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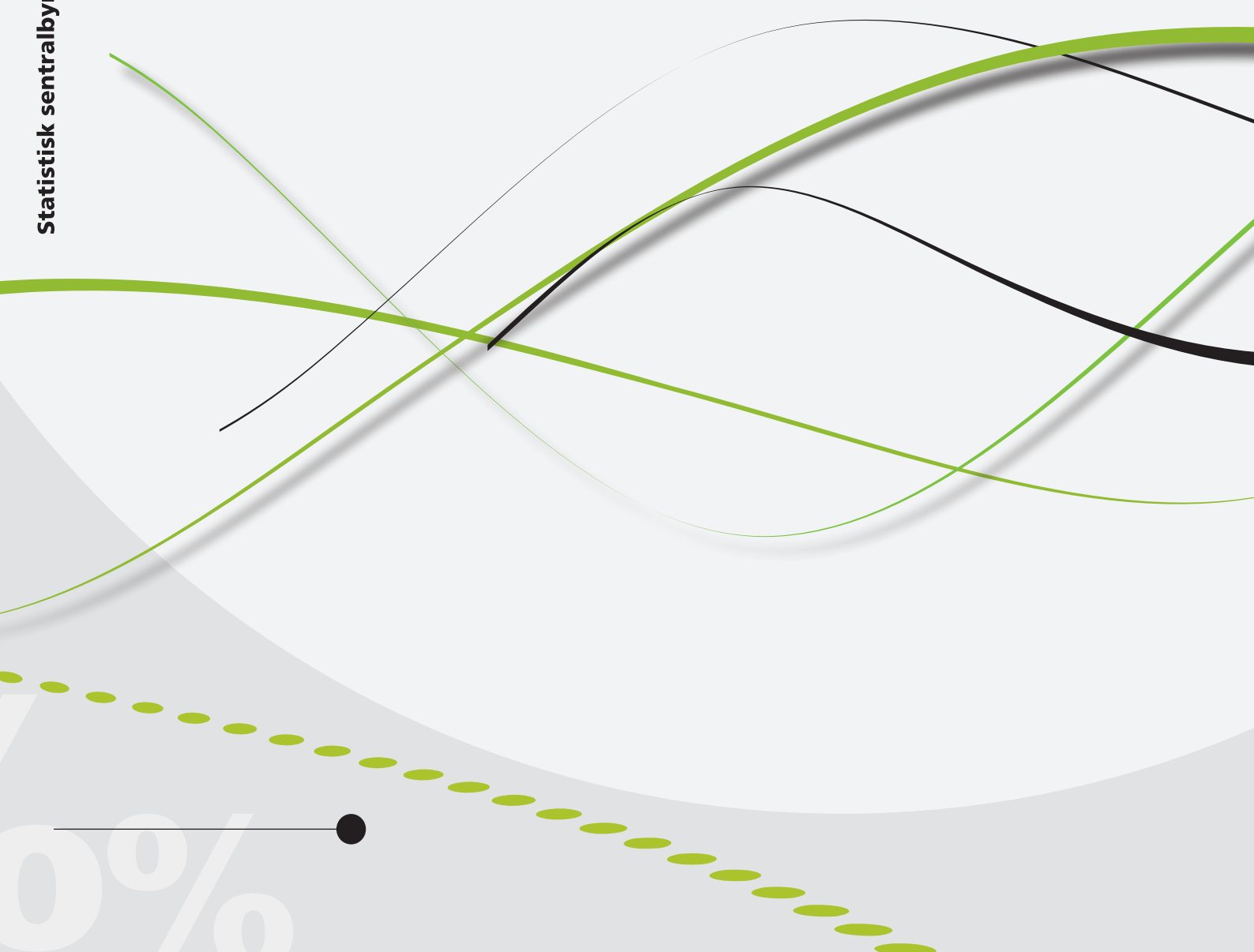

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Preface

Since the early 1990s, Statistics Norway has produced model-based projections on demand and supply of labour by education. The demand and supply side has been modeled separately, but in a consistent manner. The multi-sectoral macroeconomic model MODAG has been the core model on the demand side, and the dynamic micro simulation model MOSART has been used to project details of the supply of labour. These models are constantly being updated, taking into account new data and research.

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Statistisk sentralbyrå, 10 October 2013.

Hans Henrik Scheel

Abstract

In Norway, supply of labour by level of education has developed in line with demand for many years. At the same time unemployment rates and relative wages for different educational groups have been quite stable over time. Stability in relative unemployment and wages require that labour demand and supply match well also in the future. Both for future students, employers and the authorities, projections on demand and supply of labour by different kinds of education are useful information. Students must decide on which subjects to study, for employers it is important in their long-term planning, and the authorities must plan educational capacity, industrial development and welfare reforms.

Statistics Norway has produced projections of supply and demand for labour by different kinds of education since 1993. In this report, we present new projections up to 2030. We use the macroeconomic model MODAG when projecting the demand for labour. MODAG is a multi-sectoral macroeconomic model that captures linkages between industries. Demand for labour by five educational groups is modelled for each industry. The five groups are partly substitutes within each industry, and the employment shares depend on relative wages and technological change. In addition, there is a sub-model disaggregating employment by education and industry into employment by 28 different fields of education. Previous observed trends are used to divide projected demand for labour from the five groups into the 28 fields.

The projections show that the previous trends of increasing demand for workers with a tertiary education and upper secondary vocational education will continue towards 2030. A decreasing share of demand is directed towards primary, lower secondary and upper secondary general education as the highest level of completed education. For employees with education at the tertiary level, the projections show a high growth in demand for most of the detailed educational fields, and particularly for candidates in economics and administration and nursing and social care at a lower level of tertiary education.

Supply of labour by the 28 different fields of education is projected by using the dynamic microsimulation model MOSART. From a base year, MOSART simulates the further life course for each person in the entire Norwegian population by using estimated transition proba¬bilities. In the projections, the transition probabilities are kept constant. This implies that educational propensities and labour force participation rates are constant as well. By comparing the projections of labour demand from the MODAG simulations with the labour supply from the MOSART simulations, we get some indications of potential imbalances in the future labour market.

The projections show a higher increase in demand for labour with upper secondary vocational education than the corresponding increase in supply. A relatively low completion rate for this kind of education is an important factor behind the slow growth in supply. The projections also indicate future excess demand for teachers and nurses. On the other hand supply may increase more than demand for tertiary educations in economics and administration, social sciences, law and humanities and arts. Observed lack of engineers and persons with other fields of science seems to be reduced because of improved completion rates for these educations.

The projections from this model system are uncertain both because the projection period is quite long and because they are based on discussable assumptions. On the demand side prolongation of previous trends regarding the composition of labour in each industry is the most vital assumption, while assumptions of constant transition probabilities are important for the projections of supply. Demand and supply for the different fields of education are projected independently, and mechanisms working to reduce future imbalances are not included. Therefore, the results must be used with caution.

