rg}	$-W_{se}$	W_{rf}	0
Change of financial wealth	$-W_{fh}$	W_{fp}	W_{fg}	W_{se}	$-W_{ff}$	0
Σ	0	0	0	0	0	0

The savings of agents is one of three determinants of the aggregated total asset change (W_{fh}, W_{fp}, W_{fg}, W_{ff} for households, pension funds, government, and the foreign sector respectively). The other two determinants are net migration and revaluation of assets as Table A.2 reveals.[10] GAMMA assumes that migrants are representative agents: they have the same assets as natives of the same age. Migrants import (W_{ih}) or export (W_{eh}) those assets. Moreover, immigrants buy into the pension system (W_{ip}) with a purchase price equal to the value of pension rights while emigrants leave the pension system taking with them a money amount (W_{ep}) equal to the value of pension rights. Revaluation of bonds is not modelled: GAMMA implicitly assumes a one-year duration of bonds. That is why the revaluation of assets (W_{rh}, W_{rp}, W_{rg}, W_{rf} for households, pension funds, government and the foreign sector respectively) concerns the revaluation of shares only. The aggregate of these revaluations equals the change of the value of the firm (W_{se}).

[10] Note, the government sector is not split up anymore, while the artificial capital sector is left out of the table.

Table A.3 The total accounts: portfolio changes

	households	pension sector	government	firms	foreign sector	Σ
Change of financial wealth	W_{fh}	$-W_{fp}$	$-W_{vg}$	$-W_{se}$	W_{ff}	0
Change of shares	$-W_{sh}$	$-W_{sp}$	$-W_{sg}$	W_{se}	$-W_{sf}$	0
Change of bonds	$-W_{bh}$	$-W_{bp}$	W_{bg}		$-W_{bf}$	0
Σ	0	0	0	0	0	

The total asset change is split up into the change of bonds and shares in Table A.3. The asset changes and investments determine the balances which are presented in Table A.4. The government has a claim W^s_{cg} on firms because it owns the central bank and land development companies. This is a reason for the difference between the value of the capital stock of firms (K^s_e) evaluated in production prices and the value of shares (W^s_{se}). The effective price of capital deviates from the production price of investment goods through tax facilities. This appraisal difference is variable W^s_{res}. The total capital stock (K^s) valued at current production prices deviates from the total capital stock evaluated at effective prices (W^s_{fc}). The total assets of households (W^s_{fh}), pension funds (W^s_{fp}), the government (W^s_{ng}) and the foreign sector (W^s_{ff}) equals the total capital stock evaluated at effective prices.

Table A.4 The total accounts: balances

	households	pension sector	capital	government	firms	foreign sector	Σ
Bonds	$-W^s_{bh}$	$-W^s_{bp}$		W^s_{bg}		$-W^s_{bf}$	0
Shares	$-W^s_{sh}$	$-W^s_{sp}$		$-W^s_{sg}$	W^s_{se}	$-W^s_{sf}$	0
Capital goods			K^s	$-K^s_g$	$-K^s_e$		0
Reserves government				$-W^s_{cg}$	W^s_{cg}		0
Reserves firms			W^s_{res}		$-W^s_{res}$		0
Total assets	W^s_{fh}	W^s_{fp}	$-W^s_{fc}$	W^s_{ng}		W^s_{ff}	0
Σ	0	0	0	0	0	0	

Appendix B The circular flow

B.1 Relations between Saffier and Gamma variables

The right hand side variables are SAFFIER variables.

Goods

$-C_h$ = -c__wn___;

$-I$ = -i__wn___ - n__wn___;

$-C_g$ = -g__wn___;

T_{in} = tkxwn___ - suxwn___ + tknwn_ve - sunwn_ve + tknwn_ro - sunwn_ro;

Y_{gg} = ybbwn_ro -tknwn_ro + sunwn_ro;

Y_{ge} = ybbwn_ve + z__wn_ob -tknwn_ve + sunwn_ve;

$-E_x$ = mgdwn___ - bgdwn___;

Investments

I = i__wn___ + n__wn___;

$-I_g$ = -ig_wn___ ;

$-I_e$ = -i__wn___ - n__wn___ + ig_wn___;

Transfers

Y_t = oygwn_hu - oyhwn_ro + okgwn_hu - okhwn_ro - iglwn___;

Labour income (including employers!!)

