

DREAM

# Long-term economic projection 2014

February 2015



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# 1 Introduction

This report presents the DREAM long-term economic projection model for 2014. The projection models includes an update of all components of the total DREAM system, i.e. a new population projection, an education projection, a socio-economic projection<sup>1</sup> and a new calibration of the economic model DREAM, which is consistent with the national accounts from 2009.

The DREAM model system is designed to evaluate the interaction between the public sector and the rest of the economy in the longer term. This assessment is made with the involvement of all possible relevant factors: the ageing population, age of retirement from the labour market, changes in the level of education, oil and gas in the North Sea, agreed reforms, the tax freeze etc.

In this context, *the fiscal sustainability indicator* is a central concept. If the sustainability indicator is zero, it means that the long-term fiscal policy is sustainable - i.e. that the public sector's future income is large enough to cover the future expenditure. If the indicator is negative, it means that the future income is too small in relation to the future expenditure. In DREAM's long-term projection for 2014 the fiscal sustainability indicator is estimated to -0.1 percent. This does not differ largely from the last time, where the indicator was -0.0 and it was estimated that fiscal policy was sustainable. So the conclusion is still that fiscal policy is about sustainable. See Chapter 4 for a more detailed description of fiscal sustainability.

In the projection, relevant policies adopted after calibration year 2009 have been included. This includes the sickness benefit reform, the SU-reform, the social assistance reform and the growth plan all adopted in 2013, the reform of early retirement and flexible jobs and the tax reform from 2012, the reform package of 2011 and the recovery package including benefits reform from 2010. All relevant adopted policies from 2009 and earlier are included in the calibration. Growth Package 2014 was not yet adopted during preparations for this report and is therefore not included.

## 1.1 Reading Guide

The results of the projection are presented in Chapter 2. These results come from the input data, agreed policies and assumptions respectively and are related to the projection of the economic model DREAM. One of the key inputs to the model is the projection of population labour market attachment, which is based on the demographic and educational behaviour that DREAM's demographic and educational projection gives rise to. Chapter 3 provides a more detailed description of the results from the projection of the labour force, the population and the education level. Chapter 4 briefly describes the structure of DREAM and its basic assumptions. Also described in Chapter 4 are the substantial changes in DREAM since the last report. The results behind the popu-

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<sup>1</sup> This determines as the main labour force in DREAM.

lation, education and socio-economic projection are described in more detail in Chapter 5-7.

Are you most interested in the newest results; you can skip directly to Chapter 2 and 3. If you want more in-depth explanation of the results, and what drives them, you should read the rest of Chapter 1 and Chapters 4-7.

## 1.2 New results since the last report

Compared to the last version of DREAM several and considerable changes have been made. Firstly, a revision of the modelling of the *IO-system* has been done, now based on the latest industry nomenclature DB-07, which in itself does not change anything special. One major improvement is that it has been chosen to take out the import for re-export from the model as such exports should not be affected by competitiveness, and given that this type of import should not rely on domestic demand. A significant drawback is that it has been necessary to impute investment from the input distribution from old investment matrices as the new investment matrix has still not been released.

In connection with the work on the IO system the product taxes have been changed so you now better take into account the different tax rates on energy and non-energy products, both purely in terms of data in the calibration and by changes in energy taxes.

*The cyclical cleaning* (i.e. the smoothing of the business cycle) in DREAM has been refined. The cyclical cleaning of the IO table now takes place at a more disaggregated level, so it to a larger extent reflects industry-specific deviations from the overall economic climate. This provides a more accurate industry structure.

Basically DREAM projections are adjusted for business cycles. However, it is desired due to the economic crisis that incorporates cyclical effects on public and private property, thus making a *cyclical adjustment*. For this purpose, a new and improved system have been prepared, which ensures that the selected key macroeconomic variables - among these also the government revenue and expenditure - are in line with the Finance Ministry's current medium-term projections until 2020<sup>2</sup>.

## 1.3 The DREAM system

The purpose of the overall DREAM system is to be able to comment on developments in public finances in the long term. Is the fiscal policy sustainable? If not, what components explain the development? Such an assessment requires knowledge of the public sector's future income and expenses. The entire system deals with precisely the projection of the subcomponents of these

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<sup>2</sup> See The Convergence Programme. 2020 considered as the steady state - meaning a state where all economic sizes grow at the same rate. The period from today until steady state (2014-2019) are termed forecast year.

two quantities. One can say that the DREAM system is the toolbox that is available when the development of public revenue and expenditure must be evaluated prospectively.

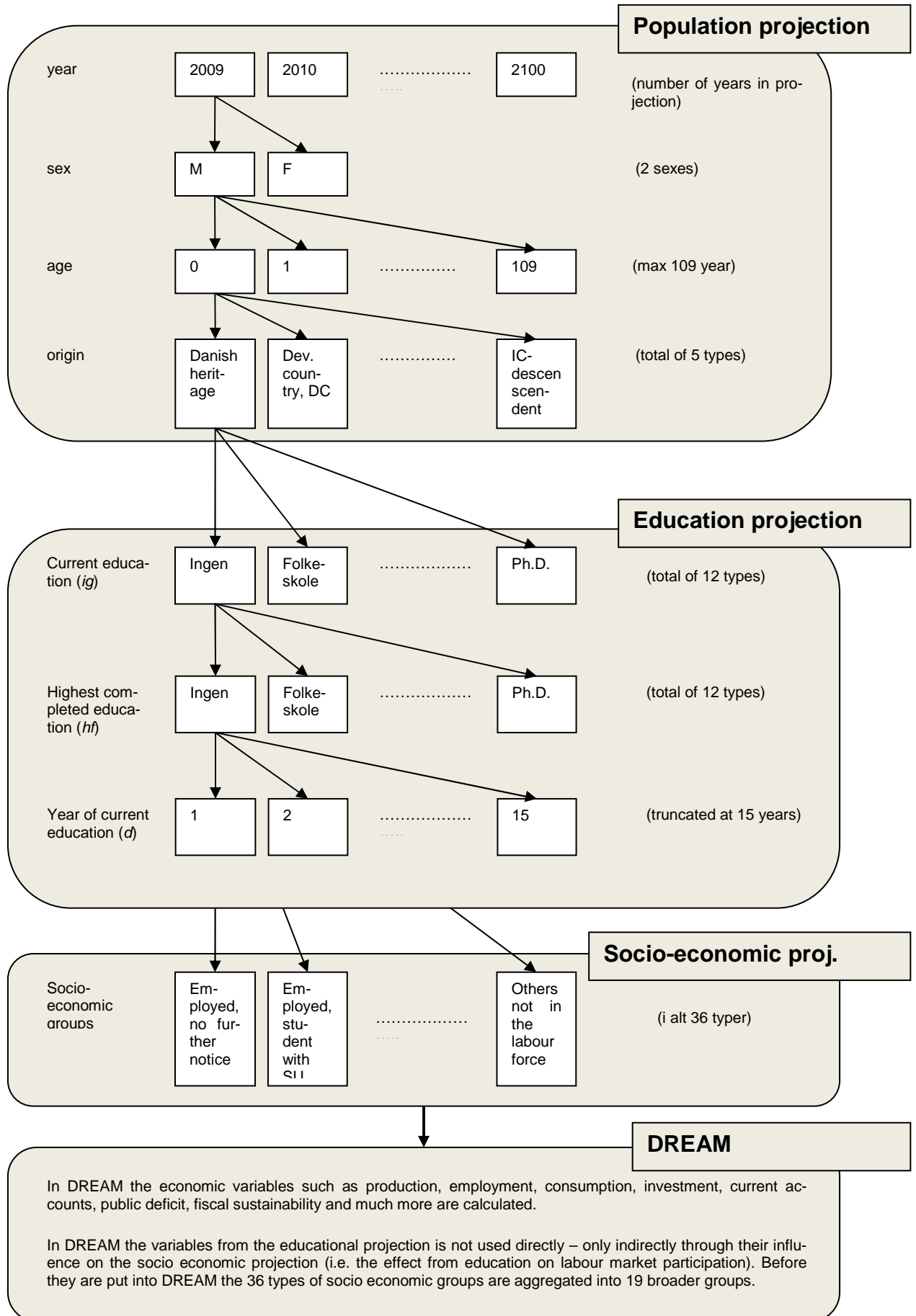
The overall DREAM system is shown in Figure 1.1. The system consists of a number of pre-models, which feed into a macroeconomic model. The first pre-model is *the population projection*. This is a national demographic projection model that projects the Danish population by sex, age and origin (immigrants and descendants from Western and non-Western countries and the rest). The model is used by Statistics Denmark for the preparation of the official Danish population projection.

The population projection is based on assumptions about immigration, emigration, fertility and mortality. For projections of mortality the Lee-Carter method is applied. This is an econometric method that makes it possible to extrapolate the declining mortality ahead. This makes it possible to analyse the so-called problem of aging. Typical analyses in this part of the system are changed assumptions about immigration, fertility and mortality. DREAM's population projection is described in detail in Chapter 5.

The population projection works as input to *the education projection*. For each year the education model provides a further breakdown of the population by on-going education and a maximum of completed education. The education model is based on transition probabilities calculated from registry data and projects the level of education by using the study-related behaviour, which there has been a tendency to do historically. The model will warn of any future phenomena that can be justified in the present student behaviour (or have to do with the future composition of the population). The model provides results that are comparable with the Ministry of Education Profile Model. Examples of typical analyses are changes in dropout rates and age at study start. The education model is described in Chapter 6.

The education projection works again as input to the *socio-economic projection*. In this the population is divided into 36 labour market categories (employed, early retirees, early retirees, pensioners, etc.). The division is basically made for each of the 36 status groups to calculate component frequencies for persons of a given age, sex, origin, and a maximum of completed education. Basically these stock frequencies are assumed to be constant. This basic assumption is corrected, however, to reflect the agreed labour market policy and on the assumption that the increasing level of education does not have a full impact on people's labour market attachment. Persons seeking education are calculated based on the education model and the number of early retirees are calculated specially because of rule changes. All adopted labour and training reforms are put into the projection as described in Chapter 7.

**Figur 1.1. The overall DREAM system.**





The Macro model is a so called overlapping generations model. This means that there is a representative household for each age (17-101 years). For example, the 30-year household consists of all 30-year-old men, all 30-year-old women and their children (in consumption, children count by half). The household demands goods, services, energy and housing and provides labour. By using the information from the three pre-models, it is possible to form very well specified income profiles of the representative households. From the population projection, we know how many people are in each household/generation. From the socio-economic projection, we know how many are associated with the labour force and how many who receive various benefits.

The overall wage level in the model is given as a market determined macro-wage. For each generation, the relative wage is determined by individual productivity divided by gender, age and origin. This productivity is calibrated in the baseline year using register-generated wages by age, sex and ethnicity. The social transfer payments are based on the rates imputed from the macro costs and the total number of receivers<sup>3</sup>. These are corrected prospectively for the development of the rate adjustment that follows the general wage level.

The households pay income tax according to a non-linear tax function, which is estimated by using the register data. This feature makes it possible to approximate the real progressive tax system so that changes in rates and progression kinks can be analysed.

The households are assumed to deposit an age-specific ratio of their income to occupational and private pensions. The private pensions consist of annuity, endowment and pension annuity. The calculations of pensions are carried out in DREAM in a large separate module, which takes into account the appropriate biometric provisions. This ensures that the model provides a sensible view on the future development of the Danish pension system; including the future tax payments from pension down payments. In addition to their pension, the households are saving up in housing stock and securities (stocks and bonds).

There are 8 sectors in the model. One large private sector, a building & construction sector, a public sector and a number of energy sectors. The private sectors have quadratic installation costs. This means that the company's cost of investing one extra unit is growing in investment levels. The effect of this is that companies adjust their capital stock gradually so that unrealistically large jumps in the level of investment are avoided.

The public services are produced by using materials, energy, capital and labour. The public sector is assumed to be service maximizing: for a given budget inputs of materials, energy, capital and labour are selected to maxim-

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<sup>3</sup> With the exception of the cost of unemployment benefits and public pensions the imputed rates do not vary across gender and age.

ize the service level. However, capital is selected so the K/Y ratio in the public sector is constant after 2030. It is assumed in DREAM that the productivity development in the public sector is the same as in the private sectors.

## **1.4 The public expenditure and revenue**

The public expenditure basically consists of three sizes: Collective public consumption, individual public consumption and income transfers. These sizes are in the DREAM modelled separately.

The individual public consumption is divided in line with the National Accounts into four groups: Health care, social care, education and recreation incl. culture, etc. These four items are projected taking into account the demographic trend. On the basis of register data it is calculated how much the average person of a given gender, age and ethnicity costs. In the projection it is for social care, education and recreation assumed that the average cost per person grows by the economy's underlying rate. Herein lies the assumption that the service level follows the general increase in wealth in the economy. However, it is assumed that health expenditure and the share of the social care costs that is related to elderly care are growing at an annual surplus growth of 0.3 percent for a period of 25 years from and including the year 2013. This surplus growth is similar to the one observed since 1995. In other words, it is assumed that the historical trend continues, but that control of health spending is achieved in the long term. Furthermore the projection is corrected by the cost of healthcare and eldercare for the development of the remaining lifespan. This is because health care costs are growing significantly in the terminal phase: The most costs are in the years just before the death occurs.

The collective public consumption is in DREAM's basic course assumed to follow GDP. In the alternative scenario it is typically assumed to be given by the level of the basic course.

The last item of expenditure is income transfers. There are 13 types of income transfers in DREAM: unemployment benefits, student grants, leave allowances, maternity benefits, sickness benefits, activation performance, cash assistance, flex allowance, early retirement, early retirement pension, a civil service and introduction. The number of persons outside the labour force and recipients of the different services is determined by the socio-economic projection. Within the labour force the distribution between employed and unemployed is determined by the macro model. As mentioned above, all adopted labour and re-training reforms are embedded in the socio-economic projection. This is of central importance for the projection of income transfers and tax revenues.

Public revenues consist of various taxes and fees. These are calculated on a relatively detailed level in the macro-model. The companies pay corporation tax and a number of charges such as energy and registration fees. Revenue from North Sea can be calculated as the macro-model includes sectors for extraction of oil and gas. Developments in the production of these sectors is determined by the Danish Energy Agency's forecast for oil and gas in the North Sea.

The households pay income tax and a number of fees such as VAT and energy taxes. The model's long-term nature makes it possible to analyse the long-term consequences of such as tax freezes and energy taxes.

## **1.5 The macro-economic model**

As shown in the previous section the macro-economic model is used for calculating numerous variables: GDP, employment, tax payments and so on. A basic course is a projection, which gives its best estimate of the future development, given a number of assumptions concerning the future (including the implementation of agreed rules). Focus is not on cyclical fluctuations, but on the structural challenges facing society in general.

It is on this basis that the DREAM system is built around a long-term macro-economic model. The model is long-term in the sense that prices and wages in each period are assumed to be able to adapt in order to achieve equilibrium in all markets. An imperfect competition is assumed to be present in all commodity markets, giving rise to the mark-up pricing in the various markets.

The model is calibrated on cyclically cleaned national accounts data from the last final year - being 2009 in writing. The cyclical cleaning gives an indication of the current structural level of the GDP, private investment, etc. From here changes in the structural level can be found by changing the basic parameters of the model. For example, one can estimate how much an increase in the labour force will benefit production - given that the labour productivity growth and the input structure in production is maintained - in relation to the current structural situation.

It is assumed that the unemployment rate over a period is adapted to its structural level, as in the model depend only on the degree of compensation between being unemployed and employed. This does not mean that DREAM in general has the view that structural unemployment is completely unaffected by other parameters than the replacement ratio. It simply means that within the relatively conventional theoretical apparatus as DREAM covers, there is no further input. If you wish to analyse a process that includes effects on structural unemployment besides via the compensation rate, these effects can be calculated outside the model and subsequently hospitalized exogenously.

It is assumed that both households and firms have perfect foresight. In other words, they know all future prices. This assumption is made in order to ensure consistent behaviour over time.

In the real world no one neither households nor companies have perfect foresight, and there exist institutional and behavioural explained inertia in the adjustment of product prices and wages. Along with stochastic unforeseen shocks to the economy, this will generate booms and busts, where the economy is never in its structural balance, but fluctuates around this. These trends are modelled not in DREAM. It must be emphasized that DREAM is a long-term structural model. The projection for each year is not a forecast of how

the economy will be in these years, but a projection of the economy's underlying trend, absent any unforeseen events.

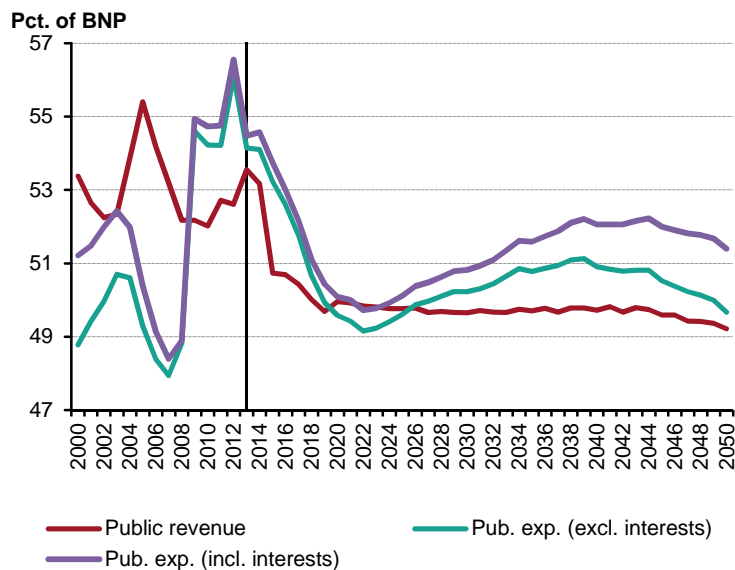
Thus the model is built to analyse the effect of long-term structural changes in government revenue or expenditure. However, it takes into account the current economic situation through its impact on private and public property by implementing an adaptation to medium-term projection from the Ministry of Finance.

## 2 Results of the projection

In this chapter DREAM's basic projection is described based on the cyclically cleaned base year 2009. Such a basic projection is an estimate of the development of the Danish economy given the demographic, educational and labour market structure resulting from the pre-models specified. The process should not be understood as an attempt to make an exact prediction of the economy in the long term, but more as an overall assessment of the public sector's long run position in the economy. In this overall assessment a wide range of factors have been involved, which affect the development of the economy: The aging population, retirement, changes in the level of education, oil and gas in the North Sea, agreed welfare reforms, the tax freeze and so on.

The overall result of the analysis shows that fiscal policy is just about sustainable. A normalization of the economic situation will ensure that the public expenditure as a share of the GDP will drop towards 2020. At the same time, the government revenue as a share of the GDP will drop as a result of a lower future tax burden from e.g. the tax reform in 2012. In 2020, revenues and expenses will be on the same level. From here, the revenues due to lower oil extraction will be declining slightly. The primary costs will - due to the fact that the baby boomers retire and are replaced by the relatively smaller vintages in the labour market - increase from 2022 to 2039 and then decline until 2050, when they again are roughly on par with revenue, see figure 2.1. The fiscal policy is about sustainable because the expenditure as a share of the GDP after 2050 declines to a greater extent than the revenue. The fact that the expenditure including interests in a number of years exceeds the revenue (and in some years by more than ½ percent of the GDP) is called the so-called hammock problem (as revenue minus the expenditure is graphically similar to a hammock). This potentially challenges the budget act's requirement for an annual structural deficit of no more than ½ percent of GDP.

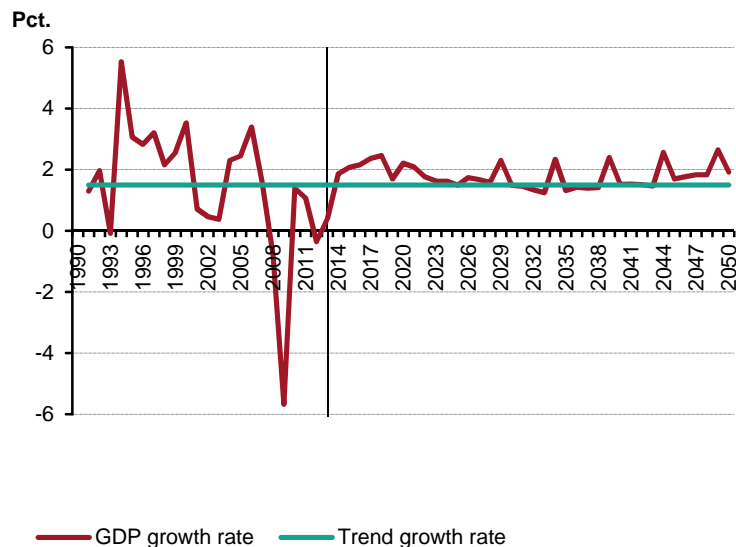
Figure 2.1. Public revenue and expenditure as a share of the GDP



## 2.1 Macroeconomic development

The basis for the analysis is a calibration of DREAM based on cyclically cleaned data. Thus a model that describes the relationship between the structural values for an economy in equilibrium is created. However, the economy is not in its structural balance - it is recovering from a major crisis. This will affect the private and public wealth and consequently the fiscal sustainability. Key figures from the Ministry of Finance's medium-term projection are incorporated until 2020, when the economy is assumed to return to its structural balance. The temporary cyclical position until 2020 has hereby been allowed to influence the public and private assets.

Figure 2.2. The GDP growth rate historically and in the DREAM projection



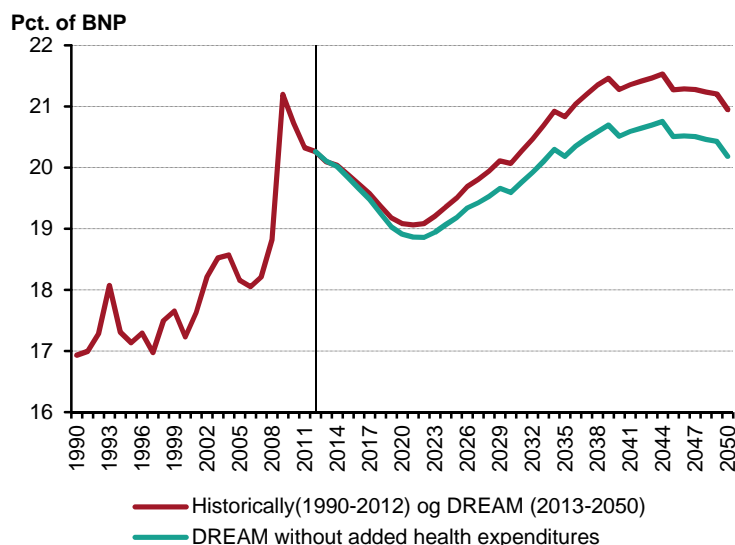
Source: Statistics Denmark, The Ministry of Finance and own calculations in DREAM

Figure 1.2 shows the historical development of the GDP growth rate from 1990 to 2013 extended by a projection in DREAM, where we have incorporated key figures from the Ministry of Finance's projection until 2020. Furthermore, a trend growth of 1.5 percent has been added. Historically, the GDP grew more than 1½ percent during the booms from 1993 to 2000 and from 2003 to 2007 and less than 1½ percent during the recessions of 2000-2003 and 2007-2013. From 2014-2020, the GDP is expected to grow more than 1½ percent since the unemployment rate is expected to gradually adapt to the structural level. After 2020, the unemployment rate is expected to remain at its structural level, and there has been implemented an underlying productivity growth at 1.5 percent. For a given labour force, this will also mean a GDP growth rate of 1.5 percent in the future<sup>4</sup>. The fluctuations in the GDP after

<sup>4</sup> This is somewhat simplistic, since the GDP is also affected by oil extraction in the North Sea, but the workforce is clearly the most crucial.

2020 are therefore greatly due to changes in the labour force given by the socio-economic projection. The periodic jump in the GDP growth in 2029, 2034, 2039, 2044 and 2049 is due to the expectation that an increase in re-training age and thus in the number of persons effectuated in the labour force. That the GDP growth rate outside these periodic jumps differs from the basic productivity growth is mainly due to the general demographic development. Developments in the demographics and the labour force are described in more detail in chapter 3.

**Figure 2.3. The individual public expenditure as a share of the GDP**



Source: Statistics Denmark, The Ministry of Finance and own calculations in DREAM

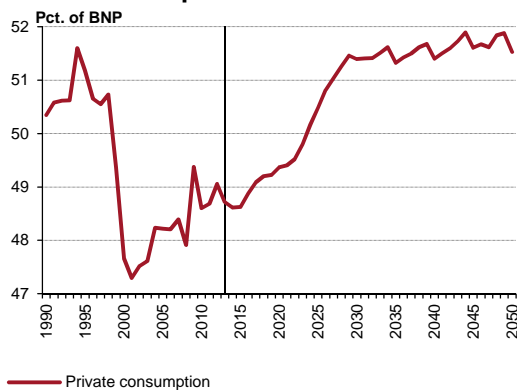
In the period 1990-2012, there has been a significant increase of how large a proportion the individual public expenditure constitutes of the GDP. This proportion has increased from approximately 17 percent to about 20 percent, see Figure 2.3. A part of the increase is due to the economic climate. In particular, the health expenditure per person has increased, due both to a change in the demographic composition as well as a wealth effect. The wealth effect expresses the fact that the age-adjusted spending per person increase more than production/income at home. In the period up to 2020, individual public expenditure as a share of GDP is expected to drop as a result of the expected normalization of the business cycle. After 2020, the health expenditures is expected to increase, due to the aging of the population and simply that in the projection it is assumed that health spending in the period 2015-2040 will increase by 0.3 percent more than the real growth in the society. Because of aging alone, individual public spending will increase from about 19 percent of the GDP in 2020 to about 20½ percent of the GDP in 2040. The additional service increase in health care costs means that the individual public expenditure will amount to approximately 21½ percent of the GDP in 2040. After 2040 a stabilization of the individual public expenditure is expected, provided that the additional service increases cease.

As mentioned, the economic crisis resulted in a sharp decline in the GDP. Certain GDP components are more cyclically sensitive than others. The public expenditure is not particularly sensitive to economic fluctuations, and its share of GDP will therefore typically increase during a recession. A foreign-generated recession will therefore be reflected in a lower share of exports, while a domestic generated recession will be reflected in a lower consumption share. At the same time, the import and investment securities as a general rule will be lower at the domestic generated recession. We will now look at the development of the Danish supply balance since 1990 to the model's base year 2009.