Sammendrag

Sammenlignet med de fleste andre vestlige land har arbeidstilbudet for ulike typer arbeidskraft i Norge i stor grad fulgt utviklingen i etterspørselen, og ledighets- og lønnsforskjellene har vært mer stabile. Den økte etterspørselen etter høyt utdannet arbeidskraft vil trolig fortsette. For at arbeidsmarked fortsatt skal utvikle seg balansert, bør det samme skje med arbeidstilbudet. Kunnskap om hvordan tilbud og etterspørsel for ulike typer arbeidskraft kan utvikle seg, vil derfor være av nytte både for studenter, arbeidsgivere og myndighetene. For studentene kan det være nyttig for valg av utdanning, mens det gir arbeidsgiverne informasjon om framtidige rekrutteringsmuligheter. For myndighetene vil informasjonen spesielt være viktig i forbindelse med planlegging av utdanningskapasitet, næringspolitikk og velferdsordninger.

Statistisk sentralbyrå har med ujevne mellomrom laget slike framskrivninger siden 1993. I denne rapporten presenteres nye beregninger som går fram til 2030. Den makroøkonomiske modellen MODAG er brukt for å lage framskrivningene på etterspørselssiden. Modellen angir produktstrømmene mellom næringene i den norske økonomien. MODAG skiller kun mellom fem utdanningsgrupper/-nivåer for hver næring. Det benyttes derfor en ettermodell for å beregne etterspørselen på et finere detaljeringsnivå hvor 28 utdanningsgrupper er spesifisert. På det aggregerte nivået er utviklingen i relative lønninger og teknisk framgang i hver næring avgjørende for sammensetningen av etterspørselen. Observerte trender fra tidligere blir benyttet til å fordele etterspørselen etter arbeidskraft videre utover på de 28 utdanningsgruppene.

Framskrivningene viser at utviklingen med økende etterspørsel etter arbeidskraft med utdanning fra høyskole- og universitetsnivå fortsetter i hele framskrivingsperioden. Det samme gjelder yrkesfaglige studieretninger fra videregående skole. En synkende andel av etterspørselen vil i framtida rette seg mot de som kun har grunnskole eller allmenne fag eller økonomiske og administrative fag fra videregående skole som høyeste fullførte utdanning. Videre viser framskrivningene vekst i behovet for de fleste utdanningsretninger innen høyere utdanning. Behovet for økonomi- og administrasjonsutdannete og helse-, pleie- og omsorgsutdannete øker spesielt mye.

Rapporten dokumenterer også framskrivninger av tilbudet av arbeidskraft for de 28 utdanningsgruppene ved hjelp av mikrosimuleringsmodellen MOSART. MOSART simulerer det videre livsløpet for hele befolkningen når det gjelder demografi, utdanning, arbeidsmarkedstilknytning og pensjonering. Framskrivingene gjennomføres med bakgrunn i opplysninger fra et utgangsår og forutsetning om konstante overgangssannsynligheter. Det innebærer at tilbøyelighetene til å starte, fullføre eller fortsette i utdanning holdes konstante sammen med forutsetninger om valg av fagfelt og tilknytning til arbeidsmarkedet.

Ved å sammenlikne framskrivingene av etterspørselen etter de ulike utdanningskategoriene med arbeidstilbudet fra MOSART, får vi en indikasjon på potensielle ubalanser i framtidens arbeidsmarked. Denne sammenlikningen tyder på at etterspørselen etter arbeidskraft med videregående fagutdanning vokser raskere enn tilbudet. Svak gjennomføring i videregående fagutdanning er en viktig årsak til dette. Framskrivingene indikerer også at det kan oppstå knapphet på lærere, og i særlig grad på sykepleiere. På den andre siden kan tilbudet øke mer enn etterspørselen for høyere utdanning innen økonomi og administrasjon, samfunnsvitenskap, jus og humanistiske fag. Observert mangel på ingeniører og andre med realfagsbakgrunn kan være i ferd med å bli redusert ettersom gjennomføringen innen disse studiene ser ut til å ha bedret seg de siste årene.

Det er nødvendig å understreke at det er forbundet en god del usikkerhet med framskrivingene. Dette skyldes betydelig usikkerhet om en del av forutsetningene samtidig som framskrivningene går nesten 20 år fram i tid. For etterspørselen er forutsetningen om trendforlengelse av sammensetningen av stor betydning, mens forutsetningen om konstante utdanningstilbøyeligheter er sentral på tilbudssiden. Tilbud og etterspørsel for de ulike utdanningsretningene er dessuten framskrevet uavhengig av hverandre, og mekanismer som vil bidra til å redusere framtidige ubalanser er ikke inkludert. Resultatene bør derfor benyttes med varsomhet.

Contents

1. Introduction

During recent decades, most OECD-countries have seen a considerable growth in demand for labour with higher skills and educational levels, cf. Freeman and Katz (1994) and Machin (2001). Part of this increase has been matched by higher supply of highly skilled labour, reflecting increased educational capacity. Nevertheless, increased wage dispersion in many countries indicates that the supply of skilled labour has not increased sufficiently to meet growth in demand. A significant part of both increased demand for highly skilled labour and higher wage premiums can probably be explained by technological shifts favouring this kind of labour, but the underlying reasons are still debated in the literature, see Acemoglu and Autor (2011).

Like in most other OECD-countries, Norway has experienced similar shifts in the composition of labour by education, but differences in both wage and unemployment rates have been more stable. Kahn (1998) suggests that this is the result of the centralization of wage bargaining during the late 1980s and 1990s. Hægeland and Kirkebøen (2007) find an increase in educational premiums over time, but still, there have been relatively small changes in wage differences in Norway compared to most OECD-countries. This probably reflects a strong growth in the supply of labour following increased demand in addition to fairly stable institutional features in wage bargaining.

In addition to a large literature examining shifts in the skill composition of labour and development in relative wages, more and improved models projecting the demand for different kinds of labour have been constructed. In a survey by Wilson et al. (2004), it is stressed that the "best practice" is to use a disaggregated macroeconomic model to project demand for labour. In Norway, this type of models has been in use by Statistics Norway since 1993, see Cappelen and Stølen (1994). By using information about input of commodities and services from other industries, the model includes an important aspect of interaction. In addition to projecting demand for labour by industry in a consistent way, the use of a macroeconomic model also facilitates the analysis of different policy assumptions. A disaggregated model can also distinguish between inter- and intra-industry changes in demand for labour by skill.