Y_{wh} = ll_wn___ + lz_wn___;

$-Y_{wg}$ = -gl_wn_ro;

$-Y_{we}$ = -ll_wn_ve - lz_wn___;

Private pensions

B_p = u__wn_lp;

Non-labour income

Y_{zh} = z__wn_hu - oyhwn_ro - oyhwn_bu + oygwn_hu + oyuwn_hu - oygwn_hu + oyhwn_ro - lz_wn___ + tivwn_bu;

Y_{zp} = zr_wn_lp;

$-X_r$ = -r__wn_ro;

Y_{zg} = -mpewn___ + bpewn___ + zr_wn_ro - oygwn___ + oygwn_hu - oyhwn_ro + oyhwn_ro + oybwn_ro + oyuwn_ro + oygwn_bu - oyuwn_ro;

W_{be} = i__wn___ + n__wn___ -d__wn_ve - d__wn_ro - ig_wn___ + d__wn_ro - s__wn_ve - okgwn_ve + okbwn_ro;

Y_{ze} = -z__wn_hu - zr_wn_lp + by_wn_ve - my_wn_ve + r__wn_ro - zr_wn_ro - oybwn_ro + oygwn_ve + lz_wn___- W_{be};

Y_{zf} = -by_wn_ve + my_wn_ve + mpewn___ - bpewn___ - s_uwn_lp + s_uwn_lp - oyuwn_hu - oyuwn_ro + oyhwn_bu + oygwn_bu - oygwn_bu + oyuwn_ro- tivwn_bu-W_{be};

Income taxes

T_y = tivwn___ + p__wn_sv - tv_wn___;

Profit tax

T_p = tv_wn___ - okgwn_ve + okbwn_ro;

Private pension premiums

P_p = p__wn_lp- c_awn_lp;

Transfers from the government to foreigners

X_{fo} = oygwn_bu - oyuwn_ro - okgwn_bu + okuwn_ro;

Savings(-)/ shortage(+)

$-S_{vh}$ = -s__wn_hu + s_hwn_lp - okgwn_bu + okuwn_ro;

$-S_{vp}$ = -s__wn_lp;

$-S_{vg}$ = -s__wn_ro+ig_wn___ - d__wn_ro + okgwn_hu - okhwn_ro + okgwn_ve - okbwn_ro + okgwn_bu - okuwn_ro - iglwn___;

$-S_{vf}$ = -s_uwn_lp + sbbwn___- okgwn_bu + okuwn_ro-W_{be};

B.2 Definitions Saffier variables

bgd uitvoer van goederen en diensten

bpe subsidies van eu

by_ primaire inkomens ontvangen uit buitenland

c__ consumptie van gezinshuishoudingen

c_a consumptie pensioenfondsen en levensverzekeringsmaatschappijen (administratiekosten)

d__ afschrijvingen

g__ totale overheidsconsumptie

gl_ loonsom sector overheid

i__ totaal investeringen, incl.overheid, excl.voorraadvorming

ig_ investeringen sector overheid

igl saldo aan- en verkopen grond van de overheid

ll_ loonsom werknemers

lz_ toegerekende loonkosten zelfstandigen

mgd invoer van goederen en diensten

mpe belastingen op productie en invoer aan eu

my_ primaire inkomens betaald aan buitenland

n__ voorraadvorming totaal

okb kapitaaloverdrachten van bedrijven

okg kapitaaloverdrachten van overheid

okh kapitaaloverdrachten van huishoudens

oku kapitaaloverdrachten van het buitenland

oyb inkomensoverdrachten van bedrijven

oyg inkomensoverdrachten van de overheid

oyh inkomensoverdrachten van gezinnen
oyu inkomensoverdrachten van het buitenland
p__ bruto premies, incl. premies aan buitenlandse pensioenfondsen
r__ rentelasten
s__ besparingen (netto)
s_u correctie pensioenvoorziening buitenland
sbb saldo lopende rekening betalingsbalans
sun niet-productgebonden subsidies
sux productgebonden subsidies
tiv belastingen op inkomen en vermogen
tkn niet-productgebonden belastingen
tkx productgebonden belastingen
tv_ vennootschapsbelasting
u__ uitkeringen door sociale en levens-verzekeringen en pensioenfondsen
ybb bruto binnenlands produkt basisprijzen
z__ exploitatie overschot (netto)
zr_ beleggingsinkomsten

Appendix C Update government finance department

A detailed description of the government sector is presented in table B.1. This is a disaggregated version of the MEV table A8. The table gives a categorical classification of expenditures. The relation between the variables of table 2.2 and B.1 is:

1. total government consumption C_g = ga_wn___ + g_nwn___ + gl_wn_ro - gv_wn___ - go_wn___ + d__wn_ro
2. indirect taxes minus subsidies T_{in} = tk_wn___ - subwn___
3. production government Y_{gg}=gl_wn_ro+d__wn_ro
4. investments I_g=ig_wn___
5. transfers aan gezinnen Y_t =oygwn_hu - oyhwn_ro
6. wage bill government Y_{wg}=gl_wn_ro
7. debt services X_r = r__wn_ro
8. non-labour income Y_{zg} = -mpewn___ + bpewn___ + zarwn_ro +zr5wn_ro - oygwn_ve + oybwn_ro
9. income taxes T_y = tivwn___ + p__wn_sv - tv_wn___
10. profit tax T_p = tv_wn___