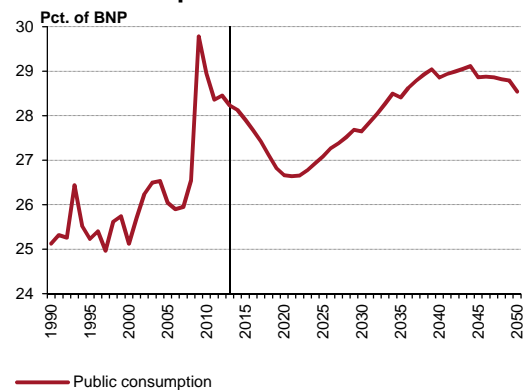
As expected, the public expenditure as a share of GDP has increased from approximately 26 percent in 2006 to 30 percent in 2009, see Figure 2.4. The public consumption's share of the GDP is normalized in line with the economic situation. In 2013, it has dropped to just over 28 percent and it is expected to drop to just over 26½ percent in 2020, after which it will increase due to ageing and the assumption of additional service to about 29 percent in 2040. The periodic jumps in public consumption are due to Welfare Agreement's changes in the retirement age that has increased, which is reflected in an increased GDP.

**Figure 2.4. The GDP demand components**

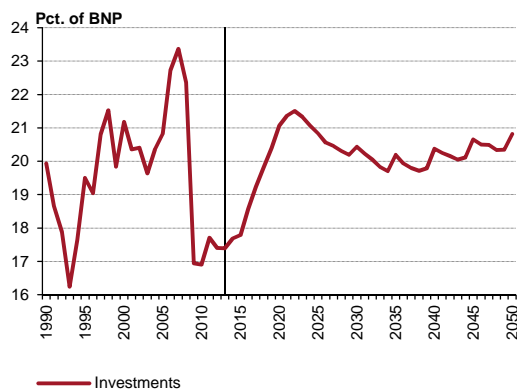
**Private consumption**



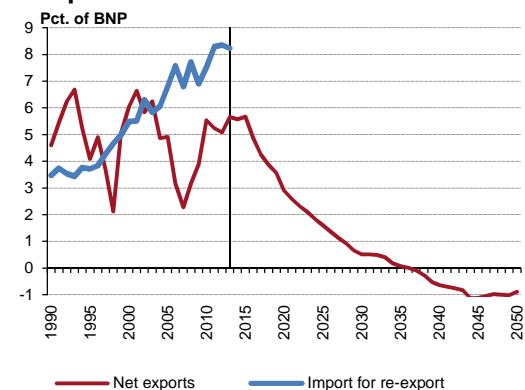
**Public consumption**



**Gross investments**



**Net export**



Source: Statistics Denmark and own calculations in DREAM



The total investments, both private and public, also dropped during the crisis from a high level of 22 percent in 2008 to a low level below 17 percent in 2009. Since the crisis, investments have remained very subdued at 17-18 percent of the GDP compared to previous typical 19-21 percent of GDP. Towards 2030, a normalization of the level of investment is expected, which will be around 20 percent of the GDP. This assures that we can maintain the current capital intensity. In the period 2018-2028, a temporarily higher investment level of approximately 21 percent of GDP is expected in order to rebuild the capital stock after a period of underinvestment. In addition, the investments follow the development in the labour force: When the labour force increases, then the marginal product of capital will increase and thus the return on investment so that companies will increase their investments. The assumption of quadratic installation costs insures that the whole effect does not happen in the same year as change in the labour force.

Since 1990, there have been positive net exports. The net exports have fluctuated between 2 and 6 percent of the GDP over the period. It is expected that we go from the current high level of approximately 5 percent to 3 percent in 2020, which turned into a deficit by 2040. Stable positive net exports are necessary for countries with high external debt. In the case of Denmark the long period with surpluses on the current account will build up a larger and larger claim abroad. After 2040 the situation changes due to a period of many elderly and few able bodies in the labour, creating a declining savings that aggravates the net export by increasing the import.

The import and export have both risen significantly since 1990 - nearly a quarter of the increase, however, is due to an increase in import for re-exports, which increased from approximately 3½ percent of the GDP in 1990 to about 8 percent of the GDP today. To achieve a true image of the actual the import and export, import for re-export is removed from DREAM. In contrast to the Ministry of Finance, a somewhat more conservative estimate of the import and export development after the calibration year is selected as a starting point, where the import share is fairly constant while the export share drops in step with the net export.

In the period 1997-2001, the GDP and the export increased significantly, while the consumption did not follow. This can be interpreted as an export-driven growth. The consumption share has increased slightly since and is expected to be its previous level when the net export is stabilized. In 2009, the ratio increased extraordinary as the export and investments dropped much more than the GDP, suggesting that the crisis was mainly imported from abroad.

There are taps in the private consumption when the labour force expanded. The reason is that the consumption is smoothed over time, while the GDP follows the production, which increases in the years the labour force expands - thus making the consumption drop in relation to the GDP in the years in which the labour force expands.

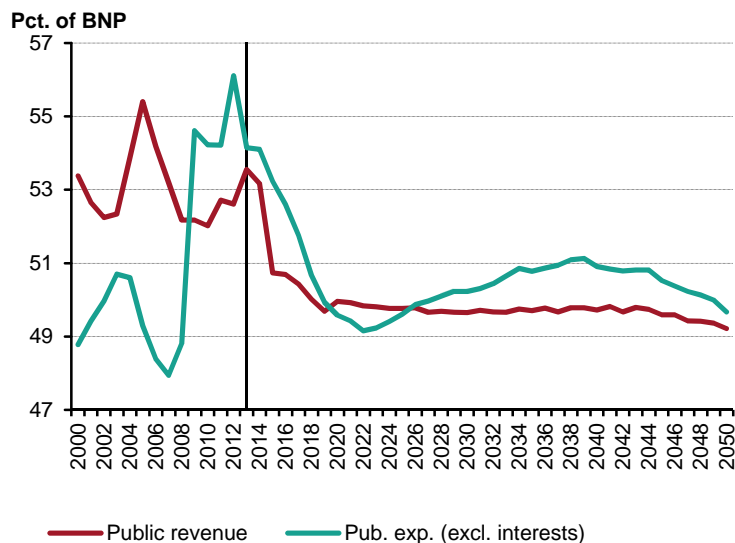
## 2.1 The public sector's income and expenditure

The economic crisis causes a sharp deterioration in the primary public fiscal budget balance. The public income drops in line with the GDP, while the public expenditure increases slightly due to increased transfers. This is reflected by a sharp increase in public expenditure as a percentage of the GDP in 2009, see figure 2.5.

Up to 2020, the normalization of the economic situation will ensure that the public expenditure as a share of the GDP will drop. At the same time, the public income as a share of the GDP will decrease - partly because the tax revenue is too high in 2013 due to a reorientation of capital pension and partly due to eased taxes as a result of the tax reform of 2012. The development during this period is fully compliant with the Finance Ministry's medium-term projection.

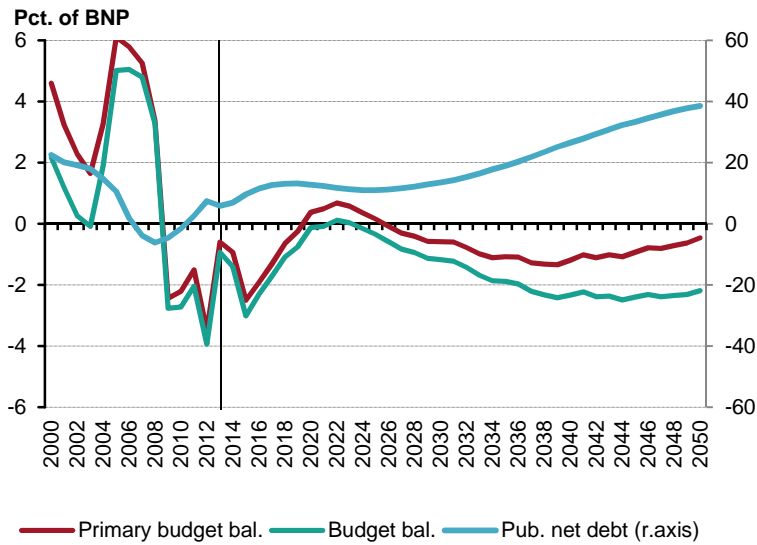
When the crisis occurs in 2008, the public net worth is 6.1 percent of the GDP, and public interest payments are very small, which reflects in the fact that the spread between the budget balance including interest payments and the primary budget balance is modest. The crisis results in the primary budget balance become negative for a number of years until 2020, when the economic situation again is normalized. After this period of budget deficits the public net worth in 2013 has turned into a net debt of 5.9 percent of the GDP in 2013, and by 2020 the debt is expected to amount to 12.8 percent of the GDP, see Figure 2.6. The increasing debt, combined with a normalization of interest rates, make the public interest payments increase, which then burden the budget surplus. In the period 2025-2050 the primary budget balance is burdened by the demographic development. This development, coupled with the increased interest payments, does that from 2035-2050 a budget deficit of about 2 percent of GDP is expected, which is somewhat larger than the Budget Act maximum allowed deficit of ½ percent.

Figure 2.5. Public revenue and expenditure as percentage of GDP



Source: Statistics Denmark and own calculations in DREAM

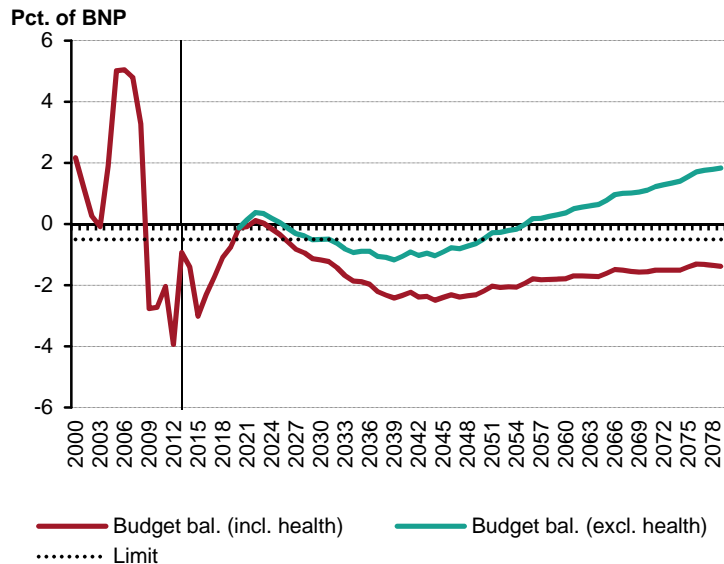
**Figure 2.6. Primary and ordinary budget balance and net debt as a percentage of GDP**



Source: Statistics Denmark and own calculations in DREAM

It is assumed that health care costs continue to increase more than the overall growth of the economy in the period 2020-2040. This assumption is greatly contributing in worsening the budget balance. Even without this assumption it would not be possible to comply with the Budget Act’s demand of a maximum deficit of ½ percent of GDP in the period 2032-2047, see Figure 2.7.

**Figure 2.7. Budget balance with and without increased health care costs as a percentage of GDP**



Source: Statistics Denmark and own calculations in DREAM

The two main explanations for the deterioration of the government budget balance are declining government income from North Sea taxation and the change in the demographic composition. Income taxation of oil and natural

gas production in the North Sea decreases in the longer term in line with the decreasing production capacity. The demographic composition mix affects the level of public expenditure and income. In the period 2022-2039, the population's share of retirees is large, while the labour force becomes relatively small. Thus the cost of elderly care and public health care is increased, while income from the withholding tax is relatively small.

**Table 2.1. Public expenditure and revenue as a percentage of GDP, 2008-2050**

	2015	2020	2025	2030	2040	2050
	--- Percentage of GDP, market prices					
<b>Public budget surplus</b>	<b>-2.3</b>	<b>-0.1</b>	<b>-0.6</b>	<b>-1.2</b>	<b>-2.2</b>	<b>-2.0</b>
<b>Public primary surplus</b>	<b>-1.9</b>	<b>0.5</b>	<b>-0.1</b>	<b>-0.6</b>	<b>-1.0</b>	<b>-0.3</b>
<b>Public revenues</b>	<b>50.7</b>	<b>49.9</b>	<b>49.8</b>	<b>49.7</b>	<b>49.8</b>	<b>49.2</b>
- Direct taxes	30.4	30.2	30.2	30.2	30.2	29.8
- Income taxes	20.2	20.0	20.1	20.1	20.5	20.3
- Corporate taxes	3.3	3.2	3.0	3.0	2.6	2.4
- Other direct taxes	6.9	6.9	7.0	7.1	7.2	7.1
- Indirect taxes	17.2	17.5	17.6	17.6	17.6	17.5
- VAT	10.1	10.4	10.5	10.6	10.7	10.6
- Excise duty	4.3	4.2	4.2	4.1	4.1	4.0
- Land taxation	1.2	1.2	1.2	1.2	1.2	1.2
- Other indirect taxation	1.6	1.7	1.7	1.6	1.6	1.7
- Other income	3.0	2.3	2.0	1.9	2.0	1.9
<b>Public expenditures</b>	<b>52.6</b>	<b>49.4</b>	<b>49.9</b>	<b>50.3</b>	<b>50.8</b>	<b>49.5</b>
- Public collective consumption	7.9	7.6	7.6	7.6	7.6	7.6
- Public individual consumption	19.7	19.1	19.7	20.3	21.4	20.9
- Health care spendings	7.5	7.5	7.9	8.3	8.9	8.8
- Spendings toward education	5.5	5.0	4.8	4.9	5.1	4.9
- Social care spendings	6.1	5.9	6.3	6.5	6.7	6.5
- other individual spendings	0.7	0.6	0.7	0.7	0.7	0.6
- Public income transfers	16.5	15.9	15.6	15.3	14.8	13.8
- Public old age pension	6.0	5.8	5.9	5.9	5.8	5.1
- Voluntarily early retirement pension	0.7	0.5	0.4	0.3	0.2	0.1
- Public disability pension	1.9	1.9	1.9	1.9	2.0	2.1
- Unemployment insurance	0.6	0.5	0.5	0.5	0.5	0.5
- Public cash assistance	0.7	0.7	0.7	0.7	0.7	0.7
- Public Maternity leave	0.5	0.5	0.5	0.5	0.5	0.5
- Public study grant	0.8	0.8	0.8	0.7	0.7	0.8
- Other income transfers	5.4	5.2	5.0	4.8	4.3	3.9
- Public investment	1.9	1.9	2.1	2.2	2.2	2.2
- Other spendings	6.5	5.0	5.0	4.9	4.9	4.9
<b>Public net interest payment</b>	<b>0.4</b>	<b>0.6</b>	<b>0.5</b>	<b>0.6</b>	<b>1.2</b>	<b>1.8</b>

Source: Own calculations on DREAM.

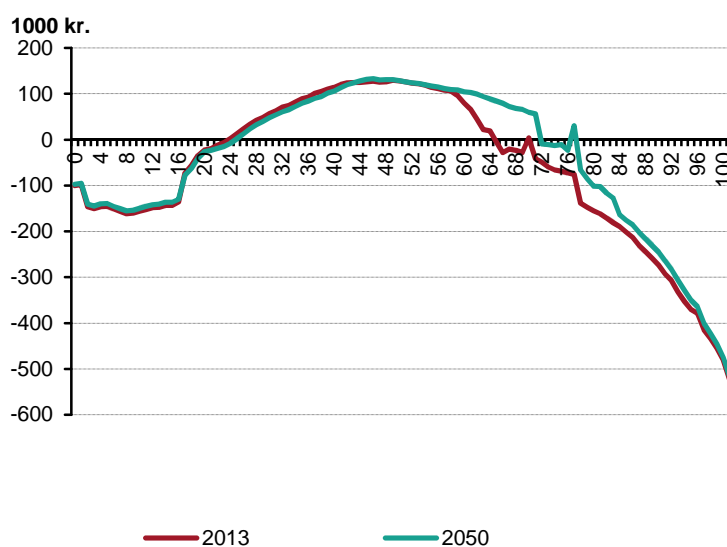
Table 2.1 shows the public income and expenditure as a percentage of the GDP divided into subcomponents. Overall, 2015 is affected by the difficult economic situation, while 2020 onwards is cyclically neutral years. The transition from recession in 2015 to normalization in 2020 means that the primary budget goes from a deficit of about 2 percent to a surplus of about ½ percent. The difference lies mainly on the expenditure side as both the costs and the income are pro-cyclical. From 2015 to 2020, it is especially the items “Other income” and “Other expenditure” that have changed. This is because the total expenditure and income that is to be corrected by the cyclical adjustment in

order to be consistent with the Ministry of Finance's medium term projection are contained as lump-sum transfers in these categories.

From 2020 to 2050, the changes in Table 2.1 reflect structural changes in the public income and expenditure. The income decrease by ½ percent of the GDP, driven by a decline in corporate tax revenue of almost 1 percent due to the decline in hydrocarbon extraction from the North Sea. The public expenditure makes up an approximately unchanged share of the GDP, reflecting a significant increase in social and health costs of 2 percent of the GDP and a corresponding reduction in social benefits.

Just over half of the increase in social and health costs is caused by a demographic development with more elderly, while the rest is due to the assumption that health and care expenditures in the period 2020-2040 will continue to increase more than the GDP. In regard of transfer payments, about half of the decline is due to the phase out of civil service pensions, which really takes hold in the period 2020-2050, after which not many are left in this pension scheme. The other half of the decline is due to a significant escalation of the early retirement and a decrease in expenditures for public pensions. In the period 2020-2040 the demographics mean more elderly and thus more retirees, which in itself mean greater expenditures for pensions. Overall, the expenditure remains virtually unchanged since it is assumed that the state pension allowance is tapered off. In the period 2040-2050, the demographic development moves towards fewer elderly, which is seen by lower health costs, but also by a sharp drop in the payment to the state pension.

**Figure 2.8. Age distributed net payments to the public sector.**



*Note: Growth and inflation adjusted.*

*Source: Own calculations on DREAM's generation calculations.*

Figure 2.8 shows the development in the age-disaggregated net contribution to the public sector in 2013 and 2050 respectively, thus speaking of a cross-

sectional assessment of those periods mentioned. The profile is almost identical up until the 60 years. In 2013, people begin to retire from the labour market from 60 years. At the pension age of 65 years, so many that have retired that the average person becomes negative net provider (with the exception of the year when the person leaves their inheritance and pay inheritance tax - here 70 years). In 2050, people retire later due to the early retirement reform and the later retirement age. Here, the average person will also become a negative net provider at their pension age (here 72 years). From 60 to 72 years, the difference is mainly due to the public pension age and the early retirement reform, but also to the people of this age have significantly fewer hospital costs due to the assumption of a lifetime correction of the health and elderly care costs. From 72 years onwards, the higher level, i.e. lower net contribution in 2050, is primarily due to the lower hospital costs, but also a lower pension benefit and higher tax payment because of higher pension.

## 2.2 The fiscal sustainability indicator

In DREAM's long-term economic projection 2014, the fiscal policy is assessed to be approximately durable. The fiscal sustainability indicator is estimated to be -0.1 percent of GDP. By comparison, the fiscal sustainability problem in the long-term economic projections 2013 was estimated to 0.0 percent of GDP.

**Table 2.2. Change in the sustainability indicator of long-term projection 2013 to long-term projection 2014.**

		Sustainability indicator	Annual amount
		<i>Pct. of GDP</i>	<i>Bio. Kr.</i>
<b>1</b>	<b>Long-term economic projection 2013</b>	<b>-0,0</b>	<b>-0,7</b>
<b>1.1</b>	<b>Pre-models excluding labour market policy</b>	<b>-0,2</b>	<b>-3,3</b>
	New population projection	-0,1	-1,5
	New education projection	-0,0	-0,2
	New socio-economic projection	-0,1	-1,7
<b>1.2</b>	<b>Technical model changes (see. Chapter 4)</b>	<b>0,1</b>	<b>2,8</b>
<b>1.3</b>	<b>Policy</b>	<b>0,0</b>	<b>0,0</b>
	Sick Pay Reform	0,0	0,0
<b>1.4</b>	<b>Total change ( 1.1 + 1.2 + 1.3 )</b>	<b>-0,0</b>	<b>-0,5</b>
<b>2</b>	<b>Long-term economic projection 2014 ( 1 + 1.4 )</b>	<b>-0,1</b>	<b>-1,2</b>

*Note: The billion amounts are calculated based on preliminary GDP for 2013 at 1,857 billion. kr. in current prices. Due to rounding, there may be a difference between the sum of the numbers and the specified total.*

*Source: Own calculations in DREAM.*

Overall, there are three types of reasons that the assessment of the sustainability changes: Data updates, methodology changes and changes in economic policy. Firstly, a number of data updates occur concurrently with the behavioural changes in society. These behavioural changes (such as increasing life expectancy, education changed behaviour or later retirement) give rise to updates of the underlying demographic projections. Data updates include changing the base year and definitional changes in the national accounts. Secondly, the methodological basis for DREAM projections improves continuously in line with the nuancing of the modelling of the Danish economy. Thirdly reforms

and other changes affect the economic policy of the future government finances and thus the sustainability.

The causes of the most significant changes in the fiscal sustainability of DREAM's long-term economic projections 2013 and 2014 are summarized in Table 2.2.

Overall, the fiscal sustainability indicator is worsened by 0.5 billion kr. in the current long-term projection compared to the projection from 2013. Of which updates in DREAM pre-models (those projections that determine the demographic developments, future educational behaviour and labour market attachment) are calculated to worsen fiscal sustainability by 3.3 billion kr., while the model technical changes improves it by 2.8 billion kr.

The latest population projections from April 2014 worsen the sustainability slightly, primarily due to an upward revision in the estimate for immigration from non-western countries. Updating the socio-economic projection also has a negative effect on sustainability, mainly due to a reassessment of the effects of the benefits and flexjob/disability pension reform and a change in the cyclical cleaning of the labour force.

Method changes in the economic model have an overall positive effect on the sustainability of 0.1 percent of the GDP. The biggest changes concerns the method for generating and cyclical cleaning of DREAM's IO table and the method used to create compliance with key figures from the Ministry of Finance's medium-term projection. Other changes include the change of production taxes. Any significant changes are described in chapter 4. The effect is not divided into sub-components, since it due to complementary changes in the model and data structure would require that all interventions should be modelled in both the new and the old model, which would have been enormously time consuming.

The only policy change that has been entered since the last projection is the sickness benefit reform. It has a slightly positive effect on public finances, but not to a degree that can be seen on the sustainability indicator.

### 3 The projection of the labour, population and education

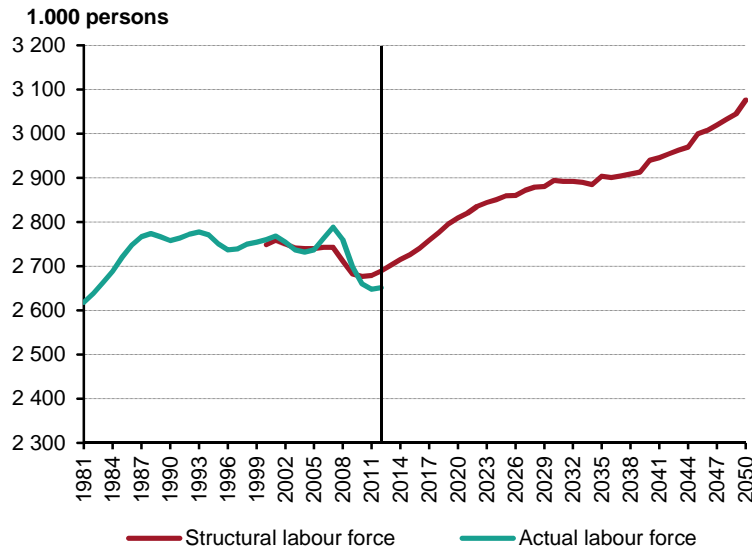
The projection for the economic development after 2020 is mainly driven by developments in the labour force. The labour force is determined based on demographics, education and applicable policy rules. This chapter describes the development of the labour force, the population and the education level.

#### 3.1 The labour force

Based on the development in the population and in their level of education DREAM makes a projection of people's attachment to the labour market (as employed, unemployed, disability pensioners, early retired, retiree, etc.).

The development of the population in the coming decades does that the elderly will make up a significantly larger share of the total Danish population, as these generations partly are large and partly are expected to live longer than the elderly do today, see section 3.2. With the prospect of an aging population, the politicians have in several rounds adjusted the law for voluntary early retirement and public pension. Among other things, the early retirement period has been shortened by two years, and it has been decided to increase the state pension age as the life expectancy increases. This means that the earliest possible retirement age towards the middle of the present century is increased by up to 7 years compared to with today.

Figure 3.1. The labour force, 1981–2050.



Note: The vertical line indicates the transition between historical data and projections.

Source: Statistics Denmark and DREAM's socioeconomic projection 2014.

Figure 3.1 shows the development of the structural labour force until 2050. It is expected that the labour force will grow rapidly in the coming decades. Towards the year 2020, the labour force increases by approximately 95,000 people. The increase is mainly due to the agreed labour market reforms, which among others shortens the early retirement period with effect from 2014 and increase the public pension age from 2019.



After 2020, the labour force continues to increase by a further 265.000 persons by 2050. This is primarily because the earliest age for public pension increases significantly during that period. In the period 2040-2050, a relatively sharp increase is also expected in the number of working people, which also contributes to the increasing labour force during this period.

Table 3.1 illustrates, which main components are important for the labour force's development until 2050. Over the entire period, virtually the entire increase in the labour force is explained by an increase in labour force participation rates, primarily among persons aged 60 and above. Up to 2020, the agreed retirement reforms thus contribute to an increase in the labour force of about 69.000 people out of the total increase in the labour force of around 95.000. Up to 2050, the retirement reform contributes with a total of 302.000 more people in employment compared to today.

Other labour market reforms such as the Growth plan, the Flex job- and early retirement pension reform, the Recovery plan etc. also contribute positively to the labour force. Up to 2020, the other policy actions thus increase the labour force by about 13.000 people. After 2020, the measures are fully phased in, why they practically have no additional effect on the size of the labour force.