The projections in this report show that the previous trends of increasing demand for workers with a tertiary education and upper secondary vocational education will continue towards 2030. A decreasing share of the employed will have primary, lower secondary and upper secondary general education as the highest level of completed education. According to the projections, 16 per cent of the employed will have completed education at this level in 2030, compared to 22 per cent in 2010. When we compare projections for demand for the different kinds of education with projections for supply given constant educational propensities and labour force participation rates, we find a higher increase in demand for labour with upper secondary education vocational programs than the corresponding increase in supply. Higher completion rates for these educations may be necessary to meet increasing demand. The projections also show a high growth in demand for most of the specific educational fields, but a particularly high growth in demand for candidates in economics and administration and nursing and care giving. Especially for nurses, but also for teachers, educational capacity may be too low to match demand.

In Section 2, we describe the main structure of the model system, while the chosen classification of labour by education is presented in Section 3. Demand for labour for five educational groups in each industry and supply of labour within the same groups are projected towards 2030 using the macroeconomic model MODAG. The model and the macroeconomic projections are described in Sections 4 and 5, respectively. The labour market prospects for the five groups of education are presented in Section 6, while in Section 7, we present how demand for labour is disaggregated to detailed educational fields. Demographic projections for population by level of education

using the dynamic microsimulation model MOSART are presented in Section 8, while projections for supply and demand for the four levels of education and different skills are presented in Section 9. Section 10 concludes.

2. Main structure of the model system

This section presents the main structure of the model system used for projecting supply and demand for different kinds of labour by education. The model system has a recursive structure, as shown in Statistics Norway's previous report on the topic, written by Bjørnstad et al. (2010). We base our study on the regular population forecasts of Statistics Norway. These projections give us the Norwegian population by age and gender and are used both in the macroeconomic projection using MODAG as well as in projections of the labour force by education using the MOSART model.

The standard version of the macroeconometric model MODAG, documented in Norwegian in Boug and Dyvi (2008), has only one type of labour. A version of the model where labour is divided into five educational groups is developed for the purpose of our analysis. Gjelsvik (2013) presents how this labour module is specified and estimated. The version of MODAG containing this labour module is presented in some more detail in Section 4. Here it suffices to say that total demand for labour by industry depends on technological progress and factor substitution with other inputs. Thus relative factor prices play an important role for labour demand in the long run. In addition, there are substitution possibilities between the various categories of labour where relative wages for the different groups matter for demand within industry. Demand for these five educational groups by industry is further divided into 28 educational fields. The employment shares within each main educational group within an industry are exogenous and here relative wages do not play any role in the model. These assumptions imply that there is substitution between employees with different educational levels but not between employees at similar levels. You can not substitute a plumber with a carpenter but you can substitute a carpenter with an engineer. Historical trends in these shares observed from past decades are generally prolonged in order to forecast the composition of labour by industry.

On the supply side of MODAG, labour force by the five educational categories are determined by linking equations for labour market participation by age and gender to the corresponding groups of individuals of working age. The difference between total supply and demand defines the corresponding rates of unemployment. Hourly wage rates are determined by estimated wage equations where various rates of unemployment enter. Although wage rates affect labour market participation rates, as well as demand for labour in a way that reduce imbalances, the speed of adjustment according to the estimated wage equations are not sufficient to avoid that unemployment can be quite persistent. According to the estimated wage equations some educational categories respond mainly to group specific unemployment while others respond only to general labour market features. These differences reflect various institutional features of wage bargaining in Norway with wages in the public sector being the most centralized and least responsive to group specific labour markets features.

Labour supply by education is also projected using the demographic-based dynamic microsimulation model MOSART, see Fredriksen (1998) and Gjefsen (2013) for a documentation of the model. Consistency between the two labour supply projections is ensured by using the most recent official demographic projection as a basis for both. Educational propensities and detailed participation rates differ by age and gender. Educational choice does not respond to mismatch in the labour market such as varying rates of unemployment. Thus, there may be discrepancies between the projections from the models and these discrepancies may be viewed as indications of potential mismatches.

3. Classification by education

In this study, we disaggregate labour by education instead of occupation for the following reasons:

- Information about a person's education is available from administrative registers covering almost the entire population. The distinction between different occupations is not as evident, and moreover, a person's occupation may change if he or she moves from one industry to another. A person's educational level is fixed until he or she eventually fulfils another level of education, and this possibility is taken into account in the MOSART model.
- Education is a more precise measure of skill.
- Based on the results from the projections the authorities may adjust the educational capacity for different fields of education.
- Choice of education makes data organization easier because data may be collected from administrative registers.
- Population and labour force are divided by education in MOSART, and it would have been costly to construct a model projecting labour supply by occupation.

For labour market authorities responsible for vocational training, it would be advantageous if labour were divided by occupation. By merging information about education and industry, it is possible to meet these needs by defining educational groups with close correspondence to occupation. This is also an important reason why we have chosen to include 28 educational groups to meet the need for detailed information, see Table 3.1. In the division into the 28 groups the aim of greatest possible homogeneity within subgroups regarding supply and demand for labour is taken into account.

Since the former version of the projections published in Bjørnstad et al. (2010), a resource-intensive updating of educational data and connections for educational behaviour in the MOSART-model was completed in 2012. This updating is documented in Gjefsen (2013), and preliminary projections of labour supply for selected kinds of labour that are consistent with the demand side were published by Gjefsen et al. (2012).

The five main levels of classification and further sub-classification of the educational fields are presented in Table 3.1. These levels are in accordance with the typical design of the Norwegian educational system and follow the Norwegian Standard of Classification by Education (NUS 2000) documented in Statistics Norway (2000). This classification corresponds closely with the International Standard Classification of Education (ISCED97). To restrict the total number of educational groups to 28, each of the three upper levels of education are divided into about ten fields. The number of employed by level and field in the data basis from 2010 is compared to the corresponding numbers from 2006 used as the basis for projections at the demand side by Bjørnstad et al. (2010). The numbers at the aggregate level are taken from the National Accounts using the same data sources to secure consistency.

The distribution in field of education is made by using administrative registers. Improvements are made in handling the classification as well as the preparation of the data. Generally, compared to the data from 2006 this work has caused the number of employed by specified educational fields to increase more than what has actually been the case. On the other hand, the numbers for "other education" in the different levels have decreased. Especially the number of persons with education from economics and administration higher degree has improved due to the data work. However, the data quality for dental studies has been reduced. The reason is that administrative registers for wage earners are used, underestimating the share of dentists, as a majority of them work as self-employed. The number of teachers at higher degree is significantly underestimated as most of them are classified

according to their field of education and not the specific education making them qualified as teachers.