11. transfers aan buitenland X_{fo} = oygwn_bu - oyuwn_ro
12. savings(-)/shortage(+) S_{vg}=-(okgwn_hu + okgwn_ve + okgwn_bu)+(okhwn_ro + okbwn_ro + okuwn_ro) +iglwn__-sv_wn_ro
13. transfers aan buitenland X_{fo} = ovbuwn

Table B.1 collective sector Table A8 2008

	Saffier names	2008
Direct expenditures	xdwn_ro	172,4
- Wages	gl_wn_ro	54,2
- Material expenditures	ga_wn___	40,8
- Investments	ig_wn___	19,3
- - Depreciation		14,7
- Transfers in kind	g_nwn___	58,1
Transfers in money	xg_wn_ro	84,1
- Subsidies	subwn___	8,6
- Other transfers in money	xgrwn_ro	75,5
- - Households	o_gwn_hu	59,6
- - - Income transfers		58,7
- - - Capital transfers	okgwn_hu	0,9
- - Firms	o_gwn_ve	2,0
- - - Income transfers	oygwn_ve	0,3
- - - Capital transfers	okgwn_ve	1,7
- - Foreign	o_gwn_bu	13,8
- - - EU taxes	mpewn___	3,2
- - - Income transfers	oygwn_bu	9,6
- - - Capital transfers	okgwn_bu	1,0
Debt Services	r__wn_ro	13,4
Bruto overheidsuitgaven	xb_wn_ro	269,9
Non-tax income	xnbw_ro	43,1
- Material sales	gv_wn__	18,0
- Income from wealth	zr_wn_ro	19,5
- - Natural gass	zarwn_ro	12,4
- - Other income from wealth	zr5wn_ro	7,2
- Other income	xnrwn_ro	5,6
- - Investments on one's own	go_wn___	1,4
- - EU subsidies	bpewn___	1,0
- - Other income transfers	oy_wn_ro	2,1
- - - Households	oyhwn_ro	1,5
- - - Firms	oybwn_ro	0,5
- - - Foreign	oyuwn_ro	0,2
- - Capital transfers		0,3
- - - Households excl succession		0,1
- - - Firms	okbwn_ro	0,1
- - - Foreign	okuwn_ro	0,1
- - sale ground	iglwn___	0,6
Net government expenditures	xn_wn_ro	226,9
Collective burden	tp_wn___	232,6
- tax on production and imports	tk_wn___	75,5
- profit taxes	tv_wn___	18,8
- income taxes	tkxwn___	138,3
Surplus		5,7

Appendix D Relation categorial and functional classifcation

Table C.1 presents the relationship between the categorical and functional classifications of the government budget. The row totals correspond with figures of Table 2.3, while the column totals present the categorical classification of Table 2.4. This table can be used to model both the functional and categorical classification in a consistent way. More specifically we can derive from the table weights which can be used to obtain the catogorical classification out of the functional classification and vice versa.

Table C.1 Relation between the functional and categorial classification of the government budget for 2008

	Direct expenditures					Money transfers			debt	Prof	non	ind	dir	total
	wages	mat cons	net inv	depr	transf in kind	h.h.	firms	foreign	serv	Tax	lab inc	tas	tax h.h.	
Defence	3,8	2,5	0,5											6,8
Education	19,9	6,2	0,6	2,0	0,3	1,1								30,1
Gen. Government	30,6	32,1	1,2	5,4										69,3
Infrastructure			2,3	7,3										9,6
Health					51,4									51,4
Soc. Security					7,2	58,5								65,7
Subsidies					− 0,8		8,6			2,0				9,8
Transfers abroad								10,7			3,2			13,8
Debt service									13,4					13,4
Labour income taxes													126,4	126,4
Profit taxes										16,6			4,3	20,9
Indirect taxes						1,9						75,5	5,7	83,1
Sale ground						0,6								0,6
Nat gas										2,2	12,4			14,6
Wealth income											7,2			7,2
Other income		19,4				1,5		0,3		0,5	1,0			22,9
Total	54,2	21,4	4,6	14,7	58,1	55,7	8,6	10,3	13,4	− 17,2	− 17,4	− 75,5	− 136,4	− 5,7
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	

[a] Source: M:\p_gamma\teksten\gammaupdateageing\boekhouding\data\cat_funct.xls

Column totals:

1. $C_g = (1) + (2) + (4) + (5)$
2. $T_{in} = -(12) - (7)$
3. $Y_{gg} = (1) + (4)$
4. $I_g = (3) + (4)$
5. $Y_t = (6)$

6. $Y_{wg} = (1)$
7. $X_r = (9)$
8. $-Y_{zg} = (11)$
9. $-T_y = (13)$
10. $-T_p = (10)$
11. $X_{fo} = (8)$

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