**Table 3.1. Main elements with significance for the development of the labour force towards 2050.**

<i>People by the thousand</i>	2014– 20	2020– 30	2030– 40	2040– 50	Total 2014– 50
Total change in labour force	95	84	45	136	360
<i>Contributed from:</i>					
Demographics	3	-52	-40	95	6
- Growth in population	22	-27	-50	92	38
- Change in age composition	-5	-8	22	5	14
- Origin composition etc.	-14	-17	-12	-3	-45
Labour participation	91	136	85	41	354
- Retirement reforms	69	127	73	32	302
- Increasing educational level	9	11	10	10	39
- Other policy initiatives	13	-3	3	0	13

*Note: The category "Origin composition etc." includes changes due to changed gender and origin composition of the population. The negative effect is achieved mainly because a larger share of the Danish population prospectively will consist of immigrants and their descendants, who on average have a lower labour participation rate than persons of Danish origin. The category "Other policy actions" include Sick Pay Reform, Growth Plan, Flex job and Disability Pension Reform, Recovery Plan, etc.*

*Source: Own calculations on DREAM's socioeconomic projections 2014.*

The population's educational levels is expected to increase in the coming years as the older generations leave the labour market and are replaced by younger people, of who significantly more on average will have completed a

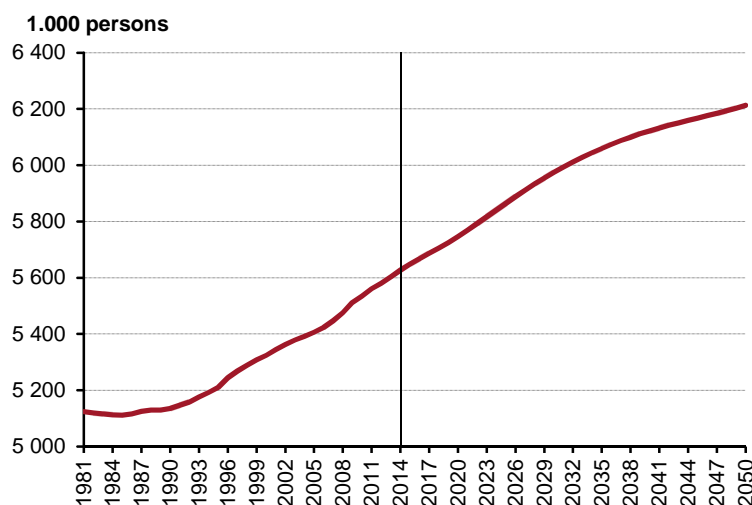
higher education, see section 3.3. As people with higher education on average have higher labour participation rates, the expected increase in the educational level has a positive effect on labour force's general labour participation. It is estimated that this educational effect increases the labour force by about 39.000 people by the year 2050.

Over the entire period up to 2050, the development in the population also contributes positively to the labour force's development by approximately 6.000 people. The contribution from the demographics however conceals opposite movements. The general increase in population has a positive effect on the labour force. Over the entire period 2014-2050, the age composition also contributes positively to the labour force's development. Up to 2050, a greater proportion of the Danish population is composed of immigrants and their descendants. As immigrants and their descendants have on average a lower labour participation rate than persons of Danish origin, the changed origin composition has negative effect on the labour force development.

### 3.2 The demographic development

The mechanisms that determine the development of the Danish population are relatively few. The population is increasing because of births and immigration and decreasing due to the death and emigration.

**Figure 3.2. The total population, 1981–2050.**



*Note: The vertical line indicates the transition between historical data and projection.*

*Source: Statistics Denmark and DREAM's socioeconomic projection 2014.*

When DREAM projects trends in the Danish population, it is with a base in a given population, projected one year at the time. The projection of the total population is done by projecting each of four events that determine the development in the population. In order to determine the future development of these four sizes, it is necessary with four sub-models that project one event each. Such sub-models are included in DREAM's population projection.

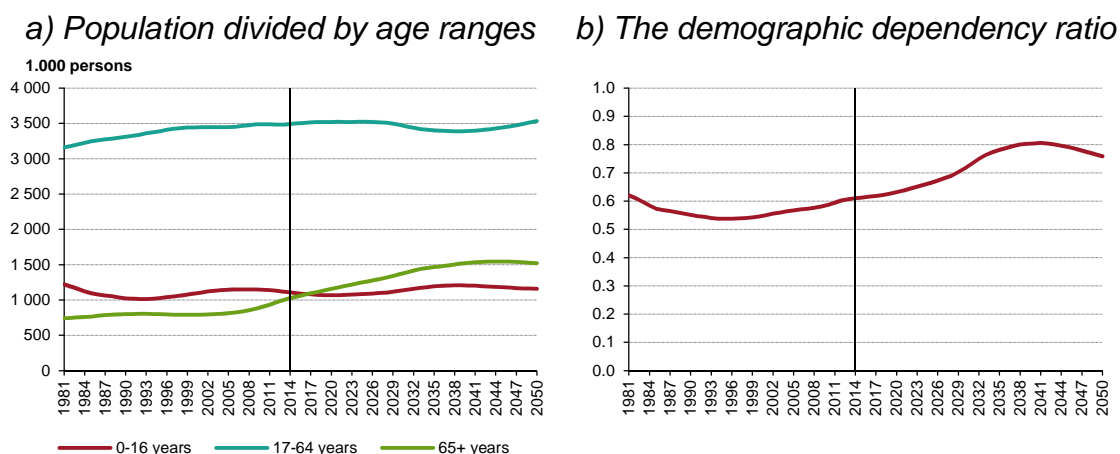
Historically, the Danish population has grown from 2.4 million people in the year 1900 to 5.6 million at the dawn of 2014. There has been positive population growth in all years except for a brief period in the early 1980s.

The tendency of a growing population is expected to continue in the coming years, see Figure 3.2, which shows the projected evolution of the population by 2050. With the applied projection principles, the total Danish population by the middle of the present century would be around 6.2 million people. Towards 2030, a fairly steady growth in the total population of just over 20.000 people annually is to be expected. After 2030, population growth is gradually decreasing towards 2040, where the population roughly will be 10.000 people more than the previous year. This population growth is expected to continue until the middle of the present century.

The total population is growing partly because of a positive net migration (i.e. expect a greater immigration than emigration) and partly due to a positive birth surplus (i.e. more births than deaths).

Looking ahead, the immigration is expected to be significantly greater than the emigration, resulting in a net migration of 15.000 to 17.000 people a year in the beginning of the projection. Then the net immigration decreases gradually and settles by around 2050 at a relatively constant of approximately 9.000 people annually. Based on the number of births and deaths, in the first 15 years of the projection a birth surplus is expected of up to 15.000 people a year. This is a continuation of the level observed in the recent historical years. In the period from 2030 to 2050, the birth rate gradually decreases from almost 10.000 to around zero people annually.

**Figure 3.3. The total population divided into age ranges and the demographic dependency ratio, 1981-2050.**



Note: The vertical line indicates the transition between historical data and projection.

Source: Statistics Denmark and DREAM's socioeconomic projection 2014.

Since the mid-1990s, the average life expectancy in Denmark has increased significantly since the mortality rate among the elderly is decreasing. In the projection this trend of an increasing life age continues. The increasing population towards the year 2050 is therefore seen to be almost exclusively in the age range of 65 or more, Figure 1.3a, which shows the development of the to-

tal population divided into age ranges for children (0-16 years), inactive (17-64 years) and withdrawn from the labour market (65 and over). The development in the population in the coming decades therefore means that the elderly will account for a significantly larger share of the total Danish population. This is partly because the post-war baby-boomers reach the age of retirement, and partly because the coming elderly are expected to live much longer than is the case today.

The demographic dependency ratio places the number of children and the elderly in relation to the number of people of working age. The target can be considered as a rough estimate of the number of people who need support or are dependent on others, divided by the number of potential parents. The development in the demographic dependency ratio is depicted in Figure 3.3b.

During the 20th century, the number of children has remained fairly constant, while the number of people of working age has increased. In the same period, the number of elderly has grown considerably more than the number of workers. In terms of the demographic dependency ratio, a hundred years ago 20 people in the working age had to provide for a little over 13 people, while 20 people in the working age today have to provide a little over 12 people. Due to a continued increase in the number of elderly prospectively, the dependency ratio is expected to increase from 0.6 today to about 0.8 by the year 2040. This corresponds to 20 people of the working age provide for about 16 people outside the working age.

### **3.3 Educational level**

In DREAM's Education projection, each person's path through the educational system is modelled. All people are assumed to begin primary school, after which the transition probabilities determine the person's path forward. In the model, each person in addition to demographic characteristics has an educational status that is updated as the person starts, finishes, continues or waives an education.

In the education projection, using the study-related behaviour, which is observed historically, projects the number of students in each type of education. Thus the results of the projection are that future youth will tend to choose the same courses as the equivalent of young people today choose.

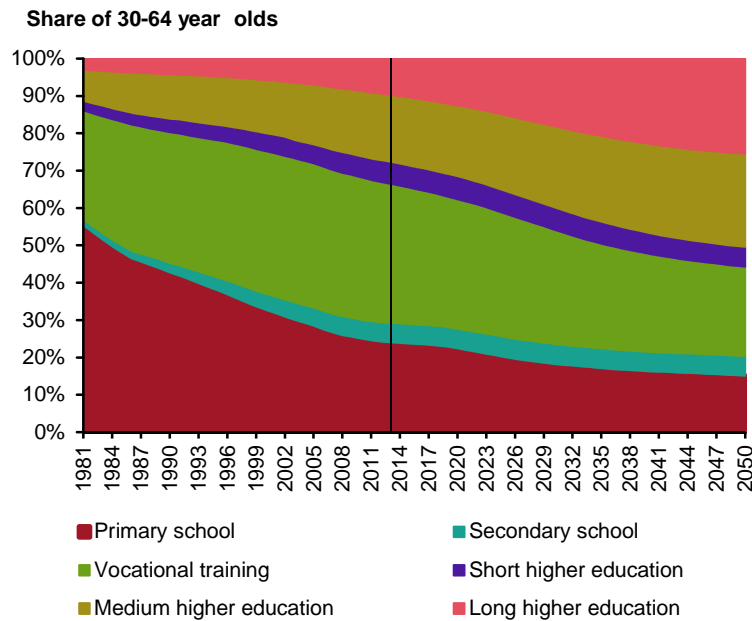
Educational level is typically measured from the concept of "maximum completed education". It involves a ranking of education on a scale where primary school ranks at the bottom and a Ph.D. at the top. The person's completed education that ranks highest is decisive for the person's "level".

The education level of the total population can be expressed by considering the potential labour force's highest completed education, shown in Figure 3.4. The potential labour force age is defined by considering the 30-64 year olds, who will typically have completed their education while being available for work.

In recent years there has been a clear tendency for an increasing share of each youth age group begin a youth education. Of these a greater proportion

goes on to a higher education. The proportion of unskilled workers in the working ages is thus diminished, so the labour force today consists mainly of skilled workers and people with a higher education. This tendency is expected to continue in the coming years as the youth age groups with a relatively high level of education replace the oldest age group on average have lower educational level, see Figure 3.4. In particular the proportion of people with a higher education is set to increase at the expense of skilled education.

**Figure 3.4. The population of 30-64 year olds divided by highest completed education, 1981– 2050.**



*Note: Highest completed education is shown as a percentage of the total population of 30-64 years. Persons with unknown maximum of completed education are recognized in primary school. The vertical line indicates the transition between historical data and projections.*

*Source: Statistics Denmark and DREAM's educational projection.*

## **4 Assumptions and methodology underlying the projection**

The purpose of the projection is to assess the development of the key economic variables, provided that the announced fiscal measures are implemented and that current welfare schemes are maintained as well as the transfer payments per person is regulated by the development in wages. The last assumptions insures that the income distribution between wage earners and welfare beneficiaries is maintained, respectively, that in a situation with unchanged composition of the population there will be a tendency for the private and public consumption to grow in parallel and that both will represent a fixed percentage of the income.

It is evaluated if these assumptions and the growing proportion of elderly in the population and increasing life expectancy mean that fiscal policy is sustainable.

This chapter describes the specific assumptions about the economic policy in the projection and presents the basic features of the DREAM model used for the projection. Also presented are the main changes of the DREAM projection compared to previous years.

### **4.1 The method underlying the economic projection**

The long-term economic projection is made by using the economic model DREAM. The projection is based on the population projection described in Chapter 5 and the projection of the number of persons in the labour force and the number of welfare beneficiaries, as described in Chapter 7.

DREAM is a so-called overlapping generation model, focussing on the demographic development and the institutions of the Danish economy, especially the public sector. DREAM is a model for a small open economy with fixed exchange rates, perfect capital mobility and residence-based taxation so that the international interest rate (before tax) can be regarded as given. It is assumed that the nominal international interest rates are 4.75 percent and that international inflation is 1.75 percent per year during the entire period of the projection so that the real interest rate is 2.95 percent. Finally, it is assumed that domestic labour-saving technological progress is 1.5 percent per year throughout the projection, so that the growth-adjusted real interest rate is 1.4 percent.

In DREAM Danish and foreign products are assumed to be imperfect substitutes in both production and consumption. Prices and wages are therefore dependent on the domestic activity and the international terms of trade are endogenous. Foreign trade is modelled by the so called Armington approach, where the price that can be obtained on the international markets for Danish export products depends on both the foreign demand and the domestic export supply to the international markets. It is assumed that foreign demand for Danish products increases with a real growth of 2.0 percent per year.

The households in DREAM are based on the projection of the Danish population. The adult population (i.e. persons who are 17 years or older) is divided

into generations, which consists of people born in a given year. For each generation, a representative household is formed. Children are distributed to those households corresponding to the historical and the projected age-specific fertility. The people in the representative household are assumed to pass away corresponding to the assumptions about the development in age- and gender-specific mortality in the population projection.

Each of the representative households decide on the number of hours worked (the intensive margin of labour supply), the composition of their consumption bundle and the savings in each period given the assumption of perfect foresight. As discussed above, the number of persons in the labour force (the extensive margin of labour supply) is set exogenously by the socio-economic projection. The various types of transfer payments are distributed in the same manner to persons outside the labour force on the representative households. Each household puts their savings in the following assets: home ownership, shares and bonds. In addition, the household labour pensions with payments determined as part of his employment, ATP and private pensions. The latter is determined exogenously, as the tax subsidy for these arrangements eliminates an inner solution in a model where there is an exogenous pre-tax return and absence of uncertainty and credit restrictions.

Both wages and working hours are endogenous given in the model. The wages are determined on the basis of the marginal product of labour and thus depend positively on productivity while working hours depend positively on the productivity-adjusted real wages after tax. The overall unemployment rate depends positively on the compensation rate and is distributed to the representative households through the age-related distribution of unemployment in calibration year.

DREAM has seven private production sectors; the construction sector, other private businesses and five energy sectors. The five energy sectors including mining, processing and distribution of energy based on fossil fuels (oil, gas and coal) are separated from the sector of the other private businesses with the aim of making it possible to calculate the consequences in the field of energy. Coal exists only as an imported product, but the other energy products are affiliated with a special production sector.

The production in the two sectors for the extraction of crude oil and natural gas respectively is in each year bound by a capacity limitation linked to long-term production forecasts from the Danish Energy Agency. Thus, the production of oil and natural gas decrease in line with the reserves in the North Sea are dwindling.

Imported and domestically produced crude oil is only used as input in the refining sector, supplying processed oil products for final consumption and to material consumption in other production sectors. Likewise is the gas distribution sector the only domestic buyer of imported and domestically extracted natural gas. Finally, imported and domestically produced processed oil and gas is used together with imported coal in the production of electricity and district heating in the last of the total three energy distribution sectors.

The production in each sector is based on the same functional form but the production function's parameters are in principle specific to each sector - albeit the substitution elasticities are usually set to the same values. It employs a KELM structure, which in the production function's top nest substitutes between labour and a capital-energy aggregate (where there is substituted between capital and an energy-aggregate consisting of the three processed energy products), as well as an aggregate of material consumption.

The companies in the private sector are stock companies who seek to maximize the value of a given amount of outstanding shares. Labour, capital and materials are used in the production process. The capital stock is gradually adjusted to the changes because of the assumption of convex installation costs for investments. There are technical advances in the production, which increases the productivity of labour (so-called Harrod-neutral technical progress). It is assumed that productivity growth is 1.5 percent per year. This assumption on the productivity development can be seen as an extension of the long-term historical tendency, although the productivity increases over the past 10 years have been a little lower.

The product markets are assumed to be characterized by imperfect competition so that the companies set the price of their own product, given the competitors' prices. The functional form implies that the corporate rate is a mark-up times their cost.

The public sector in DREAM produces goods mainly used for public consumption. The production process uses capital, labour and materials. It is assumed that the public companies minimize costs for a given production conditioned upon an exogenously determined political capital stock. There is a certain substitution between materials and labour, as well as the public sector allows for a certain substitution of own production with the purchase of goods in the private sector to meet the demand for public consumption. In addition, the public sector collects taxes and pay government transfer payments.

## 4.2 Fiscal sustainability

A given fiscal policy is sustainable if it implies that the public sector meets its long-term (intertemporal) budget constraint. It corresponds to the discounted value of all future primary budget surpluses (i.e. earnings excluding interest) shall be equal to the debt level of the starting point:

$$\sum_{t=0}^{\infty} B_t \left( \frac{1}{1+r} \right)^t = D_0,$$

where  $B_t$  is the primary budget surplus in year  $t$ ,  $r$  is the interest and  $D_0$  is the original debt.

If the fiscal policy is not sustainable, then the discounted profits are too small:

$$\sum_{t=0}^{\infty} B_t \left( \frac{1}{1+r} \right)^t < D_0$$



One obvious target for the sustainability is:

$$H = \sum_{t=0}^{\infty} B_t \left( \frac{1}{1+r} \right)^t - D_0$$

If  $H < 0$  then there is a sustainability problem. It is often chosen to measure the sustainability problem in percent of the GDP. For given development in the primary budget  $B_t$ , the sustainability indicator  $h$  indicates the share of the GDP, which the public sector must receive annually in order to obtain sustainability in the long-term:

$$0 = \sum_{t=0}^{\infty} (B_t - h BNP_t) \left( \frac{1}{1+r} \right)^t - D_0$$

or

$$h = \frac{H}{\sum_{t=0}^{\infty} BNP_t \left( \frac{1}{1+r} \right)^t}$$

The sustainability indicator  $h$  is the permanent improvement of the primary public budget as a share of GDP needed to secure that the public sector keeps its long-term budget condition. A sustainability indicator is a measure of the size of the required adjustment of the fiscal policy and says nothing about how this adjustment must be made.

In practice, the required annual tightening of fiscal policy also depend on how the tightening is achieved as different kinds of public policy affects the activity and the public budget differently. An increase in income taxes affects labour supply and thus the activity in the economy. Conversely, a public savings will reduce labour demand and thereby affect wage formation. The two types of fiscal policy influence the economic development differently and the necessary adjustment needs will be different. In this presentation a lump sum transfers from abroad to the public sector from the year 2080 and onwards are used as instrument. In order to find the measure for the necessary constant annual savings, the value of lump-sum transfers is discounted to the base year so that it corresponds to the size  $H$  in the equation above.<sup>5</sup>

The measure of fiscal sustainability for the calculations in DREAM is based on a time horizon that extends up to 124 years after the calibration year. This is done because the question to be answered with the calculation is whether the

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<sup>5</sup> This is done primarily to achieve comparability with the measure of fiscal sustainability, published by the Ministry of Finance. However, there are still differences in measures, as the Ministry of Finance's measure does not include the effect on the economic development of the changed economic policy.

fiscal policy and thus the welfare system is robust enough to the expected increase in key sizes such as average life expectancy and welfare development. For calculations with DREAM, it is assumed that 124 years after the calibration year, the population and average life expectancy are constant, public services per person grows at the same rate as the overall growth of the economy, and the working hours are constant. The assumptions mean that the economy 124 years after the calibration year is in a state where all the economic indicators are growing at the same rate (i.e. a steady state).

### **4.3 Assumptions about existing welfare schemes and the tax system**

All tax rates and current welfare schemes in the calibration year are involved in the actual calibration. Changes in the tax rates etc. after the calibration year until now and adopted amendments, which have not entered into force or fully phased in, are introduced in DREAM in the relevant year.<sup>6</sup>

The distribution of recipients of income replacing transfer payments is projected as described in Chapter 7, while the other assumptions can be summarized as follows:

- Transfer payments per person are adjusted according to the Rate Regulation Act<sup>7</sup>. It is assumed that in the future the rate adjustment pool<sup>8</sup> is used for the regulation, which corresponds to that transfer payments adjusted in line with the wage development after deductions for pension contributions. Also taken into account that the increase in payments from occupational pensions leads to a reduction in the income-related transfers to pensioners.
- The consumption of public services (individual public consumption) has a certain distribution, compared to age, gender and origin. The average cost per person in a given group is adjusted by the productivity growth and inflation, equal to a nominal growth of 3.28 percent per year. The adjustment is broadly equivalent to the average cost per person in a given population regulated by wages.
- Collective public consumption (i.e. public expenditure that cannot be readily customized) is adjusted by GDP growth.

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<sup>6</sup> As these changes are not included in the calibration, it is assumed that agents will not have knowledge of these interventions before a year after the calibration year.

<sup>7</sup> All public transfers follow a weighted average of wages and prices calculated according to the Rate Regulation Act.

<sup>8</sup> For historical reasons a sum of money equal to the difference between the transfer payments calculated by the Rate Regulation Act and calculated by wages alone are used for social investments.

- Public investment is determined so that the capital/output ratio in the public sector is gradually adjusted to a constant long term level.
- The tax freeze on housing is maintained technically for calculation purposes until 2020. It is then assumed that housing tax rates will be maintained.
- Rates and limits in income tax system are changed as described in the Spring Package 2.0 and Tax Reform 2012.
- The annual working hours and part-time share remain unchanged, however, adjusted for increasing retirement age.

#### **4.4 Assumptions about the new policy since the last projection**

The Sickness Benefit Reform from December 2013 is included in the model. The key element is the impact on the labour force assessed in the labour force projection.

Household payments to the pension annuity are adjusted down slightly as a result of a cap on tax-deductible contributions.

#### **4.5 Assumptions about the individual public consumption**

The population development's impact on production and demand for public services is included by basing it on the distribution of the individual public services by age, gender and in some cases origin.

According to the National Accounts, individual public service is divided overall in the categories: health, social care, education and recreation, culture, etc. If the registry data for the expenditure is available, this is used for the distribution of macro expenditure on gender, age and origin. If a given macro expenditure cannot be individualized based on registry data, the post in question is evenly distributed by gender, age and origin<sup>9</sup>.

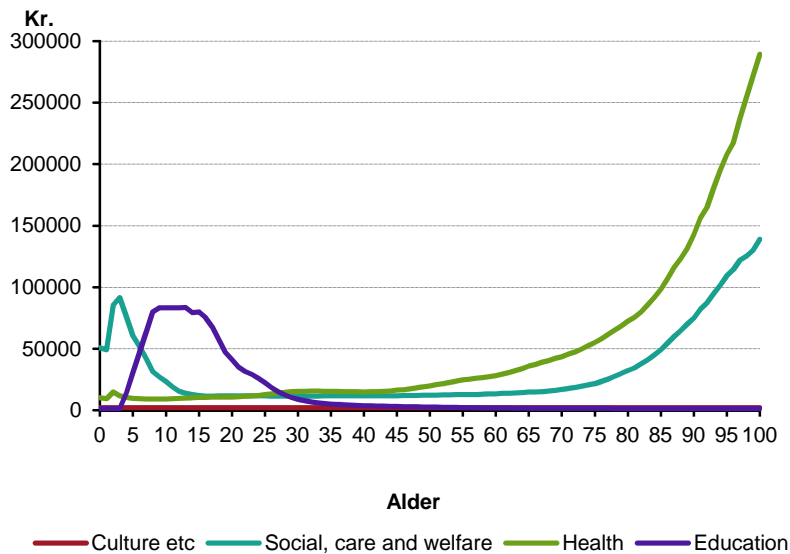
As seen in Figure 4.1 below, the average expenditure for individual public service varies heavily by age. Thus dominates the average for elderly, children and young people the average for persons in the working age.

The cost of social care includes the age group of 0-15 years, primarily the cost of day care centres. Subsequently, the increase in the cost will represent this by age increasing with the need for home care.

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<sup>9</sup> Data from 2009 is used for DREAM's 2014 projection. Microdata is prepared initially by performing a smoothing of age, assuming the same average for people over 70 and the same average of descendants and persons of Danish origin in all age groups.

**Figure 4.1 Average age allocated expenditure for individual public service, 2009**



Source: Own calculations based on register data and the National Accounts 2009.

Expenditure on health includes subareas such as medicine, hospital, medical insurance and nursery homes for the elderly. The average health expenditure is around 10.000 kr. in the first year and increases monotonically with age. The average cost per person passes 50.000 kr. at 75 years of age, and then rise sharply. The average cost of people about 90 years is approximately 140.000 kr.

The educational expenditure varies from around 80.000 kr. per child up to the 15th year. For the age groups above reduced the average education expenditure per person in step with an increasing proportion of the year group leaving education. Training costs depends solely on demographics. When training intensity under the education projection is expected to increase in the future, the process used potentially underestimate the future expenses to individual public service to education.

Among the total expenditure on health, social care and education also appears a residual that is not individualisable and therefore is just shared equally across age. For the cost of leisure, culture etc., the same principle has been used.<sup>10</sup>

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<sup>10</sup> The equally just distributed residuals are included in the total expenditure on health, education, social care and culture respectively, depicted in Figure 4.1. The average non-individualisable expenditure for culture constitutes about 2.200 kr. per person across gender and origin in 2009-level. For social care, health and education, the average non-individualiserbare cost amounts to 11.300 kr., 2.900 kr. and 1.400 kr. per person for respectively. This represents approximately 56 percent, 12 percent, and 8 percent of the total expenditure on social care, health and education respectively.

DREAM's long term economic projections have previously been based on an assumption that the average gender, age and origin allocated expenditure for individual public service is constant throughout the projection. Especially for expenditure related to health and elderly this is a debatable choice. The argument of the applied modelling has been that the process represents a compromise between two opposing trends in the development of costs related to health area. On the one hand, technological developments are assumed to be pulling in the direction of higher costs, while in line with increased prosperity and increased average life expectancy on the other hand the tendency will be that the cost per year of life decreases. This is primarily due to a significant proportion of health expenditure is so-called terminal treatment costs that is held in the last years of a person's life. An increasing life expectancy will not in itself mean that these costs will tend to grow, why there may be a tendency that health expenditures increase less than proportionally to the number of users in a given age group.

The general result in international studies is that the effect of the technological progress dominates the effect from terminal treatment, why it cannot be excluded that the use of the assumption of unchanged standards tends to underestimate the future expenditure development in healthcare.<sup>11</sup>

Based on the above, in the 2014 projection it has been chosen partly to add an additional growth contribution in the expenditure related to the health area and partly to correct the expenditure for the development of the remaining life expectancy.