Table 3.1. Classification by education and corresponding numbers of employed in the 2010-report (by 2006) and now (by 2010). 1,000 persons

Code	Field of education[1]	2006 (2010-report)	2010
0	**Total, including unknown**	**2,362.1**	**2,590.4**
1	**Primary and Lower secondary education (ISCED 0-2)**	**499.3**	**578.7**
2a	**Upper secondary education general programs (ISCED 3 and 4)**	**462.7**	**429.0**
2.1	General programs	283.7	288.2
2.2	Economics and administration	179.0	140.8
2b	**Upper secondary education vocational programs (ISCED 3 and 4)**	**607.2**	**701.6**
2.3	Electronics, mechanics work and machinery	188.3	240.1
2.4	Building and construction	83.5	113.6
2.5	Other fields of science, technique and crafts	95.6	140.7
2.6	Nursing and care giving	87.6	101.9
2.7	Other fields, upper secondary education	152.3	107.6
3	**Tertiary education, lower degree (ISCED 5, lower degree)**	**591.7**	**651.8**
3.1	Humanities and arts, lower degree	41.9	45.5
3.2	Education, lower degree	142.1	151.6
3.3	Social sciences, business and law, lower degree	29.2	37.8
3.5[2]	Economics and administration, lower degree	116.4	117.8
3.6	Engineering, lower degree	66.2	72.6
3.7	Other fields of science, lower degree	28.4	57.5
3.8	Nursing and care giving	72.8	82.9
3.9	Other fields of health and social services	55.3	56.4
3.10	Other tertiary education, lower degree	39.6	29.9
4	**Tertiary education, higher degree (ISCED 5, higher degree and ISCED 6)**	**177.9**	**229.3**
4.1	Humanities and arts, higher degree	22.2	25.0
4.2	Education, higher degree	6.1	5.5
4.3	Social sciences, higher degree	16.9	22.9
4.4	Law, higher degree	17.5	19.6
4.5	Economics and administration, higher degree	10.5	33.2
4.6	Graduate engineering	31.2	35.9
4.7	Other fields of science, higher degree	33.9	43.1
4.8	Medicine	14.5	18.0
4.9	Dental studies	6.7	2.6
4.10	Other tertiary education, higher degree	18.5	23.6
9	**Unknown**	**23.3**	**-[3]**

[1] The classification translated into Norwegian may be found in Bjørnstad et al. (2008).

[2] A group numbered 3.4 is skipped to obtain the same sub-number for corresponding groups with a lower and higher degree in tertiary education.

[3] In the data basis for employed persons by education in 2010 employees with unknown education are categorized together with those with basic education (cf. section 6.1)

Source: Statistics Norway.

4. MODAG – a model of the Norwegian economy

MODAG is a macroeconomic model for the Norwegian economy developed by Statistics Norway. The model is used for forecasting and policy analysis. In this section, we provide a short description of the model. Cappelen (1992) provides a more detailed presentation of an earlier version of MODAG with homogeneous labour, and Boug and Dyvi (2008) present the most recent version in Norwegian. Bjørnstad and Skjerpen (2006) describe the education-specific wage formation while Gjelsvik (2013) provides a documentation of the most recent model of labour by education and industry.

MODAG is a disaggregated model specifying 45 products and 22 industries. The model contains a large number of final uses (consumption, investment, and exports) of products, and these products have different prices depending on supply (home produced or imports) and destination (exports or home market).The Norwegian National Accounts provide the conceptual framework and the empirical basis of the model. Specifically, MODAG balances all products in terms of supply and use equations. The input-output structure and the account-based relationships

are supplemented with econometric equations describing how the agents tend to respond to different options.

Long run behaviour is based on fairly standard neoclassical economic theory, and in this respect MODAG has some similarities to standard Computable General Equilibrium (CGE) models. However, the dynamic adjustments towards the long run are largely estimated to fit the data. Because of the sluggish nature of most economic variables, it takes some time before the effects of exogenous shocks die out and economic developments follow in line with equilibrium relations. Wage- and price-rigidities lead to Keynesian effects in the short and medium run and in this respect MODAG is very different from a CGE model. In a standard CGE-framework a typical assumption would be that wages adjust so that demand and supply of labour, and in our case various types of labour, is equal (or in practise unemployment is equal to its "natural" and exogenous level). In MODAG however, unemployment is one of the factors that helps wages adjust following an exogenous shock to the system. So while shocks create imbalances, MODAG does not assume that relative prices adjust immediately to balance changes in demand and supply. This will also lead to standard multiplier and quantity adjustments in addition to price adjustments.

To simplify our presentation of MODAG we focus on three main markets, the financial market, the product market and the labour market. The main structure of the model implies that prices – along with interest rates, exchange rates and wages – determine demand from households and firms as well as foreign demand. The use of resources in the government sectors is exogenous in the model although the model user should adjust the assumptions to adhere to the fiscal policy rule introduced in March 2001. For a specific interest rate differential, the exchange rate between the Norwegian kroner and the Euro is determined by parity in consumer prices in the two monetary areas.[1] This parity gives a stable real exchange rate. Higher interest rates in one area strengthen the currency in real terms. A higher oil price will appreciate the real value of the Norwegian kroner. The money market interest rate equation mimics the Central Bank behaviour in the current regime of inflation targeting. Interest rates increase with a higher core inflation rate and with a lower unemployment rate in line with flexible inflation targeting introduced in Norway also in March 2001.

Products are generally assumed to be imperfect substitutes. This implies that Norwegian product prices can differ from prices set by foreign competitors. But foreign prices are taken into account by Norwegian producers in their price setting in line with theories of monopolistic competition. Norwegian prices on exports and home market are set as a mark-up on the firm's variable costs. The mark-ups usually increase if prices on competing goods produced abroad increase. Foreign prices also affect the firms' costs through imported inputs of production. For a detailed discussion of the pass through of exchange rates and import prices to domestic prices in the model, see Boug et al. (2013).

The volume of exports for each product depends on a world market demand indicator and the Norwegian export price divided by the foreign competitors' price in a common currency. Thus we may say that exports in general are demand driven. Import of each product is in general an imperfect substitute for the corresponding Norwegian product. The import share for each product is a function of the home price divided by the import price only. The detailed input-output structure captures variations in import shares by user in the base year of the model. An increase in domestic use will lead to more imports for a given import share. Some imports are considered as non-competitive in the sense that there is really no

[1]The other exchange rates in the model – most importantly US dollars Swedish kroner are fixed to the Euro rate.

corresponding Norwegian production. In these cases imports are basically determined directly from the supply and use equations in the model.

In line with institutional aspects of Norwegian wage formation, the model distinguishes between three main sectors when modelling wage formation: manufacturing, private services and the public sector. Relative wages for the various industries within each of these main groups will normally be constant in the long run. The National Accounts provide data on hours worked, employment and hourly wage rates for various production sectors by the five educational categories for the period 1972-2010. Time series for labour supply by education category were constructed using education-specific unemployment rates from Statistics Norway's Labour Force Survey. These data were used to construct a version of MODAG with education-specific sub-markets of labour thus making labour a heterogeneous factor. By estimating wage equations for each of the five educational groups in each of the three main sectors, an explicit measure of wage flexibility is obtained. Both total and education-specific unemployment rates affect wage differentials. An increase in the general unemployment level strongly moderates wages of workers with primary or secondary education, while those with tertiary education are not much affected by the general unemployment level in wage negotiations according to the model. On the other hand, those with a higher degree in tertiary education seem to focus more on the development in unemployment among their own members than other groups according to our econometric findings. This suggests that an increase in general unemployment will affect wage differentials due to slower wage growth for those with the lowest education. If, in addition, an increase in unemployment particularly affects less educated persons, wage differentials will further increase. However, an increase in unemployment for those with higher tertiary education will reduce wage differentials vis-à-vis other groups. The development in education-specific unemployment rates is found to affect public sector wages more than in other sectors of the Norwegian economy.