For the latter correction, the same approach is applied as by the Ministry of Finance. This is grounded in an assumption that the average expenditure per person for a given age group depends on the number of years to the time of death. This division clarifies those persons who are in the so-called terminal phase on average draws more on the individual public expenditure on health than the general population. Since the remaining life expectancy increase in the future, the proportion of people who are in the terminal phase all things being equal will diminish over time. Hence the average will be reduced for a given age group with increasing remaining life expectancy. The average cost per person for health and elderly care will then decrease through the projection, see Figure 4.2.

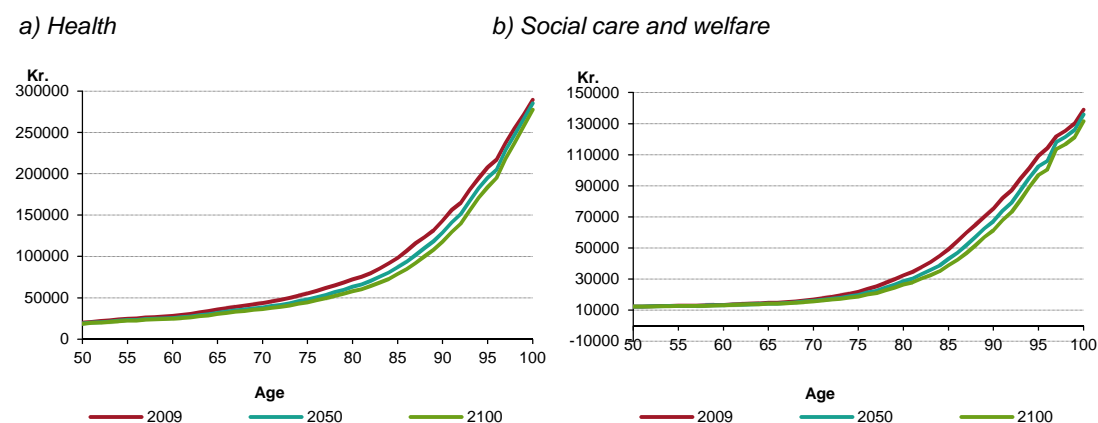
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<sup>11</sup> The technological development in Medical Science as mentioned will tend to increase the overall expenditure. However, this is a net effect. Technological development will, on the one hand, mean that continually comes a progressively greater range of treatments for diseases that previously could not be treated. When such treatments exist, there will be considerable pressure that they put them into use. Plus, new and better but also more expensive treatments will substitute known and typically less expensive treatments. On the other hand, the technological development will cause a tendency for the known technologies to become cheaper. The latter tendency is not dominant in historical data, why the net effect of technological development also in the projection is expected to be a tendency for higher health expenditures per citizen.

The overall demographic average on expenditure for health and elderly care is determined in the projection by the product of the population divided by up to three years to the expected time of death and the average cost per person also divided by number of years to death.

The isolated sustainability effect of this so-called year-to-death correction is an improvement of just about 1 percentage point.

**Figure 4.1. Projection of average age allocated expenditure for health and social care, adjusted for the expected number of years until death, 2009.**



*Note: The average per person is exclusively pictured from the age of 50, since there is no significant variation in the average expenditure by number of years to the time of death for the younger age groups. For the cost of social care and welfare, the only expenditure is related to the elderly, adjusted by the change in the composition of the population for the remaining life expectancy.*

*Source: Own calculations based on register data and national accounts 2009.*

Adjusted types of expenditure given to the first 25 years after 2013 (i.e. after the zero growth period) an additional growth contribution of 0.3 percentage points in addition to overall productivity growth of 1.5 percent. This models the continuation of the average historical tendency since 1995 for that particular type of expenditure. The length of the period is arbitrarily chosen based on the assumption that the phenomenon seen from an expense management perspective hardly can be allowed to continue in perpetuity. Conversely, it is chosen at all to involve an additional growth contribution, since it apart from the historical perspective is the tendency in the countries with which we usually compare ourselves. All things being equal, the demand for health care is not supposed to be robust to persistent deviations from international standards.

For other individual public expenditure, it is still assumed that the average per person expenditure is constant during the projection period, so this alone is the size and composition of population by age that determines the overall demographic average.

## 4.6 Technical model change of production taxes

Production taxes are taxes imposed on the input of domestic or foreign production. It is imposed all places these inputs are used, whether it is when purchasing materials, consumption, investments and export. In DREAM, these taxes are split into value based and quantity based. Previously, it was techni-

cally only possible to have a tax rate of value based production taxes for each application group<sup>12</sup>. You could not within a single group such as public consumption have a value based tax rate for the input of oil and another for the input of public services. This yielded some challenges when the energy taxes were to be changed, and if effects of a type of tax freeze on energy and another on non-energy should be implemented.

In the new system it is easy to change the energy taxes - also it is possible to exploit this division of tax rates on input types to calibrate the different tax rates on energy input and non-energy input based on data from ADAM's data bank.

## **4.7 New IO system and cyclical cleaning**

In the autumn of 2012 there was a revision of the national accounts industry branch division. The old DB03 codes were replaced by new DB07 codes, which meant that the IO system in DREAM was restructured to run on the new industry codes. This should only require that DREAM industry branches should be aggregates for some other sub-sectors, but the process was, among others things, complicated by the fact that there was no investment matrix on new industry codes (and it has currently still not arrived), so the newest investment matrix is for 2007 and the DB03.

In connection with the transition to DB07 some revisions have been introduced in the way the DREAM IO table is constructed, which is the basis for production, investment, consumption, etc. in DREAM. Furthermore, the system for cyclical cleaning of the IO table has been refined.

### **4.7.1 Generating DREAM's IO table**

DREAM's IO table in its construction is similar to the IO tables from Statistics Denmark. It describes the production in Denmark. There is information about which units provides input for other units. The supplying units are Danish production industries, foreign branches of production, taxes and subsidies, labour and mixed capital income. The receiving devices are Danish production industries, private consumption, public consumption, machine and construction investments in Danish production industries and export.

DREAM has a more aggregate IO table than Statistics Denmark on the industry side, implying simple aggregation of industries. In turn, it is more detailed concerning taxes and subsidies. For a more detailed breakdown of taxes and subsidies ADAM's databank in particular is used.

As something extraordinary and hopefully temporary, it was necessary to impute an investment matrix for 2009, since there has not been one for 2009, ei-

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<sup>12</sup> Application groups are the material purchase and investments of the individual sectors, private consumption, public consumption and exports.

ther on new or old industry code. The new investment matrix is imputed so investment totals are equal to those for DB07. The input distribution follows immediately on the investment matrix from 2007 with the DB03 industries; however it is tuned to be consistent with the existing IO table.

New data on Danish ships' chandlers in foreign ports have explicitly been taken into account, and we have chosen to place valuables along with inventory investments and breeding strains rather than distribute them to all industries investments.

Finally some simplifying structural assumptions are introduced such as adjusting for the split between wage and capital income for self-employed individuals - so that the self-employed's salary is included alongside earned income concepts in the model and linked to remuneration of labour and not to capital. The dwellings industry from the national accounts include janitors, etc. - In DREAM these are put into the construction industry, as the dwellings industry consists only of housing capital (and property taxes). As something new compared to previous, import for re-export is taken out of the IO table, because it apart from very modest customs revenue does not affect the Danish economy and gives a false impression of the development in the actual import and export.

Purely methodical the alignment of IO table has also changed. A final alignment of the table is no longer necessary as it has explicitly been taken into account, which cells should be counter-adjusted for each restriction on the IO table.

#### **4.7.2 Cyclical cleaning in DREAM**

In the 2011 projection a cyclical cleaning of the IO table among others was introduced for the first time. The procedure in this projection is basically the same as in 2011, just with a few technical improvements added.

Based on the IO table for 2009, we calculate the implicit tax rates for product and production taxes and subsidies incl. VAT severity. These tax rates are kept unchanged, as they reflect the statutory tax rates. By contrast, tax revenues will be cyclical dependent - and we cyclical-cleans tax bases in terms of production values, payroll, capital income, consumption, investments, import and export.

Production values, private and public consumption, investments, import and export as a share of GDP are cyclically cleaned using an HP filter where a possible endpoint problem is avoided by including DØRS' projection for these variables from the cyclical model SMEC. The relationship between payroll and mixed capital income is also determined based on a HP filter. Then the actual structural levels are determined based on the structural level of GDP determined by DØRS. This results in the IO table's cyclically adjusted totals. The distribution on the actual columns is found by taking a 5-year average of the actual column distribution of the IO tables.



One of the technical improvements compared to the projection from 2011 is that the cyclical cleaning operates at a more disaggregated level, so the different cyclical patterns for different industries better can be taken into account.

A number of other variables that are not part of the IO table are cyclically cleaned too; as a share of GDP, if they are deemed to follow a fairly normal cyclical pattern - otherwise by independent HP filtering. Where we do not have a SMEC forecast available we will try and counter any endpoint problem by extending the series with an ARIMA forecast.

However, it is not only cyclical variables that it may be necessary to smooth out. Another example is the depreciation rates on construction and equipment investments. One would expect that these will only slowly change in line with structural changes in depreciation patterns, but the matter of fact is that there is some interference in these series. It is significant for the user cost and the long-term  $K / Y$  ratio. To come to grips with this interference, we use the expected depreciation rates from ADAM, which are smoothed versions of the actual depreciation rates.

#### **4.8 Incorporation of business cycles in DREAM**

DREAM is calibrated to 2009, which is the latest final national accounts data incl. a full IO table we have. This ensures that we have the best possible data quality, but a lot have happened since 2009. The calibration of DREAM to the cyclically cleaned base year ensures that the model in the long-term projection is on its trend growth and that the parameters that determine the structures and agents' behaviour in the long term is not affected by cyclical conditions in the base year for the calibration.

Cyclical fluctuations are not expected to affect the basic structure of the economy, but large temporary fluctuations in the production will affect both the public finances and the private income in the short term. This short-term impact of public and private income will affect the public and private assets. With consumption smoothing a lower private wealth means that consumption will permanently be at a slightly lower level, while a larger public debt means that there will be a permanent deterioration of the public interest costs and thus the sustainability indicator. In order to give an informed opinion on the sustainability indicator, DREAM is therefore forced to take the current economic situation into account - both the business cycle from 2009 to today and from today onwards to the normalization of the business cycle.

DREAM is not built to endogenously take into account the current economic situation, but we can build an exogenously given cycle. Data published by Statistics Denmark is used from 2009 to 2013, but from 2013 onwards for the normalization of the business cycle a projection is required. Each year in conjunction with their convergence program, the Ministry of Finance prepares a medium-term projection where the economy is moving from the current economic situation and to normalization. We use this projection to cater for the business cycle impact on the public and private assets.

### 4.8.1 Incorporation of the convergence program's cyclical scenario

The incorporation of the convergence program has been redone in the "Long-term economic projection 2014". The new cyclical adjustment is adapted to the DREAM model so that the following variables are affected:

- GDP in current prices
- GDP in fixed prices
- Private consumption in current prices
- The public consumption in current price (including the overall public consumption and the individual public consumption)
- Public investments in current prices
- The unemployment rate
- Overall government revenue (including the corporate tax revenues)
- Overall government expenditure (including the government's net interest expenses)
- Government net debt

The private investments will also be affected indirectly as they are residually determined from GDP and the other components of demand.

To get DREAM to generate the results from the convergence program you have to break some of the relationships that are normally incurring in DREAM. This is due to cyclical fluctuations not normally being recreated in a long-term structural model, since it goes against the model's basic features.

In DREAM, the following normal contexts are changed<sup>13</sup>:

- The constant annual labour productivity growth, which is normally exogenously given with a growth rate of 1.5 percent, is made endogenous in the period up to 2020. After 2020, it is made exogenous again with an annual growth of 1.5 percent.
- The parameters of the basic import shares in consumption and production are made endogenous. After 2020, the parameters are locked at their new 2020 levels.
- The Keynes-Ramsey rule is repealed in the years up to 2020. From 2020 to 2030 the Keynes-Ramsey rule is reintroduced gradually.
- DREAM's normal projection of individual and collective public consumption is suppressed until 2020. After 2020, DREAM's normal pro-

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<sup>13</sup> Technically, this means that the endogenous variables we adapt, so they hit FM's medium term projection are done exogenous in the period up to 2020. In DREAM, the number of equations must be equal to the number of endogenous variables, so we are now forced to endogenize variables or suppress existing equations. The following list reflects factors these changes.

jection method is used again, just with the new 2020 level as a starting point.

- Public investments usually adapts to DREAM in a manner so that the K/Y ratio in the public sector is constant after a few years. This mechanism is deferred to take effect after 2020, so that the K/Y ratio in the public sector is constant from 2030.
- The foreign demand for Danish goods is endogenized until 2020. After 2020, DREAM's normal assumption that foreign demand is growing by 2 percent annually is reintroduced.
- Unemployment is exogenized until 2020, after which DREAM's normal assumptions again determines the development in unemployment after 2020 – just using the new unemployment rate in 2020 as a starting point instead.
- The above adjustments cause for the government revenue and expenditure in DREAM to change more in the direction of government revenue and expenditure in the convergence program. The remaining difference is embedded via lump sum transfers from households in the public sector and vice versa from the public sector to the households. After 2020, the lump sum transfers follow the GDP development, which is the normal behaviour in DREAM.
- The tax basis for corporate tax rates change until 2020. Then it develops normally in DREAM.
- The government interest rate, which is linked to net interest expense, is changed until 2020. After 2020, it is 4.75 percent, which is normal in the DREAM model.
- The government net debt is adjusted so that the government debt in DREAM is consistent with the net debt in the convergence program. The adjustment of the net debt is done due to reassessments, and therefore only mainly takes place in historical years.

## 5 The demographic development

### 5.1 Introduction

DREAM's long-term economic projection from 2014 is based on the population projection from the same year conducted in cooperation with Statistics Denmark.

The Population Projection 2014 is based on the age profile of the population on January 1st, 2014, divided by gender, age and origin as well as the historical demographic movements known at the time. The demographic movements include immigration, emigration, births, deaths and nationality switch in and up to 2013. For each origin group, the development in the number of births by gender, the number of deaths by age and gender and the number of external migration distributed on age and gender is estimated. Furthermore, the number of people switching from foreign to Danish citizenship is also projected. The origin dimension in the long-term economic projection includes Western and non-Western immigrants, their descendants, and the remaining population. A distinction between whether immigrants and descendants have Danish or foreign citizenship is also made in the demographic projection. This distinction is central, as it is used to characterize descendants and to nuance demographic behaviour.<sup>14</sup>

The population's development is projected until 2123, which is the terminal time of the model, and it is crucial to note that there is proper uncertainty associated with such a long projection horizon. The length of the projection horizon is required for the assessment of fiscal sustainability. The development is thus to be interpreted as a continuation of the development to be expected in the medium term based on current trends and assumptions.

The applied assumptions about future births, the development in the mortality rate and the number of emigrants and immigrants are briefly described in the following sub-chapters.

### 5.2 Number of births

The future number of births is estimated on the basis of historical developments in age-dependent fertility rates for women of childbearing age. Historically, the number of births per woman has been significantly higher than it is today and has fallen gradually during the preceding century. Some periods have, however, temporarily deviated from this trend. At the beginning of the 20th Century, fertility rates were about 4 children per woman. By the 1930s

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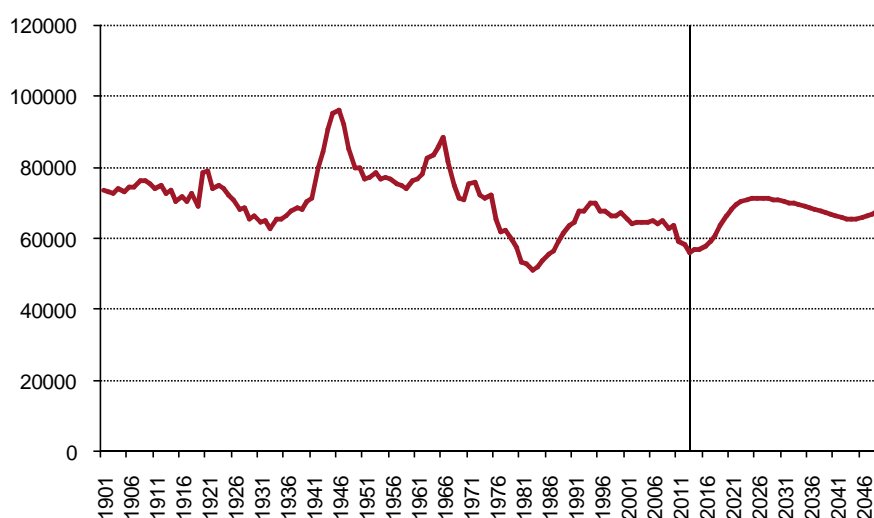
<sup>14</sup> A person is characterized as a descendant if he was born in Denmark by parents, of which none are Danish citizens born in Denmark. If there is no available information on either of the parents and the person is a foreign citizen born in Denmark, he is also regarded as a descendant.

this number had fallen to about 2 children per woman. During the first half of the 1940s total fertility rates again rose briefly to around 3. This increase resulted in a large birth cohort, the members of which are approaching retirement age today. 1946 saw a record number of births (over 96,000). From the end of the 1940s to the mid-60s average fertility rates were 2.5 children per woman. At this point fertility rates started to fall dramatically and continued to do so until 1983, when the birth rate reached 1.38 children per woman. This is the lowest ever fertility rate in Denmark, and children born in this year represent the smallest birth cohort (51,000) over more than 100 years. During the next decade fertility rates began to rise to about 1.8 in 1995, from which fertility rates have fluctuated between 1.7 and 1.9 children per woman. From 2010 to 2013, a decrease in the total fertility rate of 0.2 has been observed, which contributes to an overall decrease in the number of births of about 7,500 in the same period.

Historical fertility developments are key to the developments in the population composition. The large birth cohorts of the 1940s are nearing retirement age. At the same time, the small birth cohorts from the 1980s are entering the job market. In the next 35 years, the birth cohort, who is retiring, will be greater than the birth cohort entering the labour market. Historical developments in fertility rates are, therefore, highly significant contributors to a substantial alteration to the relationship between the number of people of working age and not of working age.

The annual number of births depends partly on the age-specific fertility and partly on the number of women in the childbearing ages. The number of births in the projection is expected to increase so that future birth cohorts are expected to include approximately 70,000 children around the year 2050, see Figure 5.1.

**Figure 5.1 Number of births 1901 – 2050**



*Note: The vertical axis indicates the recent historical year, here 2013.*

*Source: Statistics Denmark and DREAM's population projection 2014.*

By the end of the century, it is anticipated that about 75,000 children will be born per year. This projection thus implies a much smoother development in fertility rates than the historical development during the 20th Century. The development in the number of births is based on an increase in fertility rates from 1.87 in 2010 to 1.9 in 2020, after which fertility decreases slightly and stabilizes at 1.88. Developments in fertility rates are to a great extent determined by developments in fertility among women of Danish origin. From a level of 1.9 in 2010, the fertility rates for this section of the population increase to 1.95 initially before decreasing to 1.9 in the long term.

In the latter years, no significant decreases in fertility among immigrants from non-western countries have been recorded. Therefore, it is expected that fertility rates of immigrant women from non-western countries will be the same as of those of Danish origin. Historically, fertility rates amongst descendants of immigrants from non-western countries have varied widely, and it is anticipated that in the future fertility rates for this segment of the population will also come to resemble those of women of Danish origin. Historically, immigrants and descendants of immigrants from western countries have had lower fertility rates than persons of Danish origin, and it is expected that this will continue to be the case. Fertility rates for the groups in question are expected to converge at 1.75 over time.

### **5.3 Average and remaining life expectancy for 60-year-olds**

The Danish population's average life expectancy has increased significantly throughout the 20th Century. Men's average life expectancy at birth rose 25 years, and women's rose 26.2 years. In 2013, the average life expectancy for men was 78 years and 81.9 years for women<sup>15</sup>. The overall increase in male and female average life expectancy corresponds to an increase of 3.1 months per year<sup>16</sup>.

The Danish growth in average life expectancy is comparable to the average growth in other developed countries. Oeppen & Vaupel (2002) find that the growth in average life expectancy, measured as the growth in the country

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<sup>15</sup> [www.statistikbanken.dk](http://www.statistikbanken.dk): Table HISB8 - Mortality tables for 2012:2013.

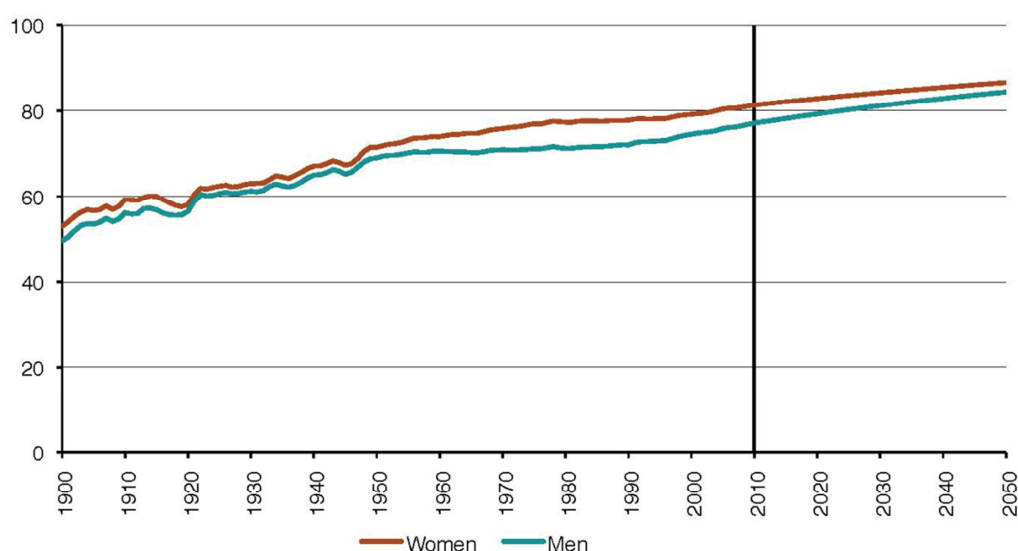
<sup>16</sup> All remaining life expectancy and alterations hereof between two years in the current chapter is based on remaining life expectancy calculated on the basis of mortality rates averaged over time. Life expectancy for year  $x$  is thus based on mortalities in year  $x-1$  and  $x$ . The averaging involved approximates the calculations employed in Statistics Denmark's mortality tables. In connection with the age limits in the retirement system being indexed in accordance with the regulations outlined in the 2006 Welfare Agreement and the Retirement Reform from 2011, it is crucial to ensure that the format used approximates the contents of Statistics Denmark's mortality tables, as the legislative changes are based on these. Given, all else equal, that the remaining life expectancy is increasing over time, the remaining life expectancy based on mortalities for years  $x-1$  and  $x$  would typically be lower than life expectancy calculated solely on the basis of mortalities in year  $x$ .

where the average life expectancy at birth is the highest, has been notably constant measured over the past 160 years. Growth in average life expectancy is estimated to be 3.0 months per year for women and 2.65 per year for men.

Up until 1960, Denmark was among the countries, globally, in which the average life expectancy was highest. Hereafter, the growth in average life expectancy has been significantly lower than in the rest of Western Europe. The growth in average life expectancy from 1960 to 1995 has been 2.4 years for men and 4.2 years for women, this being the equivalent of 0.8 months a year for men and 1.4 months a year for women. From 1995, the average life expectancy growth rates have increased again. The average annual growth between 1995 and 2010 has for men been almost four times greater than between 1960 and 1995 whilst rates for women have doubled.

This historical development leads to a significant degree of uncertainty in regard to the development in average life expectancy. In Population Projection 2014, it is assumed that the development since 1995 is more or less a permanent phenomenon. This assumption is made because a number of other countries in the Western world (including the Nordic countries) experienced similar increases in their average life expectancy from about 1980. In these countries, the same high level of increase in average life expectancy has been maintained to this day, and there is no sign of this trend declining. In the population projection, developments after 1995 are, therefore, given significant weight. The average life expectancy is projected to grow at a lower rate than in the period after 1995, but at a higher rate than the period immediately prior to that, see Figure 5.2.

**Figure 5.2. The development in average life expectancy 1900-2050**

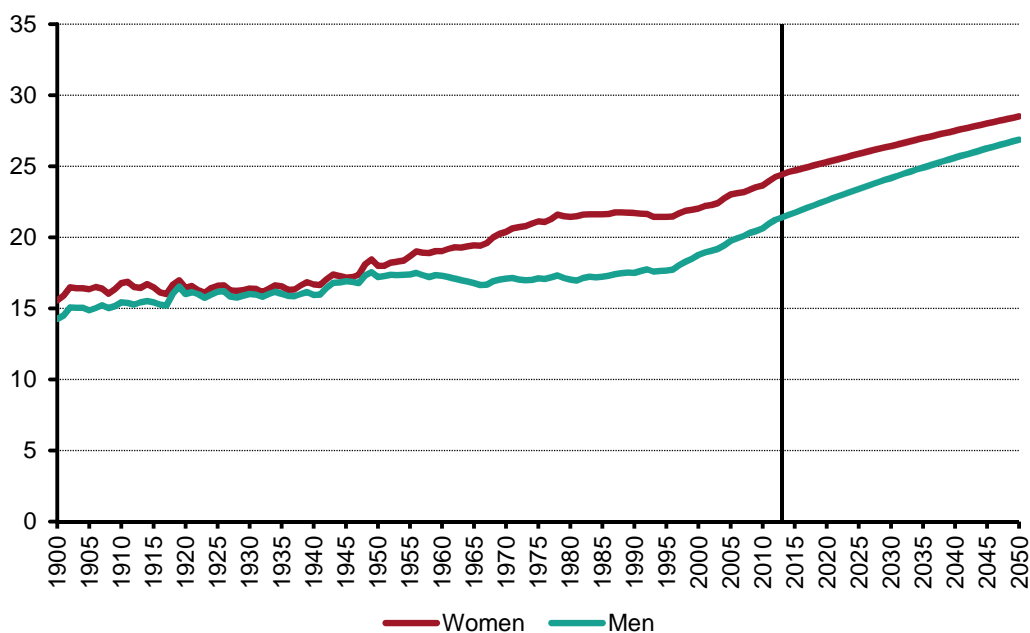


*Note: Note that the remaining life expectancies from year 1900-1990 is calculated using mortality statistics sourced from HMD, compiled using the A-group format. The remaining life expectancy for 1990 onwards is based on data compiled using the B group format. The vertical line shows the most recent year for which data is available, here 2010. The data is averaged over time such that remaining lifetime for year x in the figure is based on mortality rates for year x-1 and year x.*

Source: Demographic Projection 2014, Statistics Denmark, Human Mortality database (HMD) and own calculations.

The projection assumes that there is a gradual increase in the average life expectancy. In 2050, the average life expectancy for men will be 85.4 years, while 87.7 years for women. Up to the end of this century, the average life expectancy for men will increase by 12.7 years and by 10.1 years for women compared to 2013. This entails a halving of absolute growth rates compared to the 20th Century. Seen in the light of Oeppen & Vaupel's (2002) conclusions, which indicate a fixed rate of absolute growth, this represents an extremely cautious projection.

**Figure 5.3. The development in the remaining life expectancy for 60-year-olds, 1900-2050**



Note: Note that the remaining life expectancies from year 1900-1990 is calculated using mortality statistics sourced from HMD, compiled using the A-group format. The remaining life expectancy for 1990 onwards is based on data compiled using the B group format. The vertical line shows the most recent year for which data is available, here 2010. The data is averaged over time such that remaining lifetime for year  $x$  in the figure is based on mortality rates for year  $x-1$  and year  $x$ .

Source: Demographic Projection 2014, Statistics Denmark, Human Mortality database (HMD) and own calculations.

Relative to the development in the 20th Century, a change in the age distribution from the reduction in mortality levels, which also causes the growth in the average life expectancy, can be seen. This is evident when one considers the development in the remaining life expectancy at age 60. During the 20th Century, the remaining life expectancy at age 60 grew by 4.5 years for men and by 6.5 years for women. Since 1995 alone, the remaining life expectancy at



age 60 has grown by 3.8 years for men and 3 years for women<sup>17</sup>. A clear trend is thus evident where increases in the average life expectancy are more and more a result of increases in the remaining life expectancy among the elderly. According to the projection, the remaining life expectancy for a 60-year-old male in 2050 is 26.9 years while it is 28.5 years for women. Up until 2100, the remaining life expectancy for 60-year-olds will since 2013 have increased by 10.1 years for men and 8.3 years for women. This is thus a higher average rate of growth than that observed over the whole of the 20th Century, but still a lower average rate of growth than that observed since 1995, see Figure 5.3.

## 5.4 Migrations

The population projection divides the future population by origin. As mentioned, the origin dimension in the long-term economical projection includes immigrants and their descendants from Western and non-Western countries respectively, and persons of Danish ethnicity, see Box 1. The demographic projection further distinguishes between whether immigrants and descendants have Danish or foreign citizenship. This distinction serves partly to characterize descendants and to nuance demographic behaviour. Although the citizen dimension is disregarded as an aggregation before the long-term economic projection, the classification with the five origin groups includes significant mutual differences in average fertility, immigration and emigration propensity as well as in the average labour market attachment and income level.

Immigration to all origin groups occurs in the demographic projection. This is determined either exogenously or endogenously depending on origin and citizenship type. The exogenous immigration includes immigration to the resident group of Western and non-Western immigrants with foreign citizenship. For the other groups, the extent of immigration is set as a constant proportion of the resident population. The scope of the emigration for all population groups is defined as a constant proportion of the resident population. The total gross immigration to Denmark was 65,306 people in 2013, while emigration was at 36,413 people<sup>18</sup>.

Both the number of immigrants and emigrants annually has grown since the end of WW2. In the period 1945-1960, there was a tendency of the annual

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<sup>17</sup> In comparison, the remaining life expectancy for 60-year-old men by only about 3 years in the period from 1900-1995, while the recent growth of women is found in the 30-year period from 1965-1995. There is thus a significant acceleration in the remaining life expectancy for both men and women.

<sup>18</sup> Migrations for 2013 is calculated by February 1, 2014 and are not adjusted for any delayed reports, see the importance of this in Hansen, M. F & Stephensen, P. (2013). A person is described in the statement as an immigrant if the person is not present at the beginning of the year, not born during the year, but present at the end of the year. A person is considered emigrated if the person was present at the beginning of the year, but absent at the end of the year without being dead. This method of counting is not the total number of border crossings during the year.

emigration being greater than the annual immigration. In this period the number of annual immigrants and emigrants fluctuates between 20,000 and 30,000, but with a systematic tendency of emigration being the higher. From 1960 to the early 1970s, both the immigration and emigration increase to a level between 30,000 and 40,000 people annually, and net migration is close to 0. In the rest of 1970's, a positive net immigration is seen, which is interrupted for a short period from 1980 to 1983. From 1983 and onwards, Denmark has systematically been a country of immigration. Both the annual immigration and emigration has increased in the period from 1983 to 2010. Immigration has grown from just 30,000 people per year to just over 65,000 people per year in 2013<sup>19</sup>. The exodus during the same period increased from just over 20,000 people a year to about 36,000 people.

#### **Box 1. Definition of population groups by origin**

A person is of Danish origin if at least one parent is both a Danish national, born in Denmark.

If the person is not of Danish origin, then that person is an immigrant if the person was born abroad and a descendant if born in Denmark.

Note that this is a pure statistical definition, which ensures that no person can be placed in more than one category, and that all people can be placed in a category. It is a consequence of the definition that persons of Danish origin do not even need to be Danish nationals or to be born in Denmark.

A child of two immigrants will always be characterized as a descendant, if the child is born in Denmark. A grandson of the original immigrants can be characterized either as a descendant or of Danish origin. If grandson's parents constituted by a descendant (the original immigrant's child) and an immigrant, the person will be characterized as of Danish origin, if the parent who is a descendant, is a Danish citizen. If the parent is not a Danish citizen, the child will be characterized as a descendant.

In the analysis, immigrants and their descendants are divided by origin countries. This is done because conditions such as the immigrants' cultural and educational backgrounds have great impact on how they perform in Danish society and thus also for how they affect the welfare society. A relatively rough breakdown is used, where the immigrants' countries of origin are divided into two groups, which must reflect the cultural and educational differences. For this purpose, Statistics Denmark's classification of Western and non-Western countries is used.

In 2002, a change to the immigration policy was introduced. The immediate effect of the change was a lower overall immigration than in 2001. Subsequently, the rule change lead to immigration from non-Western countries temporarily dropping to a level of about 10,000 persons per year. In addition to an increase in the extent of immigration from 2012 to 2013, which to a large ex-

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<sup>19</sup> The war in the former Yugoslavia triggered an extraordinary increase in immigration in 1995, when the number of immigrants was 63,000.

tent should be attributed to the situation in Syria, the non-Western immigration has remained relatively stable in recent years. The projection assumes that the immigration from non-Western countries is largely maintained at a level of about 17,000 people a year.

Immigration from Western countries has been increasing up to the year 2008, although, with a brief decline from 2008 to 2009. Since 2009, the annual Western immigration has increased. The combination of relaxations in the East Agreement<sup>20</sup> and the recent years' economic conditions make it difficult to assess how large a part of the development in recent years might indicate a permanent change in migration propensity. Repeal of the transitional arrangements in East Agreement should in isolation ease the approach to the Danish labour market and increases the likelihood of a further increase in immigration from Eastern European countries. The easing of the transitional arrangements from 2006 and 2007 is, however, directly created by the large demand for labour at the time and thus a sizeable proportion of the increase in immigration since the creation of the agreement is regarded as cyclically dependent. While the net effect of the combination of the recession and the abolition of the transitional arrangements did indeed cause a decrease in migration of approximately 5,000 persons from 2008 and 2009, subsequent immigration from Western countries increased by more than 4,000 people, however. Thus, there is reason to believe that the current immigration extent is somewhat more persistent than assumed in the previous population projections. Conversely, the population trend in the number of Western immigrants also testify that the period from 2006-2009 was quite special and that growth in recent years has now slowed considerably relative thereto. Since the immigration extent remains relatively high, this indicates that emigration propensity also increased relatively compared to the previous historical period. Hence, the gross immigration extent should not be determined without registering the impact on net migration that determines the development of the population.

Because of the combination of the major changes that the legislation has caused and the relatively short time it has worked, it is out of precautionary reasons assumed, that there is no significant change in gross immigration in the future. This means that the annual number of immigrants without Danish citizenship from Western and non-Western countries in the long term is assumed to be constant in the projection. The level is determined by a number of considerations on the legislative and economic conditions as well as on the consistency with the historical development of net immigration. In the short term over a 10-year period a phase-in period occurs from the last three years' average immigration level to the long-term level. This ensures a smooth continuation of the historical development of immigrant populations in the projection period.

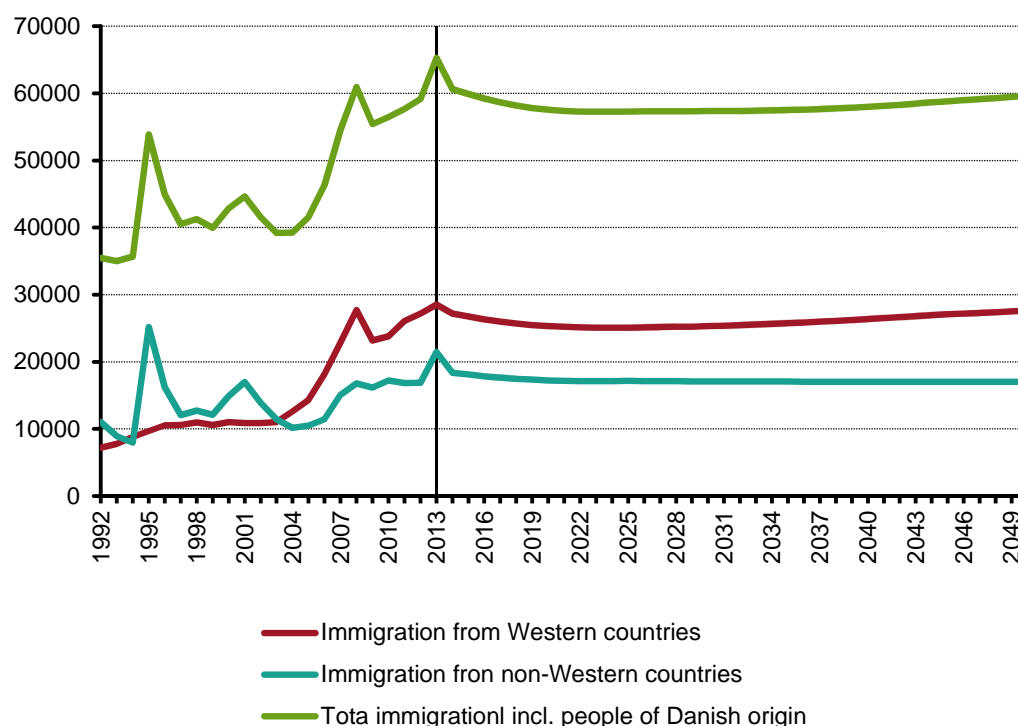
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<sup>20</sup> The East Agreement was a legislation directed at workers from the Eastern European countries adopted in the European Union in 2004, and intended as a way of transitioning these into the Danish labour market.

With the purpose of achieving a future net immigration and thus population growth, which is in line with the recent historical trend, Western immigration in the long term is determined to have an annual size of 24,000 people, while immigration from non-Western countries is assumed to be 14,400 persons per year. As mentioned above this level is achieved after a 10-year phase-in period starting from the last three years' average immigration level. The immigration and its composition by sex and age are determined by the average of the trends for the years 2011-2013 in the respective populations.

For the total immigration from Western countries an initial decline is thus expected, after which the trend of an increasing immigration continues although considerably more moderate than historically observed. The immigration from Western countries decreases from a level of about 28,600 in 2013 to about 25,100 people around the year 2025. This is followed by a gradual increase to about 29,000 persons per year at the end of the projection period. The total gross immigration will from 2014 initially decline from about 60,000 to just over 57,000 people a year later and then increase to a level around 63,000 people, see Figure 5.4.

**Figure 5.4. Gross immigration in Denmark 1992-2050.**



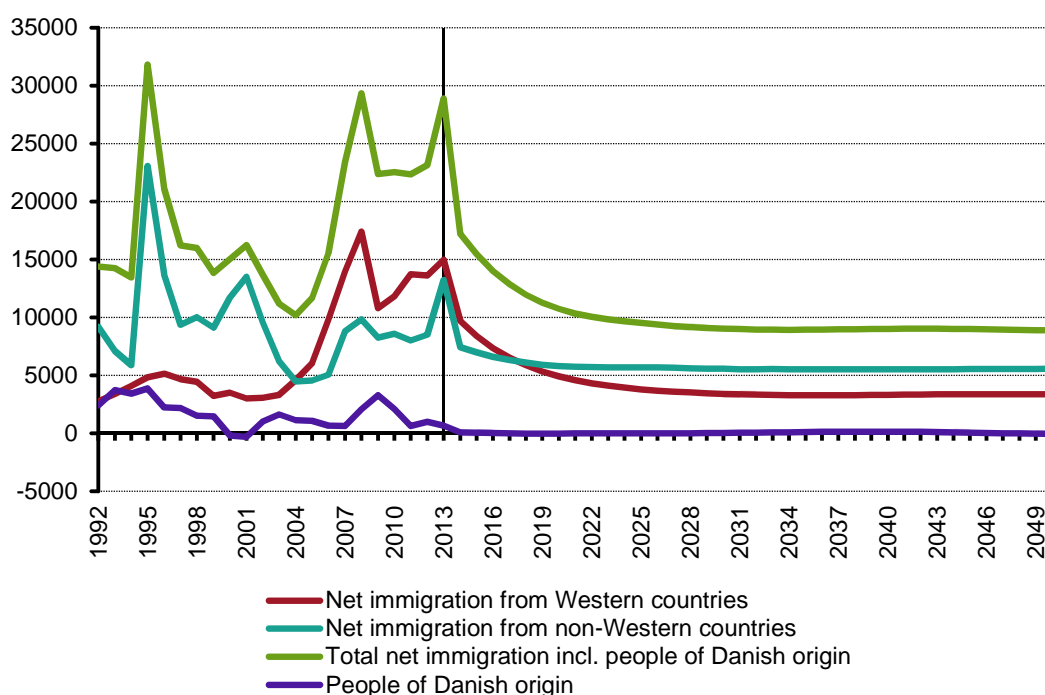
Note: The vertical line indicates the last historical year (2013). Note that historical data are not adjusted for delayed reporting (see the publication "Denmark's future population – Population Projection 2013").

Source: Extract from Person Statistics Database (1992-2013) and Population Projection 2014.

It is assumed that there is a constant age-related emigration rate for each population group determined by their origin. This assumption and the assumed immigration profiles mean that net immigration changed only slowly and with limited strength during the projection period. Net immigration from

non-Western countries decreases from approximately 7,400 to 5,600 people a year during the projection period, while net immigration from Western countries decreases from about 9,700 to about 3,400 persons per year during the projection period. As the net immigration of people of Danish origin is practically zero, the total net immigration decreases from about 17,200 to about 9,000 people annually during the projection period, see Figure 5.5.

**Figure 5.1. Net immigration to Denmark 1992-2050.**



*Note: The vertical line indicates the last historical year (2013). Note that historical data are not adjusted for delayed reporting (see the publication "Denmark's future population – Population Projection 2013").*

*Source: Extract from Person Statistics Database (1992-2013) and Population Projection 2014.*

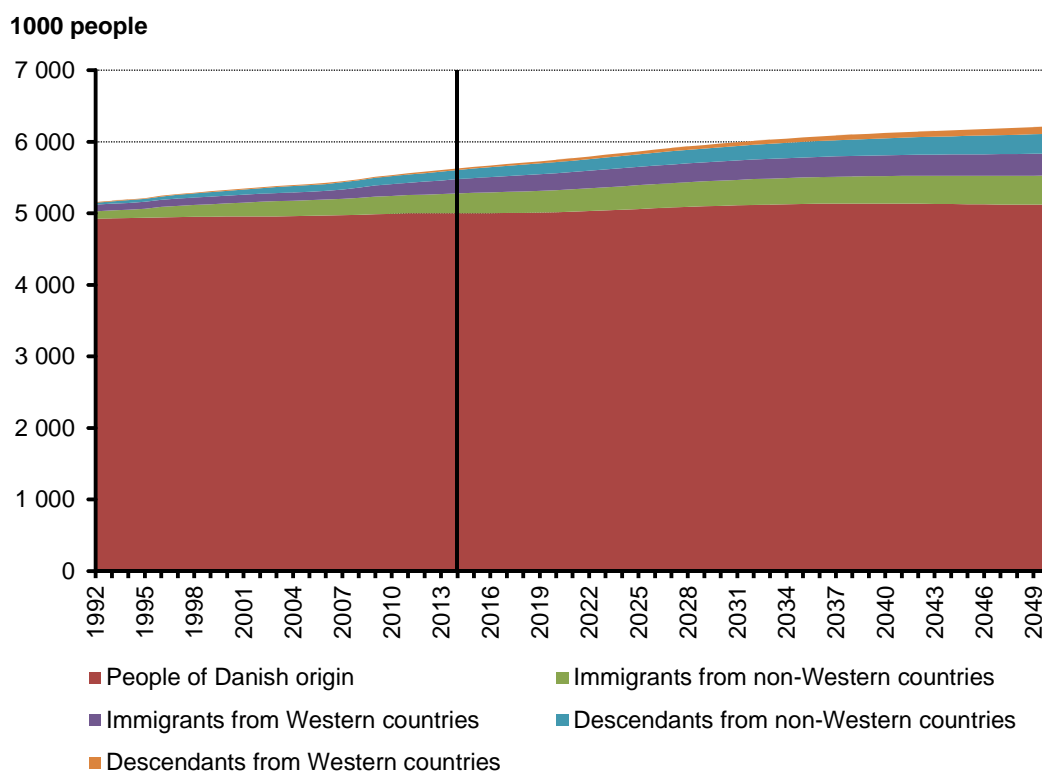
It is difficult to estimate the future trend in immigration and emigration, because it depends not only on the Danish immigration law, but also on foreign immigration rules and the prevalence of war and disasters. Initially, the current migration pattern has been maintained. Thus a future net immigration level is expected to be relatively low. This condition may tend to underestimate the extent of future migrations, because the globalization is expected to contribute to an increasing migration volume. However, it is difficult to assess the impact of globalization on net immigration and the composition of immigration.

## 5.5 The future development in the population composition

Denmark's population has grown from 2.4 million people in 1901 to just over 5.6 million at the beginning of 2014. There has been positive population growth in all years except for a brief period in the early 1980s.

The Population Projection 2014 gives the result that the trend of population growth continues - albeit at a slower pace - through the 21st century. In the middle of the century, the population is expected to reach a level of 6.1 million people, which with the applied assumptions is expected to increase to 7.1 million at the end of the century. After a short initial decline an increasing annual growth in population is expected until around the year 2025, when the population reaches almost 5.9 million people. Subsequently, the annual increment in the population decreases gradually until 2045, after which the annual growth again increases, see Figure 5.6.

**Figure 5.2. The development in the overall population divided by origin, primo 1992-2050.**



Note: The vertical line indicates the last historical year (2014).

Source: Extract from Person Statistics Database (1992-2013) and Population Projection 2014.

The proportion of immigrants and descendants and their distribution across countries of origin are important to the economy and public finances, as the average labour participation for particularly immigrants from non-Western countries is lower than for other population groups. An increasing proportion of the population in this group will therefore result in a lower average labour participation and a growing average net public expenditure. There are in particular two circumstances in the future population development and - composition, which are important for the growth of the labour force and for the public finances. One relates to the mutual balance between the number of immigrants, descendants and persons of Danish origin, while the other concerns

the distribution between individuals inside and outside of the active working age.

### **5.5.1 Distribution by country of origin**

By 1 January 2014, resident immigrants and their descendants made up a total of 11.1 percent of the total population. This proportion increases gradually until 2080, after which the share stabilizes at around 20 percent. The growth in the proportion of immigrants and descendants are decreasing over time so that the proportion until 2050 has grown by 6.5 percentage points, while it only grows by 2.3 percentage points the following 40 years.

If only immigrants and descendants from non-Western countries alone was to be considered, these populations combined would make up 7.2 percent of the population in 2014. These population groups' share of the total population is growing until about year 2080, where they jointly make up about 11.8 percent of the population. Hereafter this share will slightly decline. The share of immigrants from non-Western countries is peaking in 2055, while the share of immigrants from non-Western countries is peaking in 2085. Both population groups' share of the total population then declines.

### **5.5.2 Age distribution**

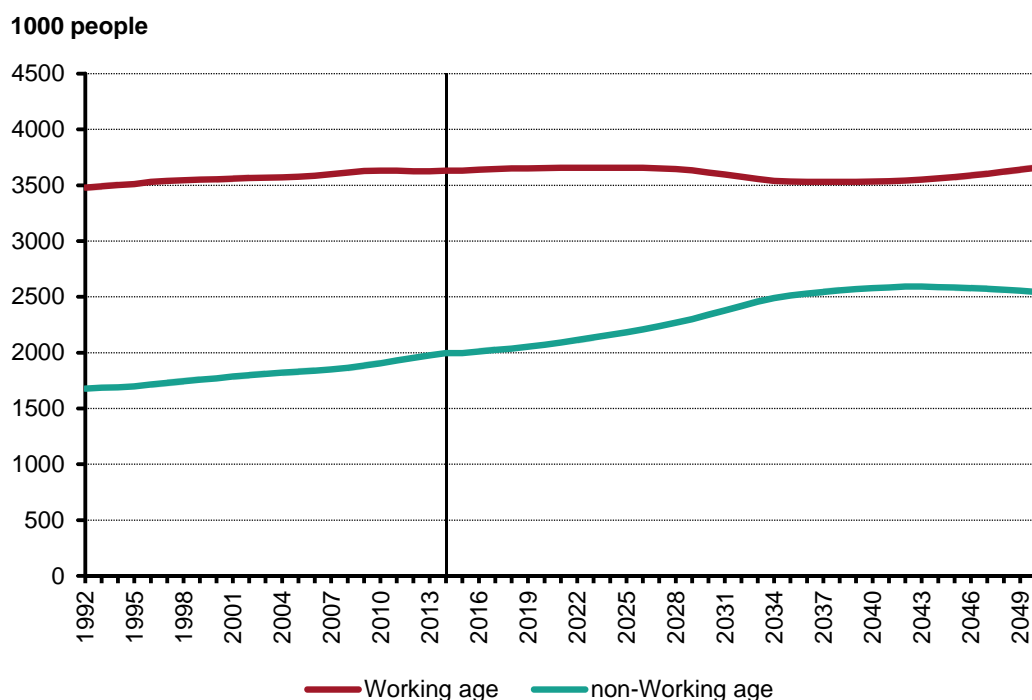
Over the past hundred years, people of working age, which we here define as people between 15 and 64 years, have constantly increased in size. At the beginning of 1900 there were almost 1½ million people of the working age, while in 2000 there were just about 3½ million. Thus, there are currently more than twice as many parents or breadwinners as a hundred years ago.

A relatively stable level for the number of families is expected up until 2030, when the number of people of the working age is expected to be around 3.6 million. Subsequently, a temporary decrease of approximately 100,000 is expected by the year 2040, see Figure 5.7. In the period after 2040, the number of people of the working age is increasing until the projection's end. To the extent that the working age population has expanded in the period – among other things due to the increasing life expectancy, which increases the earliest possible retirement age - the development of the number of people of working age may be strengthened. In the year 2014, the 15-64 year olds represent about 65 percent of the population, while the share in 2050 and towards projection's end is 59 percent and 56 percent respectively.

During the 20th century, there has been an increase in the number of children and the elderly, i.e. persons outside the working age. By 1900, there were about 1 million children and elderly, which have risen to approximately 2 million in the year 2014. This means more people in age groups that typically need support. This trend is expected to continue in the coming years, such that there are almost 2.6 million children and elderly in 2040, see Figure 5.7.

A temporary decrease in the number of people in these age groups is then expected, but already around 2055, the number of people increases again. By 2100, the number of people outside the economically active population has grown to 3.1 million.

**Figure 5.3. Number of people in and outside the working age, 1992-2050.**



Note: The vertical line indicates the last historical year (2014).

Source: Extract from Person Statistics Database (1992-2013), own calculations and Population Projection 2014.

The main reason that the number of people outside the working age has increased is due to far more elderly people, while the number of children - with the exception of a short period from 1940 - has not increased. Thus, the number of people over 64 years has increased from roughly 200,000 in 1900 to about 1 million at the entrance to 2014. This trend is expected to continue in the coming years so that the number of elderly will peak around 2045 with 1.5 million people, see Figure 5.8. This means that in about 30 years it is estimated that there will be approximately ½ million more elderly than today. In the period 2045-2055, the number of elderly decreases a bit, but is then increasing. In 2100, the number of people older than 64 years has grown to just over 1.9 million people.

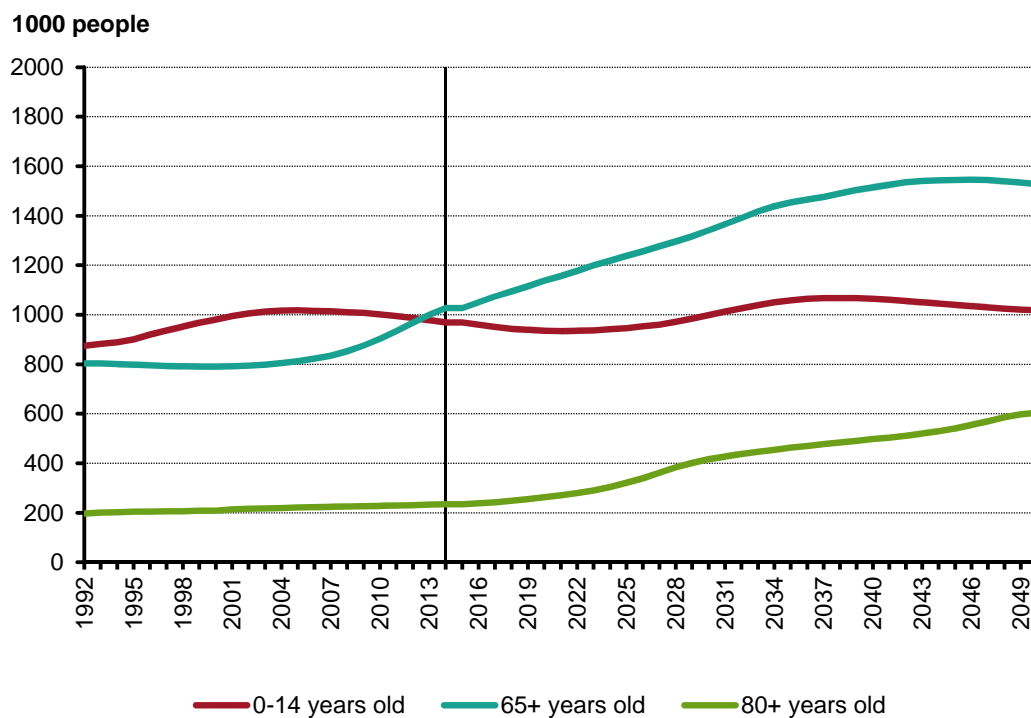
This development means that while people over 64 years in 2014 represents 18.2 percent of the population, the share will grow to 25 percent by 2045, where it peaks temporarily. By 2100, people over 64 years represents 27.4 percent of the population. The number of people under 15 years is expected to vary on a rising trend during the projection. Up to 2020, the number thus



decreases from about 970,000 to 940,000, followed by a gradual increase to a level of approximately 1.1 million in 2040. Subsequently, the development towards the end of the century is still characterized by alternating decreases and increases in the population under 15 years old.