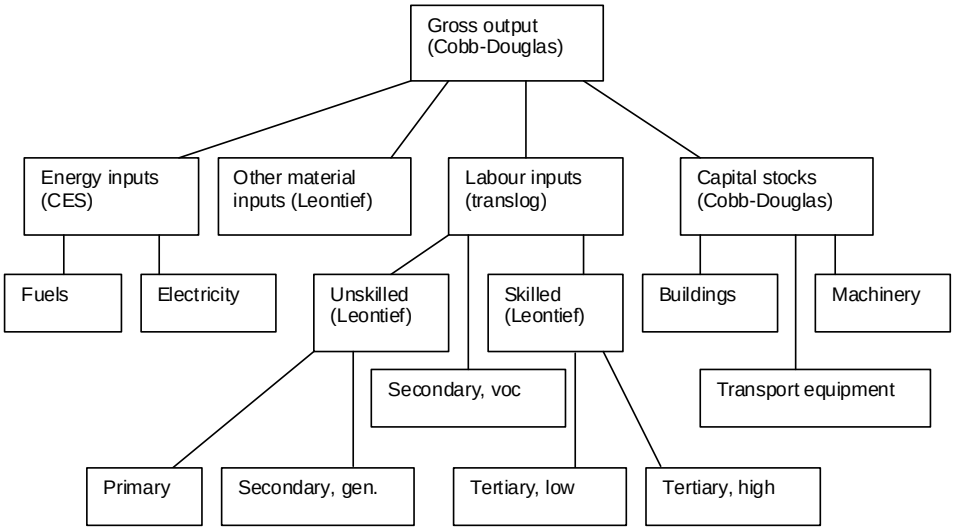
In manufacturing, wage costs follow in line with labour productivity and product prices in the long run, given that no changes occur either in the total or education-specific rates of unemployment. In addition to variables that are of significance in the long run, changes in consumer prices and in the payroll tax rate also affect wage growth. Tertiary educated workers are compensated for increases in consumer prices to a higher degree than those with a primary or secondary education. In private and public services, wages depend on the so-called alternative wage alongside total and education-specific unemployment rates. The alternative wage in private services is a weighted average of hourly wages in manufacturing and the public sector, while the alternative wage in the public sector is a weighted average of hourly wages in manufacturing and private services. Also the unemployment benefit ratio affects alternative wages. For a given unemployment rate, the wage trend for each education category in the service sectors, follow the wage trend for the same education category in manufacturing. If the composition of labour stays the same in all three sectors, the average wage level in each sector will also develop in parallel in the long run.

The version of MODAG used in this study distinguishes between eleven different factor inputs in each industry. In addition to five different types of labour, material inputs are divided in two subgroups where energy consists of electricity and fuels within a CES structure (constant elasticity of substitution) while other material inputs are contained in a Leontief aggregate with no substitution within the aggregate. The stock of real capital by industry is disaggregated into three components.[2] The advantage of the disaggregated production structure in MODAG is that it can account for considerable heterogeneity between production processes;

[2] Real capital is disaggregated further in the petroleum industries but here gross investment by category is exogenous. Capitals stocks are determined by a standard accumulation function assuming geometric depreciation. In some industries transport equipment not only includes vehicles but also ships and airplanes.

some are labour-intensive, while others employ relatively little labour. Firms' demand for various types of labour will vary across industries. Hence, changes in industry structure will affect the relative demand for different types of labour at the aggregate level. Figure 4.1 gives an overview of how the inputs are combined in all 15 private industries. In Agriculture & forestry, Fishing and Aquaculture (3 industries) there are no substitution between labour inputs and the aggregate is Leontief and aggregate labour inputs enter only at the upper level. In three government sectors aggregate labour input is exogenous and is disaggregated according to a Leontief structure.[3]

Figure 4.1. The nested production structure by industry



Source: Statistics Norway.

In 15 industries the demand for input factors is based on a Cobb-Douglas production function in materials, a CES-aggregate in energy and a translog-aggregate in labour with vocational education and high- and low-educated labour. Capital stocks enter as inputs in the Cobb-Douglas aggregate at the upper level. There is Hicks-neutral technological change represented by an exogenous total factor productivity factor by industry. All industries have constant returns to scale except for Building & construction (decreasing returns to scale) and Domestic transport (increasing returns to scale). In the translog-structure the factor shares depend in general on relative wages, the stock of capital divided by gross output and a trend, which in the absence of observable variables, is assumed to represent skill-biased technological change (but possibly also other factors). A technical and complete description of demand for various labour inputs is given by Gjelsvik (2013).

The econometric analysis of the behavioural equations for labour demand or cost shares for various types of labour, shows that the trend variable is positive for highly educated labour and negative for labour with low education. This implies that the marginal product of skilled labour is increased more than that of unskilled labour due to technical change, so there is skilled biased technical change, see Acemoglu (2002).

The MODAG model assumes that there is no substitution between the different types of labour within the two aggregates, high- and low-skilled labour. This means, for example, that a 1 per cent increase in the number of hours worked by those with a high education level translates into a 1 per cent increase in the number of hours worked by the two educational groups that belong to this aggregate. This change is further disaggregated to the various groups that belong to these categories. All substitution is therefore confined to the level of the five groups and

[3]The 22nd industry is housing rents but this sector has no input of labour.

not at the most detailed level. Note also that we assume there is substitution between labour with different education. We do not have data on different tasks or jobs. In principle an employee may have high education but has a job that does not correspond to or need this level of education. This employee will be aggregated together with other employees with a similar education although they may perform different tasks. Therefore, to the extent that there is mismatch in our data in the sense that individuals have jobs for which they are "overeducated", this is not reflected in our measures of imbalances between supply of and demand for education.

As will be explained in Section 5.2 the baseline scenario shows that unemployment is fairly constant for the various educational groups. Since labour supply is the sum of employment and unemployment this implies that labour demand follows labour supply quite closely. In MODAG, unemployment is determined residually and labour supply is mainly determined by demographic variables and variables that capture labour market pressure. Labour supply increases if wages increase while demand for labour falls. Consequently, there are two relationships between real wage and unemployment: (i) the wage setting, resulting in higher real wages when unemployment is low and (ii) the demand for and supply of labour, creating higher unemployment as real wages increase through lower demand for labour. These two relationships jointly determine unemployment so that the real wage implied by the wage setting is consistent with the real wage consistent with the price setting and the demand for labour. If the unemployment rate is lower than this level, real wages will be higher, leading firms to reduce the demand for labour. The level of unemployment will increase until there is correspondence between the real wage rate implied by wage setting and the real wage rate consistent with the firms' price setting and demand for labour.