Over the next 20 years, it is estimated that the number of people aged 80 and over will double from about 235,000 to 470,000 thousand people, see Figure 5.8. The growth in the number of people aged 80 years and older continues to increase - but not monotonously - and the number represents about 600,000 and about 800,000 people in 2050 and 2100 respectively. This increase is especially interesting because public consumption per person is significantly higher for the latter than for the other age groups.

**Figure 5.4. Number of persons 15 years and over 65 and 80 years respectively, 1992-2050.**



Note: The vertical line indicates the last historical year (2014).

Source: Extract from Person Statistics Database (1992-2013), own calculations and Population Projection 2014.

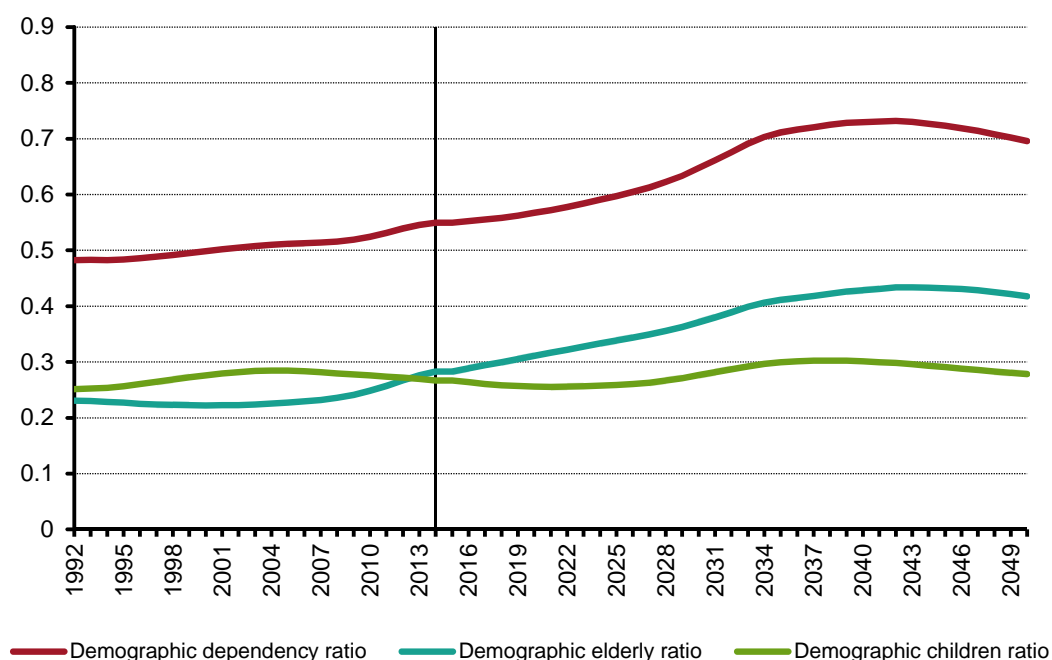
In relation to the future financing of the welfare state, the development of the relationship between the different age groups in the population is of the essence. The ratio between the different age groups in the population is often measured by the development in the demographic dependency ratio, which put the number of children and the elderly in relation to the number of people of the working age. The target can be considered as a rough estimate of the number of people who need support, divided by the number of potential parents or breadwinners. The sharp increase over the last hundred years in the

number of people of the working age has meant a decline in the demographic dependency ratio.

*The demographic dependency ratio* is defined as the sum of the number of persons aged 0-14 years and the number of persons aged 65 or older, divided by the number of people aged 15-64.

Measured by this definition, it takes almost four of working age to support two people outside the working age today. In the future, fewer people of working age and more outside of working age are expected. This means that, around 2040, it is expected to take four people in the working age to support about three people not in the working age, see Figure 5.9. From 2040, the dependency ratio increases to nearly 0.8 towards the end of the century, hence four people in the working age have to support more than three people.

**Figure 5.5. Demographic quotas, 1992-2050.**



Note: The vertical line indicates the last historical year (2014).

Source: Extract from Person Statistics Database (1992-2013), own calculations and Population Projection 2014.

The composition of people outside of the working age is markedly different than by the beginning of the 20th century. This is seen by splitting the demographic dependency ratio into a demographic children ratio and a demographic elderly ratio respectively.

*The demographic children ratio* is defined as the number of people aged 0-14 divided by the number of people aged 15 to 64 years.

*The demographic elderly ratio* is defined as the number of people aged 65 years and older divided by the number of people aged 15 to 64 years.

During the 20th century, the number of children has remained fairly constant, while there are more people in the working age. Thus, in 1900 about 0.6 children per parent or breadwinner, which today has fallen to just under half. The projection maintains this level, so that the children ratio is stabilized around 0.3, see Figure 5.9.

Conversely, the number of elderly has through the 20th century grown considerably more than the number of people of the working age. At the beginning of the century, there were 0.1 elderly per person aged 15 to 64 years. In 2014, there are nearly three times as many elderly per active in the working age. Up until 2040, the demographic elderly ratio is expected to reach a level of approximately 0.4. After a temporary decline in the demographic elderly ratio, it will increase again in the second half of the century, approaching 0.5 toward the end.

The change in the composition of the demographic dependency ratio – from mainly covering the support of children in the early 20th century to about an equal distribution of children and elderly today to primarily supporting the elderly - impacts the public finances. This is because public expenditure for a person of 65 years or more - with the current expenditure composition - is significantly higher than the cost of a child.

The basis for the long-term economic projection is therefore a population development that involves an increased tendency to an aging of the population and a tendency to a reduced change in the composition of the population of origin.

## **5.6 Comparison with the Population Projection 2013**

Generally, the comparison below primarily focuses on differences in overall flows and stocks between the population projections used for the long-term economic projections in 2013 and 2014 respectively<sup>21</sup>.

In 2050 and 2100, the total population has increased by approximately 75,000 and 135,000 people relatively according to the Population Projection 2013. This increase is primarily attributable to a consistent increase in net immigration, but is also due in part to the excess of births in the long term being higher than in the previous population projections. Due to a continued decline in period fertility between 2012 and 2013, it is assumed in the projection that fertility in the short term is lower in Population Projection 2014 than in the 2013 projection. After 2020, the period fertility will briefly be above last year's level for the long term to coincide with this. This qualitative pattern applies to all origin groups and is in addition to the continued decline in the historic fertility also grounded in that the cohort fertility in the projection is restricted. The restriction ensures that this does not fall below the level of the long-term level of

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<sup>21</sup> A more detailed discussion of the differences in Population 2013 and Population 2014 can be found in the forthcoming Hansen & Stephensen (2014).

1.88 minus the historical variation in fertility for the cohort that today have lived through their fertile age. A stable cohort fertility will therefore give rise to the initial decrease in the period fertility offset by a subsequent increase. The difference in the number of births varies in projection annually between approximately -400 Initially and about 1,500 people in the long term.

Relative to last year's projection, a marginally fewer number of deaths is noted up to about 2030, after which the number of deaths gradually exceeds the number from the 2013 projection. The primary reason for the long-term difference is to be found in the altered levels of the net immigration. Although both sexes may be recorded with smaller increases in the development of life expectancy relative to earlier, the number of deaths in the long term is relatively robust to the difference in the underlying projections in death probabilities, thus this will primarily explain the difference in projection's first year.

The increase in the net immigration is mainly due to an upward revision of the estimate for the exogenous influx of immigrants without Danish citizenship relative to the 2013 projection. The upgrade is motivated by the desire for a future net immigration, which do not differ significantly from what can be observed historically. In DREAM's population projection from 2013, the extent of the exogenous immigration in the long term was fixed at 35,000 people annually. Of this amount, immigration from Western countries made up 22,000 people. In the Population Projection 2014, the exogenous immigration is fixed at 38,400 people annually, of which 24,000 come from Western countries. The increase in exogenous immigration is supplemented by a smaller increase in immigration to the descendant groups, why the total annual gross immigration is approximately 4,000 people more than in the 2013 projection.

The increased immigration is offset by a higher emigration. Initially, the emigration Population Projection 2014 is about 500 persons higher than before, which grows to about 3,300 people in the long term. The progress in immigration and emigration respectively give rise to that the net immigration initially is about 4,000 people higher than before, which can be reduced to approximately 700 people towards the projection's end.

The development in the composition of origin does not vary much between the two projections. The share of people of Danish origin has decreased slightly at the expense of other population groups. The population's age composition is also fairly robust between the two projections, but parent, children and elderly quotas will ultimately be marginally lower due to the increased immigration.

## 6 The education model

### 6.1 Introduction

DREAM's education model provides a long-term projection of the education level in Denmark based on DREAM's population projection and observed educational behaviour. The model provides a detailed vision of how many applications there are likely to be for different kinds of educations in the future and how the number of graduates from each type of education can be expected to develop in the future.

The education model has been developed to provide a breakdown of DREAM's population projection and is an integral part of the DREAM projections. The population projection describes the total population by age, sex and origin. This serves as input to the education model, which further divides the population into 12 categories for highest completed and any on-going education. The result of the education model's projection is used in DREAM's population accounts to determine the population's labour market attachment.

DREAM's education model differs from the previously used model by methodically relying on micro-simulation<sup>22</sup>. This means that the model simulates individuals' educational behaviour to give a comprehensive picture of the level of education.

The model is based on transition probabilities calculated from registry data and therefore projects the level of education by using the study-related behaviour, as seen as a tendency historically. This makes the model good at warning of future phenomena that can be justified in the present students' behaviour or any phenomena that have to do with the future composition of the population<sup>23</sup>.

### 6.2 The model

As described in chapter 5, the DREAM population projection projects the Danish population divided by sex, year of birth, origin, year of death/ emigration and possible year of immigration. This information serves as input to DREAM's education model. The education model divides the population further up based on 12 education categories.

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<sup>22</sup> For a more detailed discussion of the changes in the transition to a micro-simulation model, see DREAM's Education Projection 2012, <http://www.dreammodel.dk/pdf/Uddannelsesfremskrivning2012.pdf>.

<sup>23</sup> For a more detailed discussion of the changes in the transition to a micro-simulation model, see DREAM's Education Projection 2013, <http://www.dreammodel.dk/pdf/Uddannelsesfremskrivning2013.pdf>.

The 12 education categories are equivalent to UNI•Cs main divisions where to the category "Unknown" is added. See Table 6.1 for an overview. Educational attainment unknown is assigned to preschool children and immigrants whose education level is not known or cannot be translated to the Danish education system.

**Table 6.1. Overview of types of education**

<b>Education</b>	<b>Possible grouping</b>
Ph.D.	
Partial university candidate	Long-cycle higher education
Complete university candidate	
University bachelor	
Medium-cycle higher education	Higher education
Professional bachelor	
Short-cycle higher education	
Vocational training	
Secondary school (business)	Upper secondary education
Secondary school (preparatory)	
10th grade	
Primary school	
Unknown	

The Ph.D. and graduate programs are designated as long-cycle higher education. Complete graduate programs hardly exist anymore, but there are many people who have previously been granted such. The term university candidate is used here in the sense of complete and partial graduate programs combined. The higher education includes short-cycle higher education, professional bachelors, medium-cycle higher education and university bachelors. The secondary and vocational training is referred to as upper secondary education.

The education level is typically measured from the concept of "highest completed education". This means that you rank all different programs on a scale corresponding to the sequence in Table 6.1, where the top ranked education is placed on top. That of a person's completed education which ranks the highest on this scale is decisive for the person's "level". If, for example, you only have completed some but not all of your higher education, this will not count in your favour no matter how far you have reached.

### **6.2.1 Micro-simulation**

Micro Simulation models are a type of models in which behaviour is simulated at the micro level. In the DREAM education model, individuals' educational behaviour is simulated to be used in a projection of the level of education in

Denmark. DREAM's micro simulation education model was introduced in DREAM Education Projections 2012.

DREAM's education model is a dynamic micro-simulation model, in the sense that each person's education status is updated every year. The person's educational history and condition is important for subsequent educational choices<sup>24</sup>.

The model is built around time units within a year. Basically, the individuals in the model do not interact with each other; each person makes his choice of education independently of the rest of the population.

For every living individual and for each of the future individuals the population projection operates with, an individual is created in the education model. At the start of the simulation, there is thus approximately 5.5 million individuals in the education model. The characters' demographic characteristics and their emigration or death date as well as future immigration and future births are determined by the population projection.

Each individual has a number of demographic characteristics: gender, origin and year of birth plus the individuals' date of emigration/time of death, which as mentioned are estimated outside the education model. The characteristics sex, origin and year of birth are all relevant to how the individual acts in the simulation, while date of emigration/time of death alone determine how long the individual lives in the model. It is assumed that the choice of education does not affect the fertility and death rates, and vice versa.

In addition to the demographic characteristics, each individual in the model has an educational history and condition, which is updated as that individual starts, finishes, continues or waives an education or study. The individual's educational status is described by one of the following three variables:

- *Highest completed education*, which is the highest-ranking education the individual has completed. This is independent of the individual's present study and not necessarily the most recently completed training.
- *Present education* indicates which education the individual is studying in the current year. If the individual is not enlisted in an educational program, but for example is out on the labour market, the present study is set to "not in education".
- *Number of years in current education* indicates the number of years since the individual started the current education. This should not be confused with the number of completed years of education.

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<sup>24</sup> The importance of the educational history is limited to last year's educational status, the number of years a person has been studying and the person's highest completed educational level.

The individuals' educational choices are determined each year based on a number of transition probabilities, which are constructed based on the latest year's observed education behaviour in Denmark. These data are retrieved from Statistics Denmark's register data. Which transition probabilities are used depends on the individual's demographic characteristics and current education status. In a later section, the structure of the transition probabilities is described closer.

## 6.2.2 Movement through the model

The total population movements through the educational system can be illustrated by considering the transitions between the different types of education.

In Table 6.2, it is stated how large a proportion of all students in a given type of education that - regardless of demographic characteristics and educational status - after completion of said education (completion or dropout) continue on each of the other types of education. For example, it can be seen that 49 percent of all primary school students immediately after graduation (or waiver) continue in the 10th grade, while 25 percent go on to a preparatory secondary school and 10 percent take one or more sabbatical year(s).

Table 6.3 shows the development of the highest completed education. The percentages in each cell indicate the proportion of individuals with the horizontally given education as highest completed, which during the simulation completes a higher ranked education. From the table, it can be seen that 28 percent of all people who continue studying after primary school complete a preparatory secondary school. 94 percent continue to study after a general secondary education and of these, 44 percent complete a university bachelor's degree. The highest level of education operated with is the PhD program. If you have a graduate degree and continue to study, you will only be able to rise to the level of Ph.D. That is why 100 percent is denoted in the cell at the bottom right. 10 percent of those with a university candidate achieve a Ph.D. at one point.

In the diagonal (grey) fields in Table 6.3, the development since last year's projections is indicated in percentage points. For people with vocational upper secondary background, it is seen that in this year's projection, 91 percent is expected to continue to study. In last year's projection, the corresponding expectation was that 86 percent would later begin a higher ranked education. Based on the latest educational figures, it is expected that more people continue to study after completing a secondary education, short-term and higher education. Slightly fewer university bachelors are expected to complete a university candidate and fewer graduates are expected to take a Ph.D.



**Table 6.2. Transition between current educations.**

<i>Percent</i>	Primary school	10th grade	Secondary school (preparatory)	Secondary school (business)	Vocational	Short-cycle higher education	Professions-bachelor	Medium-cycle higher education	University-bachelor	University candidate	Ph. D.	Not in education
Primary school		49	25	9	7	0	0	0	0	0	0	10
10th grade	0		41	15	24	0	0	0	0	0	0	19
Secondary school (preparatory)	0	0		2	5	2	6	0	9	0	0	77
Secondary school (business)	0	0	6		10	6	8	0	13	0	0	57
Vocational	0	0	3	2		2	2	0	1	0	0	89
Short-cycle higher education	0	0	0	0	6		23	0	6	1	0	63
Professional-bachelor	0	0	0	0	3	2		0	3	8	0	83
Medium-cycle higher education	0	0	0	0	0	1	9		8	8	0	74
University-bachelor	0	0	0	0	2	3	6	0		62	0	27
University candidate	0	0	0	0	0	0	0	0	3		4	92
Ph.D.	0	0	0	0	0	0	0	0	0	7		92
Not in education	1	1	6	1	35	7	19	1	20	6	3	

*Note: The table shows the observed transition probabilities from one state (vertically) to another (horizontal). The percentage corresponds to the proportion of individuals who go from starting an education specified in the row to be undergoing an education specified in the column. No distinction is made between dropout and completion of a current education, and that is abstracted from the number of years a student is under way. The figures are calculated on the basis of all individuals' modelled behaviour throughout the simulation period. Transition to primary school at start of school is excluded. Each row in the table adds up to 100, which due to rounding not necessarily apply in the table.*

*Source: DREAM's education projection 2013*

**Table 6.3. Transition between highest completed educations.**

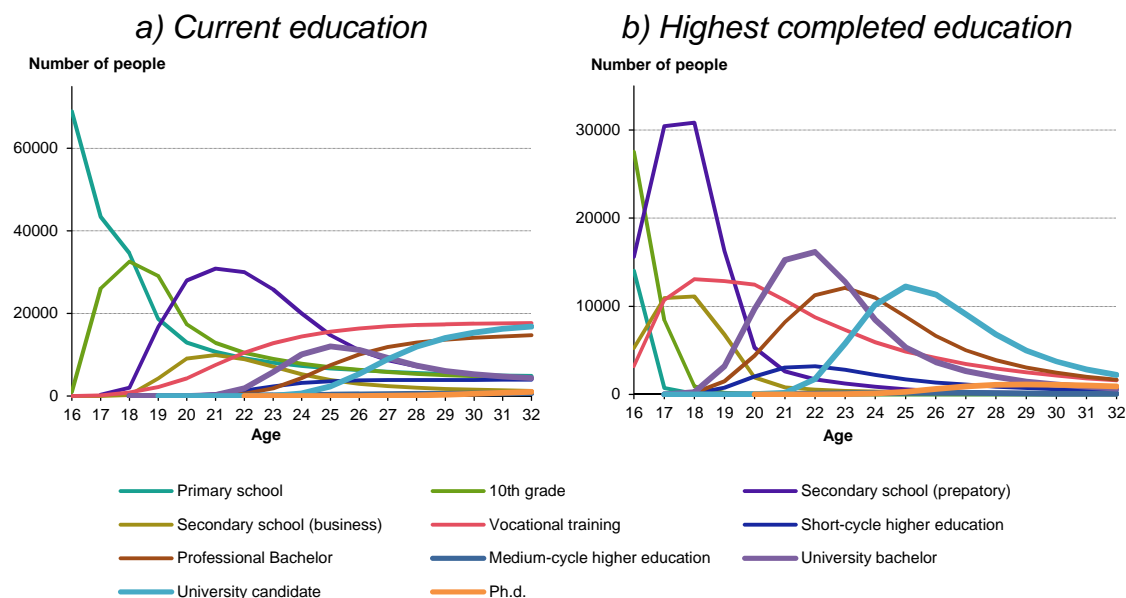
	Primary school	10th grade	Secondary school (preparatory)	Secondary school (business)	Vocational	Short-cycle higher education	Professional-bachelor	Medium-cycle higher education	University-bachelor	University candidate	Ph.D.
Unknown	3	2	1	1	29	13	10	0	12	22	6
Primary school	95 (+1)	50	28	9	11	0	1	0	0	0	0
10th grade		89 (-1)	49	16	30	1	3	0	1	0	0
Secondary school (preparatory)			94 (+2)	0	11	10	33	1	44	2	0
Secondary school (business)				91 (+5)	21	20	24	0	33	2	0
Vocational					22 (+2)	28	57	0	10	5	1
Short-cycle higher education						43 (+5)	72	1	20	7	0
Professional-bachelor							19 (+2)	4	9	86	1
Medium-cycle higher education								41 (-1)	13	81	6
University-bachelor									82 (-4)	99	1
University candidate										10 (-3)	100

*Note: The table shows the observed transition probabilities from one state (vertically) to another (horizontal). The percentage corresponds to the proportion of individuals who goes from having a level of education as indicated in line to achieve the level indicated in the column. Each row in the table adds up to 100, apart from the grey fields. Due to rounding, the table's row total may however differ. The cells in the left part of the table are empty because it is not possible to "upgrade" to a lower level of education. The numbers in the diagonal grey boxes indicate the proportion of those who have completed the education to later upgrade their education level. The figures in brackets indicate the development since last year's projection. The figures are calculated on the basis of all individuals' modelled behaviour throughout the simulation period.*

*Source: DREAM's education projection 2013.*

In order to get a more detailed impression of the population's movement through the education system, one can take the cohort of people who in 2013 is 16 years old, i.e. just about to leave primary school and look at their future status in relation to current and highest completed education.

**Figure 6.1. Current and highest completed education for a cohort of individuals born in 1997.**



*Note: Individuals not taking an education are omitted from the left figure. In the right figure, individuals with unknown highest completed education are not included. Age 16 corresponds to the year 2013, 17 to year 2014, and so on.*

*Source: DREAM's education projection 2013.*

In Figure 6.1a, you see how 10th grade is almost exclusively for the 16-17 year olds, while preparatory secondary school and vocational training top for the 17-18 year olds. Vocational courses have a much greater age spread, but also comes relatively early in the life cycle. Later in the individuals' lives, i.e. after secondary education, the short-cycle higher education becomes popular, a great deal enrolls as professional bachelors, while the enrolment on medium-cycle education is modest. University bachelors and University candidates are displaced in terms of age, as the prior usually forms the basis for the latter. Finally, a Ph.D. is completed rather late in the life cycle, namely after completing a graduate degree.

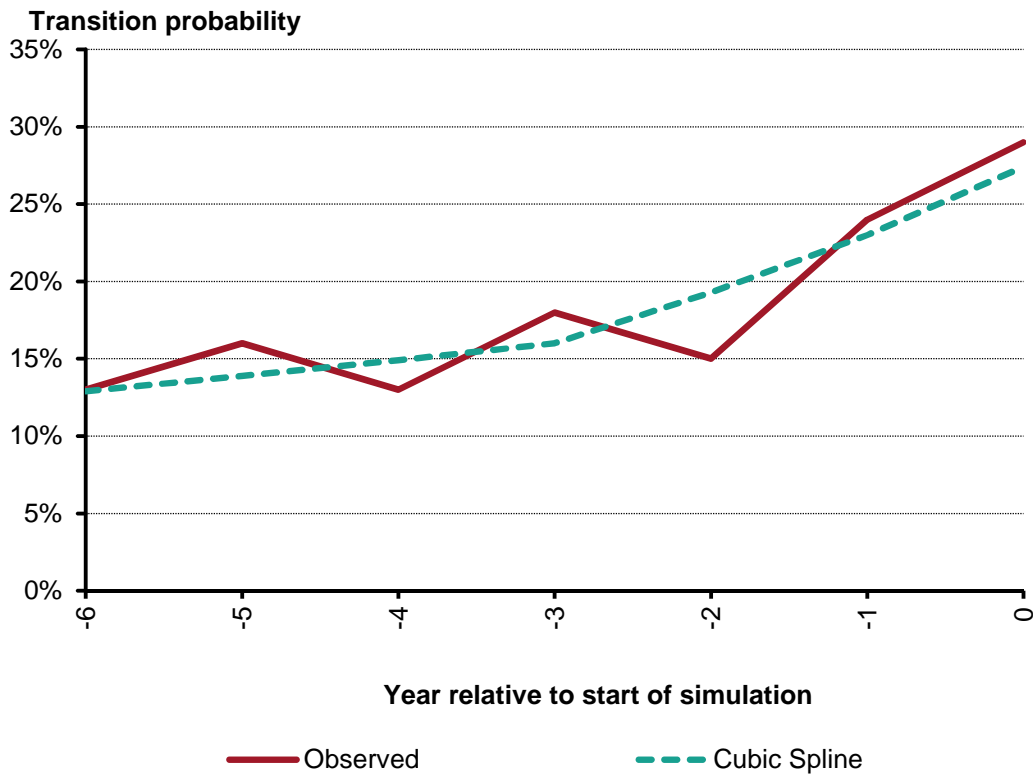
In Figure 6.1b, one can see that the level of education is already levelling out, when you reach 32 years. Most in this age group are vocationally trained, closely followed by graduates and bachelors. Of the blue line you can see that according to the model, there is a group of people who never get more than a primary education.

### 6.2.3 Calculation of the transition probabilities

The probabilities for an individual with given demographic characteristics and given training status starting, waiving, continuing or completing an education is central to the education model.

The transition probabilities are determined on registry data, combined with a method to clean the noise and ensuring that the probabilities are based on a sufficiently large group.

Figure 6.2. Noise cleaning the transition probabilities.



Note: Transition probabilities are noise cleaned using cubic spline with cross-validation. The noise cleaning is based on data for the 10 years before the simulation starts.

Source: Own calculations.

The noise cleaning of the transition probabilities is carried out by using cubic spline with cross-validation. A smooth curve is drawn between the last 10 years of transition probabilities, and the method chosen ensures that the latest data years are given particular emphasis. Figure 6.2 illustrates the noise cleaning of a transition probability.

All transition probabilities to determine what education an individual will possibly be starting the following year are noise cleaned. The transition probabilities that describe whether an individual completes, withdraws or continues on

an on-going education are calculated as an average over the last three data years.

#### 6.2.4 Grouping of transition probabilities

For the purpose of the education model, a long series of observations are collected to describe the probability of whether an individual completes his/her education. The observations are linked to a number of characteristics such as gender, age, origin, current education, duration of education and highest completed education. The combinations of possible outcomes of each of these characteristics are numerous. For some combinations, there are no data (for example, 16-year-old girls with Danish origin and professional background, studying at a higher education in the fourth year). For other combinations, the data is very thin with a single or very few observations. To avoid basing the probabilities used in the model on too thin a database, it is desirable to group observations across the underlying characteristics in such a way that the variation in behaviour within each group of observations is minimized and the difference in behaviour between each group of observations is maximized. CTREE's ("conditional inference tree") is used in the education model for this purpose.

CTREE refers to a type of binary decision trees, which are characterized by being able to group a large amount of observations from a number of background variables. The CTREE-implementation used in the model splits the total group of observations in two such that the behaviour of the two resulting groups differs as much as possible from each other. The split is selected based on a statistical test<sup>25</sup>. The split is continued recursively on the two resulting groups of observations until there are no longer any possible splits left to which, the difference in the behaviour of the two groups is statistically significant. The split will also stop if the group of observations is less than a predetermined minimum threshold<sup>26</sup>. The groups obtained by the last split are referred to as terminal groups.

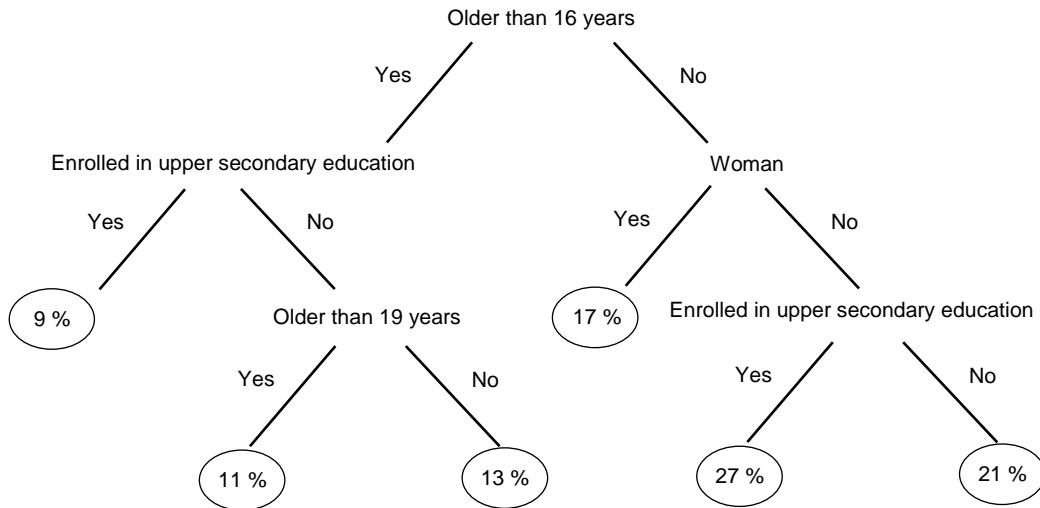
Figure 6.3 shows an example of a complete structured CTREE. The example is fictitious, but can be used to illustrate how various characteristics determine which probability an individual in the model is attached to. Of the tree can be read that the probability that an individual of more than 16 years has started an upper secondary education and completes this education is 9 percent. Similarly, the probability associated with a male younger than 17 who is enrolled on an upper secondary education is 27 percent. The figures are fictitious.

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<sup>25</sup> The applied statistics test is  $X^2$ -test with Bonferroni correction. P-value is 0.05.

<sup>26</sup> In the education model, a stop criterion of 20 observations is typically as a limit to when a group needs to be split further. In addition, a minimum group size of seven observations is applied.

**Figure 6.3. Example of the structure of a CTREE.**



*Note: The figure shows an example of the structure of a CTREE.*

*Source: Own creation.*

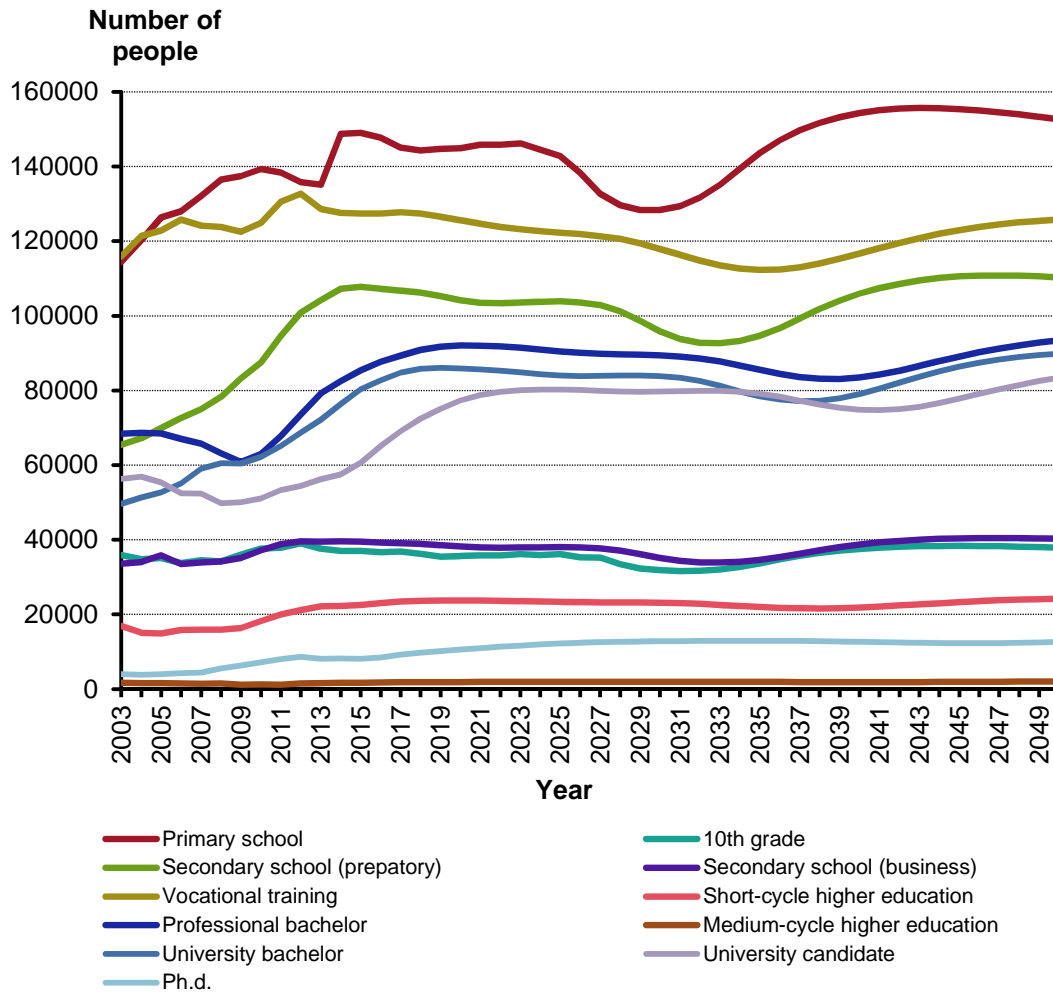
In the education model, the following four groups of transition probabilities are processed using CTREES: 1. Students' probability to complete their education, 2. Students' probability to continue or drop out of their education and their possible future education status, 3. Non-students' probability to begin an education including which education and 4. finishing students' probability to begin a new education and if so which one.

The structure of the tree is based on the CTREE algorithm. A core feature of the algorithm is the use of statistical tests to determine whether, and if so how, the population must be split up. A full CTREE from the model is based on four to six determining variables. In some cases, the tree is based on several million observations. You can read more about DREAM's use of CTREES in Hansen et al (2013) as well as in Rasmussen et al (2013).

### **6.3 Description of the latest projection**

Below, a general description of the results of the latest education projection is displayed, i.e. the projection which is based on DREAM's 2013 population projection and education behaviour up to and including October 2012.

Figure 6.4. Historical and projected current educations.



Note: This is simulated figures for 2014 and onwards. It should be mentioned that primary school only includes 8th and 9th grades in this figure.

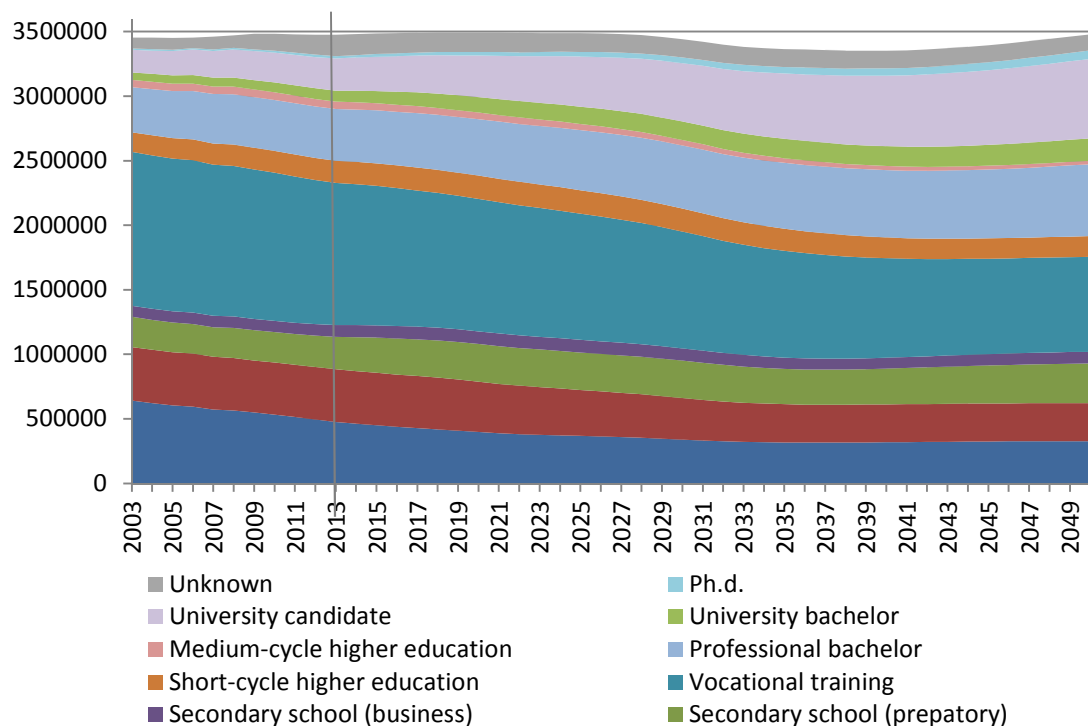
Source: DREAM's education model 2013.

Demographics play a major role in relation to the number of pupils in primary school. In the projection, i.e. from 2014 and onwards, it is seen that on the higher education besides demographic effects there is a tendency for the increase in the number of students to grow a number of years, after which the effects are deflected, see Figure 6.4. For the partial university candidate, this can be explained by the fact that in recent years there has been an increase in the number of high school students. A large portion of the preparatory secondary school students is expected to continue as university bachelors, to then apply for admission to the Master's program. The increase in the number of students is thus shifted to the education, typically in tandem.

Figure 6.5 shows the model's projection of highest completed education for 17-64 year olds. Given an unchanged retirement age, this age range may be considered as the potential labour force. Among others, the potential labour force is getting better and better educated in the coming years, as the propor-

tion with higher education increases significantly in the projection. In particular, the proportion of people with long-cycle higher education increases. This is offset by a decrease in the proportion of people without a higher education, where especially the proportion of vocational educated people is decreasing in the projection. Only a slight decline in the potential labour force's share of people with a youth or primary education is observed.

**Figure 6.5. Potential labour force (17-64 years) divided by highest completed education.**



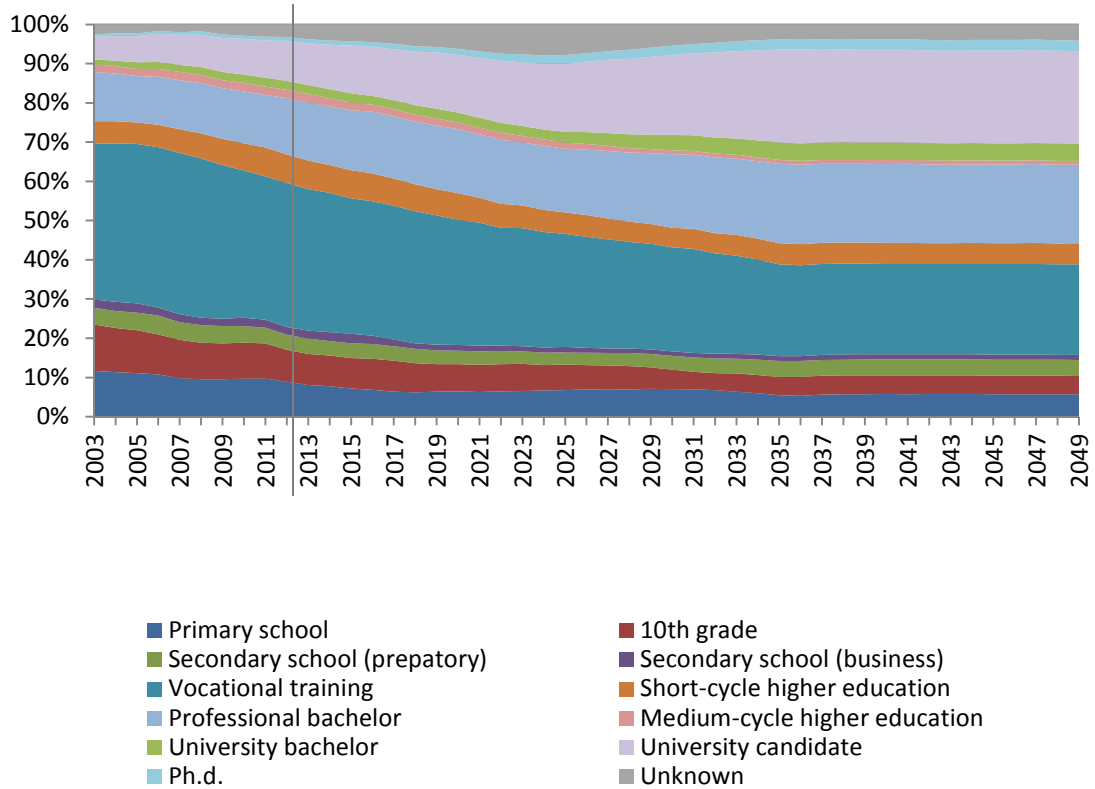
Source: DREAM's education model 2013.

Figure 6.6 shows 40-year-olds broken down by highest completed education. This provides a more immediate picture of trends in the education level. The educational objectives among the 40-year-old are also measured. A 40-year-old has typically finished his/her education so the education level of these individuals will usually not change further.

The figure shows that the proportion of the 40-year-olds with a higher education is expected to increase considerably in the projection. In particular, the proportion with long-cycle higher education increases. This occurs primarily at the expense of the proportion with vocational training, which is decreasing over time. It is also seen that the development towards a higher level of education has been a long time coming.



**Figure 6.6. 40 year olds divided by highest completed education (relative)**

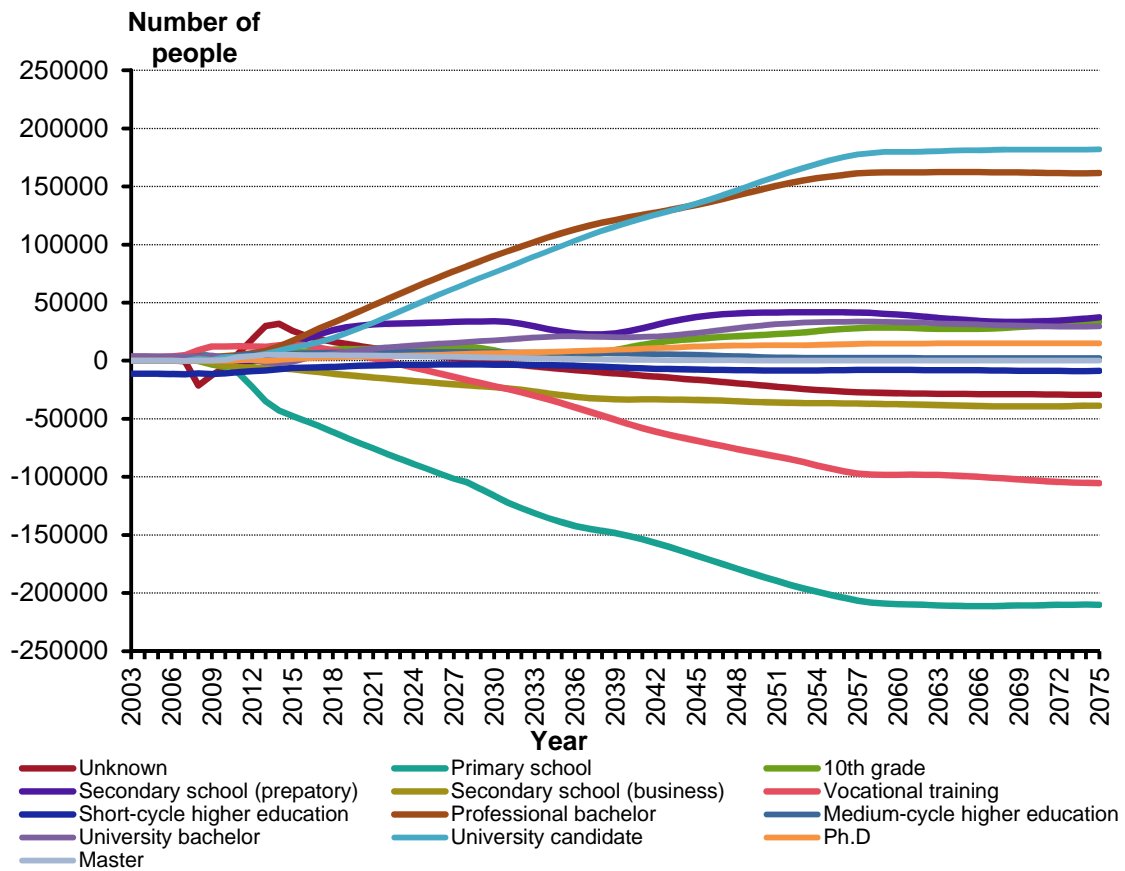


Source: DREAM's education model 2013.

## 6.4 Comparison with previous projection

In DREAM's previous long-term economic projection, education data from the education projection 2010 was used. The changes compared to the previous projection are caused by updating the education data, the population projection and changing of the education model. In addition, a more cautious approach for the treatment of trends in this projection is assumed.

**Figure 6.7. Differences in highest completed education in relation to previous projection for 17-64 year olds.**



Source: DREAM's education projection 2010 and 2013.

The difference compared to previous education projections can be seen in Figure 6.7. As shown there are some slight revisions in historical data (the years before 2013). As for the projection period after 2013, the most eye-catching change is a large increase in the number of university graduates and bachelors. This is offset by a decrease in terms of primary school and vocational training.

The education projection thus predicts a somewhat higher level of education than previous projections. The primary reason for the increase is the changes in educational behaviour in recent years.

## **7 Labour force and welfare beneficiaries**

### **7.1 Introduction**

With the long-term assessment of fiscal policy in mind, DREAM is making a projection of people's attachment to the labour market. The future development of the labour force and the number of benefit recipients depends mainly on developments in population age structure and educational attainment. In addition, labour market policies have a significant impact on the size of the labour force, including to a large degree people of the early retirement and setting a fixed retirement age forward.

The population development in the coming decades means that the elderly will account for a significantly larger share of the total Danish population, as these generations for one are large and for another expected to live longer than equivalent elderly do today. With the prospect of an aging population, the politicians have in several rounds adjusted the legislation for voluntary early retirement pension. Among other things, the early retirement period is shortened from a maximum of five years to a maximum of three years. In addition, it has been decided to increase the public pension age in line with increases in life expectancy.

In DREAM's projection of the labour force, effects due to changes in demographics and effects from the changed labour participation are both included. The projection shows that the labour force is expected to increase by approximately 95,000 persons by 2020. The trend of an increasing labour force continues thereafter, and in 2050 around 360,000 more people are expected to be in the labour force than today. The increase in the labour force is primarily due to an increase in employment among people over 60 years as a result of later retirement.

In the same period, the number of welfare beneficiaries is also expected to be increasing. In 2020, the number of welfare beneficiaries besides unemployment is thus expected to have risen by about 50,000 people compared to today, while the increase towards the middle of the current century is just about 130,000 people. The increase primarily relates to the aging of the population, meaning that the number of public pensioners increases considerably.

The following section provides a more detailed description of the development of the labour force in the future. This is followed by section 7.2, which gives a brief review of the method of projection of the labour force and number of benefit recipients. Section 7.4 provides a description of the labour market policy, which is included in the projection. Finally, the chapter ends with section 7.5 which provides a description of how working hours and productivity are part of the economic model DREAM.

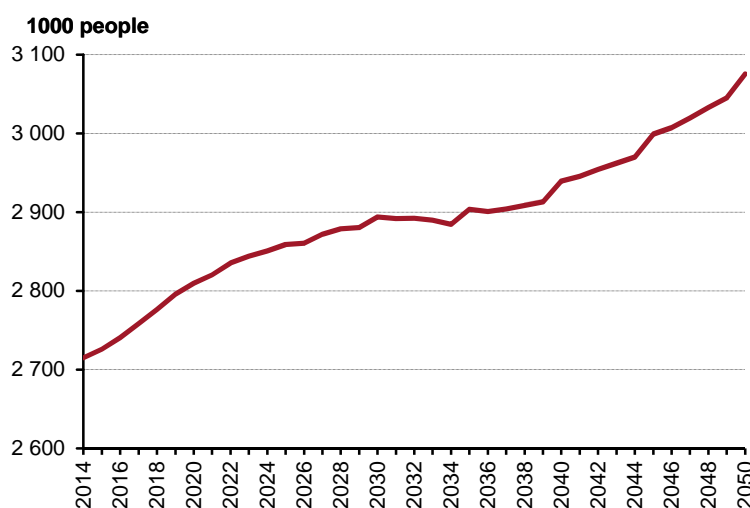
### **7.2 The labour force and the number of benefit recipients**

The long-term labour force developments depend, more than anything else, on developments in the population's age spread, composition by origin and educational level since labour market participation in the projection varies

across these different criteria. Furthermore, the future developments in the labour market will be highly dependent on developments in the life expectancy of 60 year-olds since this is crucial to retirement ages after 2030 as a consequence of the Welfare Agreement's indexation mechanism. DREAM's most recent population projection includes a significant increase in 60 year-old life expectancies which by the middle of the current century would increase the earliest possible public pension entitlement age by up to 7 years relative to the current entitlement age.

DREAM's long-term economic projection takes its basis in a cyclically adjusted baseline, which ensures that the fiscal sustainability indicator is as independent as possible of cyclical variation in the baseline year. The projection is therefore based on developments in the structural labour force, see Figure 7.1. It is our assessment that the cyclical component of the labour force in 2012 is of the order of slightly less than 40,000 people.

**Figure 7.1. Structural labour force, 2014–2050.**



*Source: DREAM's Socio-Economic Projection 2011.*

As shown in Figure 7.1, the labour force is expected to increase substantially in the coming decades. Towards 2020, the labour force increases by approximately 95,000 people. The increase is mainly due to the adopted reforms intending on shortening the period of early retirement with effect from 2014. From 2019 the minimum age for public pension is raised gradually by two years until 2022.

After 2020, the labour force continues to increase by an additional 265,000 persons up until 2050. This is primarily due to the Welfare Agreement that contains an indexation mechanism to ensure that the earliest age for public pension is adjusted in line with developments in the life expectancy of a 60 year-old. This rule of indexation of retirement and DREAM's latest demographic projection implies that the public pension age be raised by one additional year in 2030, 2035, 2040, 2045 and 2050, resulting in positive leaps in the labour force in these particular years, as shown in Figure 7.1. In the period 2040-2050, a relatively strong increase in the number of people of the working

age is also expected, which contributes to relative boost to the labour force during this period.

Table 3.1 illustrates which main components are important for the development of the labour force until 2050. Over the entire period, the entire increase in the labour force is virtually explained by increasing labour participation rates, primarily among persons aged 60 or above. Up to 2020 the agreed retirement reforms thus contribute to an increase in the labour force of about 69,000 people out of the total increase in the labour force of around 95,000. Up to 2050, the retirement reform contributes with a total of 302,000 extra people in employment compared to today.

Other labour market reforms such as the Growth Plan, the Flex-job and Disability Pension Reform, the Recovery Plan etc. also contributes positively to the labour force. Up to 2020 the other policy actions thus increase the labour force by about 13,000 people. After 2020, the measures are fully phased in and thus have virtually no additional effect on the size of the labour force.

The population's education level is expected to increase in the coming years as the older generations leave the labour market and are replaced by young people of whom significantly more have completed tertiary education on average. As people with higher education on average have higher labour participation rates, the expected increase in educational attainment has a positive effect on labour force participation. It is estimated that this training effect increases the labour force by about 39,000 people towards 2050.

**Table 7.1. Main elements significant to the development of the labour force up until 2050.**

<i>People in thousands</i>	2014– 20	2020– 30	2030– 40	2040– 50	Total 2014– 50
Labour force, total	95	84	45	136	360
<i>Contribution from:</i>					
Demographics:	3	-52	-40	95	6
- Population growth	22	-27	-50	92	38
- Changes in age composition	-5	-8	22	5	14
- Other composition effects	-14	-17	-12	-3	-45
Labour participation	91	136	85	41	354
- Retirement reforms	69	127	73	32	302
- Increasing educational level	9	11	10	10	39
- Other policy actions	13	-3	3	0	13

*Note: The category "Other composition effects" includes changes due to changed gender and origin composition of the population. The negative effect is achieved mainly because a larger share of the Danish population going forward will consist of immigrants and their descendants, who on average have a lower labour participation rate than persons of Danish origin. The category "Other policy actions" include Sick Pay Reform, Growth Plan, Flexjob and Disability Pension Reform, Recovery Plan, etc.*

*Source: Own calculations on DREAM socioeconomic projections 2014.*

Up to 2050, a positive contribution to the labour force of approximately 6,000 people is expected from demographic development. This covers opposite effects. Up until 2030, a changed age composition contributes negatively to the labour force development as the generations who leave the working age are greater in number than the generations that join the labour force. After 2030, the opposite effect begins to show, and in the entire period from 2014 to 2050 the changed age composition contributes positively to the labour force development by about 14,000 people. Over the entire period to the middle of this century there will be a higher number of people of the working age, which also contributes to the labour force development. The contribution here is estimated to be around 38,000 people by 2050.