Domestic demand consists of household consumption and housing investments, gross investment, inventories, and use of various material factor inputs by firms and in the government sector. Firms' use of inputs follows from the structure shown in Figure 4.1. Gross investment by industry and type follow from the capital accumulation formula and the model of capital also presented in Figure 4.1 where various user costs of capital are included. Inventories and government use of material inputs are exogenous. The model involves a traditional Keynesian multiplier, where higher household income leads to more spending, which increases production in the next round and activates further growth in employment and income. In this way, the initial change in aggregate demand causes a change in aggregate output for the economy that is a multiple of the initial change. Flexible inflation targeting by the central bank will modify this Keynesian effect in the medium and long run due to increased interest rates that will increase household saving and investment in housing. There are also effects via the exchange rate that works to reduce exports and increase import shares that will counteract expansionary effects of changes in domestic demand.

5. Projections of the Norwegian economy towards 2030

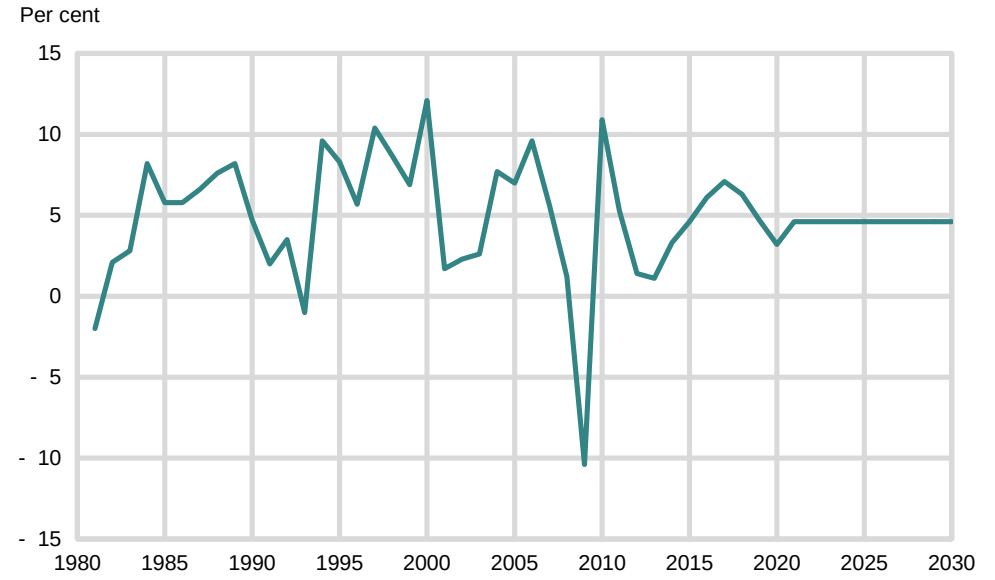
In this section we present a baseline scenario for the Norwegian economy from 2012 to 2030 using MODAG. The projection is based on final National Account data for 2010 and preliminary data for 2011 and 2012. The labour market module in the National Accounts extends only to 2010. This is why the simulation starts in 2010. Our focus is on medium and long-term development, not on short term cyclical features of the Norwegian economy, but the results are nevertheless consistent with recent developments and consensus forecasts for 2013 and a few years ahead. We first present some important assumptions in our baseline scenario before showing the macroeconomic results as well as employment by industry.

5.1. Assumptions for the baseline macroeconomic scenario

MODAG is a model of the Norwegian economy. In order to construct the baseline scenario we have to make a number of assumptions regarding developments in the world economy. These assumptions are important for a small open economy like the Norwegian economy. Secondly, we have to make assumptions regarding the details of fiscal policy in particular the use of resources in government production of services. Finally, we have to assume how the petroleum sector develops as this sector is very important for Norway. Petroleum production is to a large degree determined by the amount of remaining natural resources given that oil and gas prices are high enough to secure profitable extraction.

Figure 5.1 shows historical growth rates of imports for Norway's trading partners. This variable is important for the demand for many Norwegian products abroad in addition to relative prices according to the Armington-approach. The current market growth is very low reflecting poor growth in the OECD economies and in Europe in particular. We assume that a moderate cyclical upturn will begin in late 2014. During the 2020s annual growth rates are assumed to be in line with the historical average for 1982-2012 which is 4.6 per cent.

Figure 5.1. Growth in export markets. Per cent



Source: Statistics Norway.

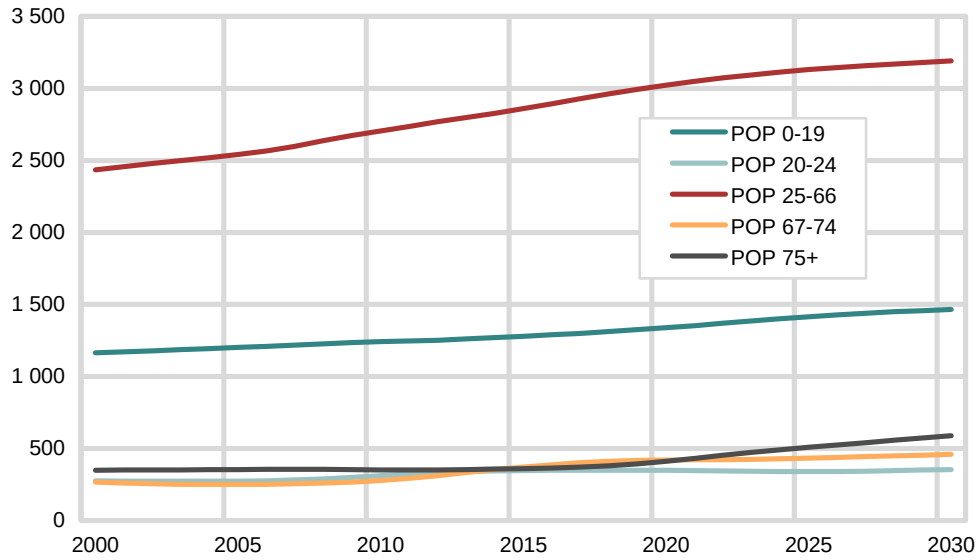
We further assume that after a few years of very low consumer price inflation, the inflation rate will equal roughly 2 per cent annually in the euro area from 2018 in line with inflation targets of many central banks. The money market interest rate in the euro area is assumed to increase from the currently very low level to 4 per cent in 2018 and be constant thereafter. World markets prices on manufactures are assumed to increase only by half a per cent. The crude oil price (Brent Blend) is currently (September 2013) roughly 110 USD per barrel. We assume it will decline to 100 USD by 2014 and stay constant at this nominal level until 2015 when it will increase in line with consumer price inflation so that the oil price is constant in real prices from 2015-2030. The average export price on natural gas is held constant in nominal terms reflecting a somewhat bleaker market outlook than for crude oil. This implies a reduction in the real price of gas by almost 50 per cent from 2010 to 2030.