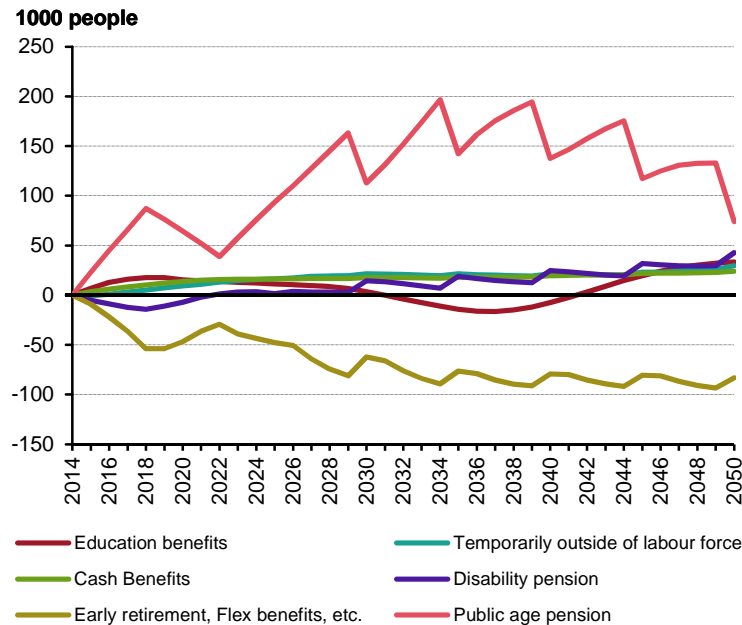
Other composition effects primarily covers the fact that the population origin composition is expected to be changed up until 2050. From a level of 13.2 percent of 17-64 year olds in 2014, the immigrants' and descendants' share of all persons in the age group is expected to increase to 20.9 percent in 2040. Hereafter the share's increase rate is reduced, and in 2050 the share is 21.7 percent. As immigrants and their descendants on average have a lower labour participation rate than persons of Danish origin, the origin changing composition has a negative effect on the labour force development. Altogether, this effect is estimated to be about -45,000 persons in the period up to 2050.

As the long-term development in the labour force, the number of people who receive public benefits also depends on the population's age composition, composition by origin as well as education.

As shown in Figure 7.2, the number of welfare recipients is expected to grow by close to 50,000 people by 2020 compared to today. The increase mainly follows the population's development in age composition and an increasing average life expectancy, which together increase the number of pensioners with about 65,000 people. Conversely, the number of early retirees decreases by just about 46,500 people in the period. This is in line with the maximum pre-retirement period being shortened. There is also expected to be fewer disability pensioners in 2020 than today. Over the entire period 2014-2020, the number thus decreases by about 7,000 people. This is mainly due to the adopted retirement reform, which limits access to disability pensions for the younger population. The effect of this reform dominates the opposite effect of the shortened early retirement period, which is expected to increase the number of disability pensioners. It happens when a portion of those utilizing the early retirement scheme under the current rules are instead transferred to disability pensions when the possibility of early retirement is restricted. For the same reason, more are expected to be on cash benefit, sick pay and unemployment activation in 2020 compared to today. In total, the number of people in these groups increases by approximately 23,000 by 2020. A part of the increase is also due to other labour market policies, including the Retirement Reform, which is presumed to increase the number of people on sick pay among other things. Finally, the number of SU recipients is expected to in-

crease by approximately 15,500 in 2020 compared to today, which follows from a general increase in the number of students, especially in higher education, where students typically receive SU.

**Figure 7.1. The number of benefit recipients minus unemployed in relation to 2014, 2014–2050.**



*Note: The number of people includes both employed and non-employed recipients of the given type of transfer.*

*Source: DREAM's socioeconomic projections 2014.*

The increasing trend in the total number of welfare beneficiaries will continue until 2030, when the number of welfare recipients has increased cumulatively by about 130,000 people compared to 2014. Hereafter, the increased retirement age ensures that the total number of welfare beneficiaries is fairly constant until the middle of the current century. Overall, the number of welfare recipients increases by almost 125,000 persons in the period 2014-2050.

Overall, the development in the period 2020-2050 is determined by the same mechanisms as in the period up to 2020. The number of pensioners is increasing as life expectancy within society increases. When the public pension age is increased in the period 2019-2022, and every five years from 2030 onwards, a decrease in the number of pensioners is seen. The number of people on early retirement is decreasing since the early retirement period is shortened and going forward there is significantly fewer who are registered for the early retirement scheme than today. In the longer term, the number of disability pensioners increase when the retirement age is increased, since a part of the people who no longer have the option of retirement is instead expected to enter disability pension.

### 7.3 The socio-economic projection

The purpose of the DREAM's socio-economic projection is to divide the total population by age, sex, origin and highest completed education into labour market categories (employed, early retirees, pre-retirees, pensioners, etc.).

In the DREAM model, the total Danish population is divided into 20 labour market status categories. The labour force is divided into six status groups for employment: a group that is a common term for ordinary as well as supported employment and five groups of recipients of welfare beneficiaries. People outside the labour force are divided into 14 status groups, which differ by the benefit, the group receives. Groups outside the labour force include maternity leave, sick pay, unemployment activated, non-labour ready cash benefits, early retirement, pre-retirement, public pension, etc.

The breakdown of the population by labour market attachment is based on the composition of the population by sex, age, origin, highest completed education and labour market status in 2012<sup>27</sup>. Based on this, the structural share of the total number of persons in a particular status group (population frequency) is calculated. This share is calculated for a given gender, age, origin and highest completed education.

In each projection year, the stock frequency of the overall projected population is multiplied with given demographic characteristics (gender, age and origin) as well as highest completed education. This projected population is available from DREAM's education projection. By multiplying a population size with a stock frequency the population is split further by labour status.

In practice, the stock frequency is calculated as follows: Let  $N_{g,a,o,e}^{RAS}(s)$  denote the structural number of people by age  $a$ , gender  $g$ , origin  $o$ , whose highest completed education is equal to  $e$ , that is in the status category  $s$ . The share of the total number of people at a given age, gender, origin and highest completed education is in the status group  $s$  then given by:

$$freq_{g,a,o,hf}(s) = \frac{N_{g,a,o,hf}^{RAS}(s)}{\sum_s N_{g,a,o,hf}^{RAS}(s)}.$$

Note that summed over status the frequencies will add up to one. This means that when split, all people will be categorized in just one status group.

When the stock frequencies are known, the projection is made by multiplying the stock frequency with a population size: Let  $N_{g,a,o,e,t}^{UDD}$  denote the number of persons at time  $t$  by given demographic characteristics and highest complet-

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<sup>27</sup> Mid-figures are used, calculated as the simple average of two consecutive early statements of the Register-based Labour Statistics (RAS). The latest data year, 2012, is thus the average of the Register-based Labour Statistics in early 2012 and early 2013.



ed education according to DREAM's education projection. In the socio-economic projection, the split in the labour status occur for each projection year  $t$  by multiplying a structural stock frequency of the relevant population size:

$$N_{g,a,o,e,t}^{Socio}(s) = freq_{g,a,o,e}(s) \cdot N_{g,a,o,e,t}^{UDD} \quad \forall t,$$

where  $freq_{g,a,o,e}(s)$  is the stock frequency to a person with given demographic characteristics and highest completed education is in status category  $s$ , and  $N_{g,a,o,e}^{Socio}(s)$  is the population size for a person with the same demographic characteristics and highest completed education, that at time  $t$  is in the status group  $s$  according to DREAM's socio-economic projection.

## 7.4 Labour market policies in the projection

In the long-term projection, the expected effect of already adopted policies is included. The retirement reforms adopted over the last decade have the greatest impact. These increase retirement age significantly and restrict access to the pre-retirement scheme, which is also made a three-year scheme at the same time. The retirement reforms are discussed in detail in Section 7.4.1. The expected effect of several other labour market policies is also included in the projection. The actions included in the projection are described in Section 7.4.2.

### 7.4.1 The retirement reforms

To meet the challenges coming from a changing age structure with considerably more elderly, the politicians have in recent years adopted several retirement reforms.

With the Welfare Agreement from 2006, it was decided to increase the public pension age in line with the increasing life expectancy. The intent is to ensure that the expected maximum period of public pension is the same for all generations. The Withdrawal Agreement from 2011 contains three main points: the advancement of the increases in the retirement age, which was agreed to in connection with the Welfare Agreement, shortening of the maximum pre-retirement period from five to three years (as mentioned above) and increased pension offset against the retirement benefit.

With these reforms, the early retirement age is gradually being brought up to six months a year from 2014 to 2019. In 2022 and 2023, a further increase in the early retirement age by six months will occur, so that the lowest age for early retirement in 2023 total is increased by four years from the current 60 to 64. As the increase in the public pension age in the same period is of only two years, the maximum period of pre-retirement period is shortened from five to three years.

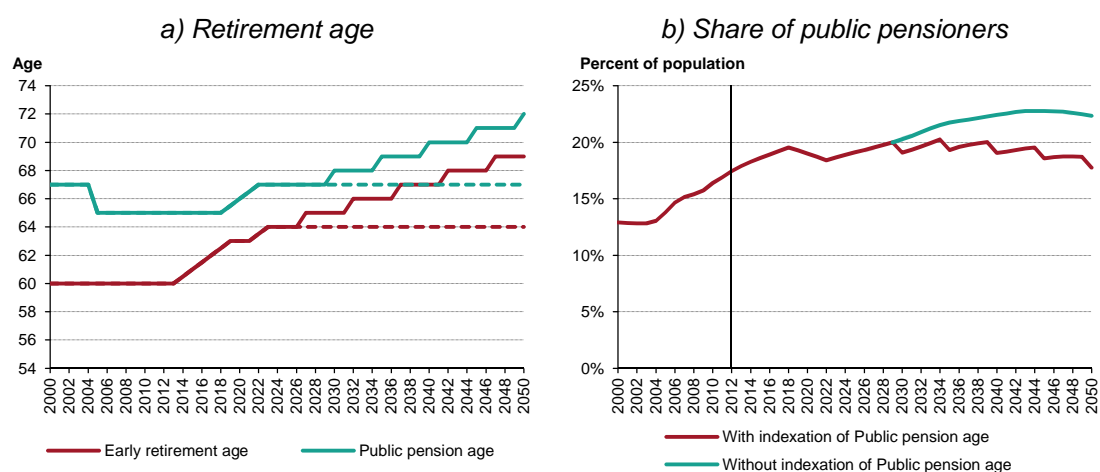
The public pension age is gradually brought up to six months a year from 2019 to 2022. Subsequently, the public pension age will be regulated so that it follows the life expectancy of a 60 year old. The first adjustment of the public

pension age after this indexing mechanism occurs in 2030, and the regulation can be either 0, ½ or 1 year depending on the increase in the remaining life expectancy. The adjustment is repeated every five years thereafter.

From the year 2027, the early retirement age changes by the same regulation as the public pension age, but with the entry into force three years earlier so that the pre-retirement period remains at three years for all age groups. Overall, the indexation mechanism will imply that both retirement reforms in the long term increase in line with the increase in the remaining life expectancy for a 60 year old.

As seen in Figure 5.3, a significant increase in the remaining life expectancy of a 60-year-old is expected, which is why the indexation mechanism in the retirements reform increases the public pension age by a further five years from 2030 until the middle of the present century, see Figure 7.3a, which shows the development of pre-retirement and public pension age in the projection.

**Figure 7.2. Development in retirement age and the share of public pensioners, 2000–2050.**



Note: The dotted lines in the figure to the left illustrate the retirement age without Welfare Agreement's indexing mechanism. The vertical line in the figure to the right indicates the transition between historical data and projections.

Source: Own calculations in DREAM's demographic and socio-economic projection 2014.

With the retirement reforms' later early retirement and public pension age, some of the age groups, which today are eligible to receive public benefits, will no longer be able to receive benefits until they comply with the new age requirements. To assess the effect of retirement part of the reforms, it is necessary to assess how the structure of the retirement pattern changes when the pension age is adjusted upward.

This is done based on the known distribution for each generation found by a projection of constant proportions. If the age profile of a status group is to be corrected, one of two methods is used to make the correction. One method is an "extrapolator", which is pursuing an observed tendency for a given age interval to further apply it to a number of age groups corresponding to the dis-

placement of early retirement or pension age. This method is typically used when it is assessed that a trend is definitely age-related. The second method is an "elastic", which for given ages stretches behaviour to further apply for a given number of ages. This method is typically used when it is considered that behaviour is influenced by the possibility of early or actual retirement in the form of early retirement or public pension respectively. The methods are described in Hansen and Hansen (2011). By these corrections, it is taken into account that the distribution of many of the status groups is affected by the possibility of early retirement and public pension.

As explained in section 7.2, the retirement reform expected to increase the labour force significantly. This is a result of the older part of the population being maintained in employment when the opportunity of transferring to public pension disappears. In the period from the turn of the century to the present day, the share of the population receiving public pension has increased from 13 to 18 percent as a result of the fact that life expectancy has increased during the period. This increase is expected to continue in the coming years. The approved increase in the retirement age by two years in the period 2019-2022 will maintain the share of the total population on public pension below 20 percent, despite the rising life expectancy, see Figure 7.3b. In the period after 2020, the Welfare Agreement's indexing mechanism ensures that the share of the total population on public pension remains around 20 percent, despite the life expectancy increasing. If the agreed increases in the public pension age are not implemented, the share will rise to almost 23 percent in the middle of the present century.

#### **7.4.2 Other labour market policies in the projection**

##### *Sick Pay Reform*

In December 2013, a reform of the sickness benefit system was adopted. The reform ensures an earlier effort towards the citizen concerned. The purpose of this effort is to get more people back to work. The reform is assumed to reduce the number of sickness benefits, which are mainly transferred to the unemployment activation instead.

##### *Growth Plan*

In 2013, the Growth Plan DK was adopted. The Growth Plan's two main objectives were firstly to improve business conditions and secondly to increase the supply of qualified labour. The Growth Plan contained a reform of cash benefit and SU, which was aimed to motivate the unemployed to choose education and to get students to complete their educations more quickly.

The Cash Benefit Reform entails, among other things, a lower rate on the SU-level for beneficiaries for fewer than 30 years. This will increase the incentive to search towards employment or education, which is considered to increase the labour force by approximately 500 people in 2020. The SU-reform contains, among other things, an incentive to complete the education faster, since the right to SU lapses if the student is more than six months late, and you can

only get SU within the period of the standard study. Overall, the SU-reform is expected to increase employment by almost 4,500 people in 2020.

#### *Reform of early retirement and flexjobs*

In June 2012, an agreement was reached, reforming early retirement and flexjobs. The main element of the agreement is that people under 40 years cannot get awarded disability pension, but instead has to be included in the so-called resource progress, which assists the individual in getting into work or education. In addition, the wage subsidy is reduced to people in such jobs.

In the short term, the reform is assessed to reduce the number of early retirees, while the number of people in resource courses is increased. During a resource course you receive resource course benefit that is at the same level as any prior benefit. The projection assumes that about a third of the people in the resource course receive sickness benefits, while the remaining two-thirds receive cash benefits. Looking ahead, the reform must also be expected to have a positive effect on employment, since the resource courses are assessed to be able to help people back into work. It is thus the basis for the projection that the reform increases the workforce by approximately 5,000 people in 2020. A part of the increase in employment, however, is supported employment in the form of light jobs and flexjobs.

#### *Recovery Plan*

Of other labour market policies, the effect of the so-called recovery plan is embedded, which includes a reform of the unemployment benefit system, including a halving of the benefit period from four to two years.

The persons, who under the new rules are expected to exhaust their right to unemployment benefits, on one hand increase the number of unemployed/activated receiving cash benefits, and on the other hand the number of unemployed who do not receive a benefit, since they are not entitled to social assistance, as their wealth or spouse income is too high. Of the current unemployed who would be affected by the shortened benefit period about seven out of ten is effected and cannot get cash benefit if the benefit period is reduced to two years. This share is maintained in the projection. The shortened benefit period is expected to have a positive effect on employment, since some benefit recipients are expected to transfer to employment, partly as a result of the increase in job search, as it has been observed immediately before the expiration of the unemployment benefit period. Overall, the recovery plan is expected to increase the labour force by about 3,000 people in 2020.

#### *Future number of early retirement pension recipients*

DREAM's socio-economic projection is based on the assumption that the proportion in each socio-economic group will remain constant. This means that a constant share of future generations of a given gender, origin and highest completed level of education in each voluntary early retirement age will make use of the provision.

In recent years, however, a clear tendency is evident for both reduced utilisation of the provision and a reduced take up. Thus, a projection based on constant population spectrum proportions would over-estimate the number of voluntary early retirement pension recipients. As a consequence, DREAM's projection methodology has been revised so that future numbers of early retirement pension recipients are now calculated on the basis, amongst other things, of observed payment of voluntary early retirement provision contributions. The method involves three fundamental elements (1) *enrolment*, i.e. the proportion of a given generation that register for the provision by making early retirement pension contributions, (2) *drop-out rates*, i.e. the proportion of those who have enrolled in the early retirement provision scheme in a given generation that drop-out of the scheme by ceasing to make early retirement provision contributions prior to reaching voluntary early retirement age and (3) *uptake*, i.e. how great a proportion of those entitled to receive early retirement pension payments in a given generation actually make use of the facility to do so.

The projection method is documented in a working paper by Hansen, Schultz and Kirk (2011), and we refer the reader to this for a more detailed description of the methodology employed. The separate projection of the early retirement scheme reduces the number of early retirees relative to a projection based on constant stock frequencies. The people who moved from the early retirement scheme, instead surplusses to employment (approximately 84 percent), disability (11 percent), other transfer payments such as sickness benefit (4 percent) or retirement of its own funds (1 percent).

#### *Number of students*

In the socio-economic projection, the number of students is taken from DREAM's education projection so that the total number of students in the projection of the population's labour market participation rate for a given gender, age, origin and highest completed level of education corresponds to the education projection.

The total number of students is divided according to whether they form part of the labour force or not, similarly an estimate is made of the number of students in receipt of state education grant and loan scheme payments ("Statens uddannelsesstøtte, SU"). This subdivision is made relative to these groups' internal distribution in the projection's baseline.

#### *Reduced educational impact*

In recent decades, the educational level of the population of working age has increased significantly as an increasing share of the younger generations have gained an education beyond primary school and steadily replace the older generations with a lower educational level.

As a clear positive correlation is observed between education and professional participation, i.e. people with higher education have on average higher labour participation rate, the increasing level of education in recent decades

should immediately have resulted in the increase in the average employment rate, which does not seem to be the case. The labour participation rate however has been relatively stable over the last 20 years with a tendency to a slight decrease, although the level of education in this period has increased significantly.

This suggests that historically no full impact on the labour participation has been observed, if the level of education increases. Estimates conducted by the Ministry of Finance also show that the actual impact on the labour participation from more people having achieved a qualifying education in the period 1981-2007, has amounted to between 25 and 50 percent of the 'proportional' educational impact (i.e. the effect on labour force participation that would occur if increased education became fully implemented in the labour force with the observed cross-sectional correlation), see. Søggaard (2011). Seen in this light, an educational impact on people's labour market attachment of only one third of the impact is included in the projection; an impact that would have occurred if the changes in the educational composition was not fully reflected in participation rates.

#### *Other labour market policies*

In the projection a phase-out of schemes which have been abolished also takes place. This applies the phase out of the service job scheme and the number of persons on labour leave is set equal to zero from the first projection year. Finally, the effect of removing the Start Help is included. Overall, these reforms have a small positive effect on the labour force of about 100 people in 2020.

## **7.5 Working hours and productivity**

In DREAM, the total labour force is divided into six social status groups that include (1) employed students, employed persons who receive a benefit in the form of (2) sickness benefit, (3) disability benefit, (4) early retirement or (5) public pension and finally (6) other employees. The group of other employees is a common term for ordinary as well as supported employment. In the 2014 projection, these six status groups offer labour, i.e. they are assigned working hours and productivity. Working hours is allowed to vary across the status groups.

In DREAM, a working hours index<sup>28</sup> is used, which initially is assumed to be constant over time. In the absence of political reforms, the projection is based

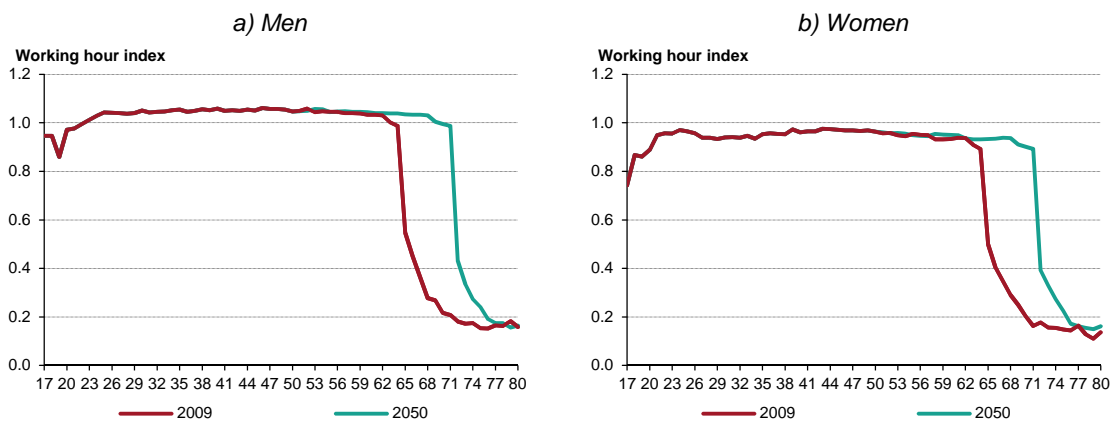
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<sup>28</sup> Data for the average yearly time spent working measured in hours og divided in type of employment and demographic characteristics originates from a 33 percent spot test by Lønregistret. The type of working hour index used in DREAM uses the yearly working time from Lønregistret prescribed by the average yearly working time i the public sector from the National Accounts.

on the assumption that the population in the future will tend to choose the same working hours as an equivalent person chooses today (for given age, sex and a maximum of completed education). The working hours index is assumed to vary across the six socioeconomic groups of employees who all have productivity.

Figure 7.4 shows the used working hours index where a full-time employee corresponds to one. From about age 25 and up to the current early retirement age, the working index is virtually constant. Through early retirement ages forward to the current public pension age, there is a tendency for a declining number in working hours, which may reflect that more people are choosing to work part time. From the earliest retirement age, a significant decrease can be seen in the working hours index, after which working hours are decreasing in line with increasing age.

**Figure 7.3. Average working hours index for other employed with a vocational education, 2009 and 2050.**



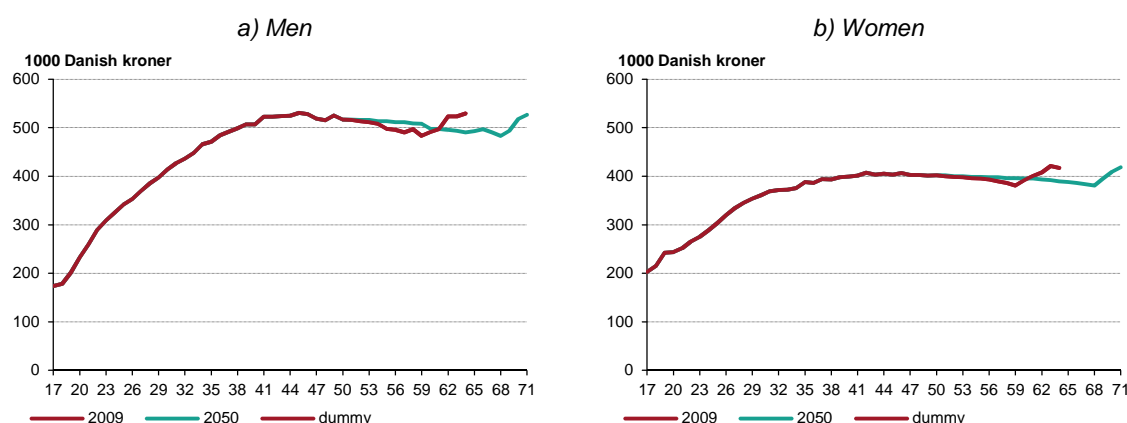
Source: Own calculations on the DREAM model.

This indicates that the average working hours largely depends on both the early retirement and public pension age. In the projection, the working hours index is therefore corrected for increasing retirement ages. The applied principle for indexing the working hours index is that for each generation the behaviour observed the last 10 ages before early retirement age in the base year is stretched to also apply for the number of ages which the early retirement age is raised with for the analysed generation. As shown in Figure 7.4, this projection method results in that the relative constant working hours from age 25 until the age immediately before the early retirement age is expected to continue in the additional years in the labour market, based on the fact that the retirement age is increased.

In DREAM, a productivity profile<sup>29</sup> is used to indicate the average productivity of a person in a given age group with a given sex and for a given origin. As a starting point, the productivity profile is assumed to be constant over time, but when the productivity is dependent on the retirement ages (as shown in Figure 7.5, where productivity for both sexes is increasing from the first possible early retirement age), an assumption is included that productivity depends on the retirement ages as these develop according to the Welfare Agreement's retirement reform.

As shown in Figure 7.5, the productivity in the projection's base year for both sexes is increasing to about the age of 40, after which the productivity index is relatively constant until immediately before the early retirement age, however, with a slightly declining trend. Through early retirement ages, the productivity is increasing, because the individuals who are taking early retirement typically have a lower than average income, hence why the average productivity increases.

**Figure 7.5. Average productivity for people of Danish origin, 2009 and 2050.**



Source: Own calculations on the DREAM model.

If the course of correction for increased retirement age in Figure 7.5 is considered, it is seen that in the projection it is assumed that the relatively constant trend from age 40 is expected to continue in the extra years on the labour market. To continue the relative portion of constant productivity profile can be seen as a consequence of the chosen projection of working hours in the additional years in the labour market resulting from the Welfare Agreement's retirement reform, which maintains a relatively high average work time, which is why gross wages and thus productivity will also be on the same relatively constant level.

<sup>29</sup> For a population in a given age group, with a particular gender, and for a given origin, the productivity profile is based on the average gross wage prescribed by the number of year-round employment. The profile is scaled to frame the total payroll in the economy, the relationship between gender, age and origin groups maintained. Information on income is based on a 33 percent sample of the register of individual incomes.



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