Fiscal policy is specified in accordance with the fiscal policy rule that was introduced in Norway in March 2001. We assume a nominal return on the government pension fund of 5.5 per cent annually implying a real return of 3.5 per cent using international consumer price inflation (CPI) as deflator. In 2013 the

structural oil adjusted deficit is slightly less than this return and we assume the adjusted deficit to follow the rule over time, but not every year. Public consumption is assumed to grow by 2-2.5 per cent until 2020 and 2 per cent thereafter. Public investment in infrastructures increases by 5 percent during the next few years and then 2 per cent from 2016 to 2030. Total investment in the public sector is also affected by purchases of new fighter aircrafts during the period 2015-2024, amounting to more than 60 billion kroner during these years. From 2017 to 2024 military investments in aircrafts are 7 billion kroner annually. Tax rates are reduced slightly from 2014-17 and are then held constant until 2030. Social transfers grow in line with entitlements and are mainly driven by demographic trends following the population forecast from 2012. Nominal growth in the "base amount" (Grunnbeløpet) follows wage growth.

Figure 5.2 presents the main features of the most recent population forecast. Due to high immigration the Norwegian population is forecasted to increase quite rapidly during the coming two decades. The ageing of the Norwegian population takes place in particular after 2020 when the population 67 years and older increases markedly. The number of young people (0-19 years) is increasing somewhat while the potential "student" population (20-24 years of age) is quite stable. The population in the "core" working age group (25-66 years) increases rapidly at the moment but this growth rate is forecasted to decline somewhat due to lower immigration during 2020-2030. In our scenario the number of elderly people largely determines pensions and government transfers as well as spending on social care while the number of young people is important for government expenditures on education.

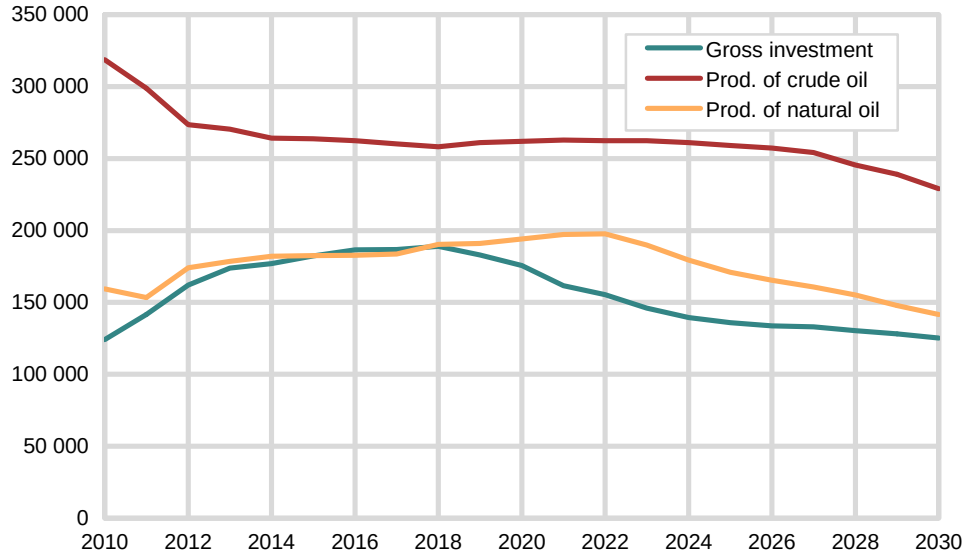
Figure 5.2. Population 2000-11 (registered) and forecasted (2012-2030). Thousands



Source: Statistics Norway.

Finally, we present some details on expected developments for the Norwegian petroleum extraction industry. Investments in explorations and extraction are at a high level currently but are expected to decline from 2020 and through the rest of the simulation horizon. Gross output in the extraction industry in 2010 prices will start declining a few years later when natural gas exploration starts falling. Crude oil production falls less and mostly towards the end of the 2020s. These assumptions are largely based on information from the government Petroleum directorate in 2009.

Figure 5.3. Gross investments and production in petroleum. Million NOK. 2010 prices



Source: Statistics Norway.

5.2. Macroeconomic trends in the baseline scenario

Table 5.1 summarizes the macroeconomic development in the projections. We do not focus on providing a forecast that tries to capture the details of current business cycle movements, although there are some features resembling a traditional business cycle from 2010 to 2020. Instead our focus is on medium to long run features of the economy that are important for industry developments and demand for labour with different education and/or skills. Thus the key macroeconomic variables move close to their expected long-term trend and demand for labour by education in our analysis results mainly from structural rather than cyclical factors.

The Norwegian economy experienced a marked downturn following the international financial crisis. Nevertheless, the crisis in the Norwegian economy has been mild in comparison to most OECD- countries. At the peak in 2007 the Norwegian unemployment rate was only 2.5 per cent, as measured by the labour force survey, and had increased to only 3.2 per cent in 2012. Data for 2013 indicate an increase to 3.5 per cent, and in our scenario there is not much further increase. The unemployment rate is forecasted to stay around this level in the longer term according to the baseline scenario. This level is not far from the historical average of the previous three decades. Total GDP is expected to grow less than GDP in the mainland economy due to the decline in petroleum extraction. This also explains why total exports grow less than exports of traditional goods. The very moderate growth in gross investments in spite of high growth in government investment is mainly due to lower investments in the petroleum sector that is expected during the 2020s. Household consumption grows in line with growth in households' real disposable income. There is a decline in households saving ratio during the first five year period until this ratio is fairly constant at 5 per cent during the rest of the simulation period. The relatively high growth in consumption relative to mainland GDP is partly due to increased pension payments and demographic changes but also because of slightly lower taxes in the coming four years. The room for fiscal stimulus according to the fiscal policy rule is partly used for higher military expenditures on investments and growth in public consumption related to the ageing of the population.

Real consumer wages grow by approximately 1.5-2 per cent annually. Nominal wage growth, combined with a relatively stable exchange rate at approximately 7.7 per euro, lead to a fairly constant terms of trade for the exposed sector, which expands less than the rest of the economy. The slightly lower growth in real wages during 2016-20 is mainly due to somewhat higher unemployment that reaches a

peak in 2020. In addition, lower productivity growth related to low growth in the capital stock (determined by low gross investment in the private non-oil sector) also affects real wages.

Table 5.1. Macroeconomic projections (annual growth rates if not stated otherwise)

	2011-15	2016-20	2021-25	2026-30
National accounts data				
Household consumption	3.3	2.7	3	2.5
General government consumption	2.3	2.3	2.1	2.0
Gross fixed investment	6.2	0.5	0.3	1.3
Exports	0.6	1.9	1.4	1.3
Exports, traditional goods	2.0	4.0	3.6	3.4
Imports	4.1	3.1	2.7	2.8
GDP	2.1	1.6	1.7	1.5
GDP, mainland	2.8	2.0	2.3	2.1
Labour market				
Hours worked, total	1.6	0.9	0.9	0.9
Labour force	1.4	1.1	0.8	0.5
Unemployment rate, level in per cent	3.4	3.5	3.6	3.5
Prices and wages				
Wage per hour	3.9	3.8	4.1	4.2
Consumer Price Index (CPI)	1.7	2.1	1.9	2.3

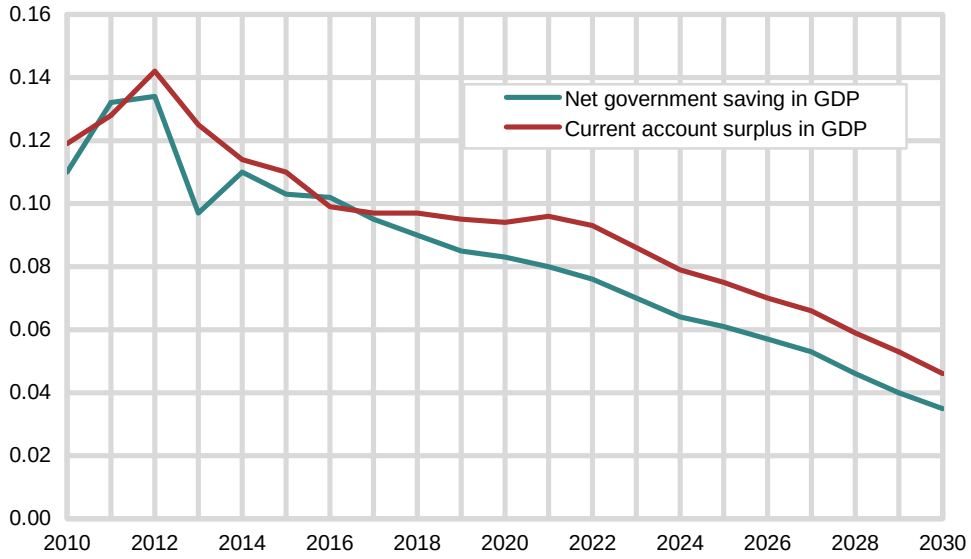
Source: Statistics Norway.

The labour participation rate fell during the years of the financial crisis and has not yet fully recovered. We expect labour participation to stay around 71 per cent in the next coming years and then to increase to nearly 72 per cent by the mid 2020s. Basically we therefore forecast a stable participation rate and that labour supply in Norway tracks labour demand quite closely as unemployment is stable too. The declining growth of the labour force is therefore due to demographic factors and lower immigration in particular. Immigration is expected to remain high for some years, but then decline markedly during the 2020s. There are at least two arguments for a somewhat higher participation rate in the future. First, labour force participation is higher for those with a tertiary education compared to those with a primary or secondary education. Since the number of tertiary educated persons increases while the number of persons with less education decreases in our projections, we expect the average participation rate to increase as well. Secondly, higher real wages lead to higher labour supply in particular in terms of hours per employee. On the other hand labour participation rates for some immigrants are quite low and this will lower aggregate participation rates. An ageing population will do the same but participation rates for those 62 years and older has been increasing for some time and this counteracts some of the ageing effect.

Total exports grow much less than imports. This is due to declining production of oil and gas. Terms of trade does not change very much, partly due to our assumption of a constant real oil price. Norway has been running surpluses on its current account for a long time. From 1996 and onwards the government has been investing its budget surplus abroad in a pension fund leading to a close relation between the current account surplus and net financial investment by government. This is also seen in the baseline scenario in the years ahead and is shown in Figure 5.4.

The moderate growth in total exports and petroleum production is also the main reason why total GDP is expected to grow very slowly compared to historical trends until 2030. Mainland GDP, however, grows more in line with the current trends. The decline in the growth rate is mainly caused by lower growth in labour supply due to demographic factors and lower immigration. If we look at the growth rate in labour productivity (approximated by the growth rate in mainland GDP minus total number of hours worked), we see that our baseline scenario forecasts a fairly stable productivity growth of 1-1½ per cent annually.

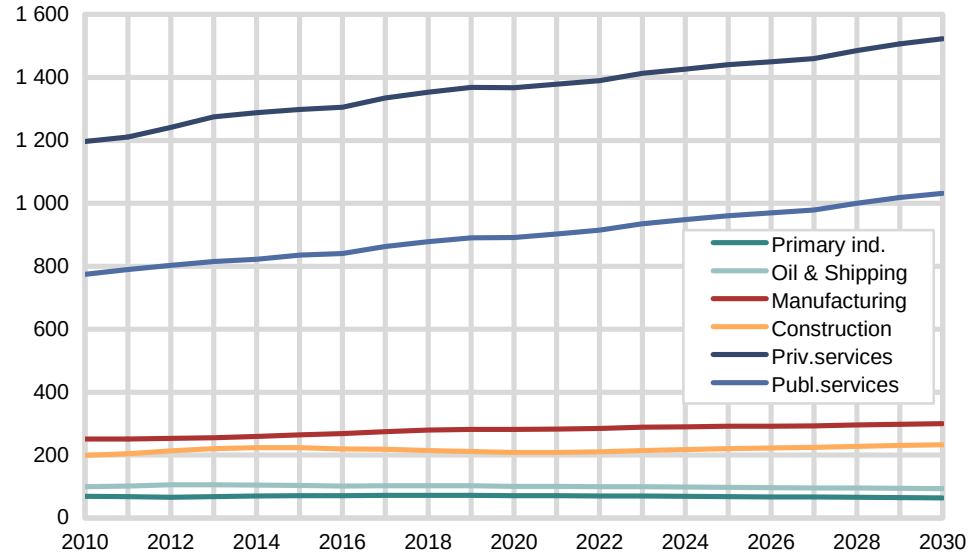
Figure 5.4. Current account and net government saving as share of nominal GDP



Source: Statistics Norway.

The structure of employment by industry is important for the demand for different skills. Figure 5.5 shows total employment by some industry aggregates, while Figure 5.6 shows the relative composition of employment. We forecast moderate decline in employment in primary industries,[4] with continuing decline in agriculture but some increase in fish farming. In Manufacturing,[5] total employment is fairly constant in the years ahead due to more employment in industries related to offshore activities. Construction and Electricity production is also quite stable with some moderate increase. Employment in services industries both private and public, are expected to increase considerably.[6] This is a fairly standard feature of all projections of the structure of employment in Norway.

Figure 5.5. Employment by sector, 1,000 persons



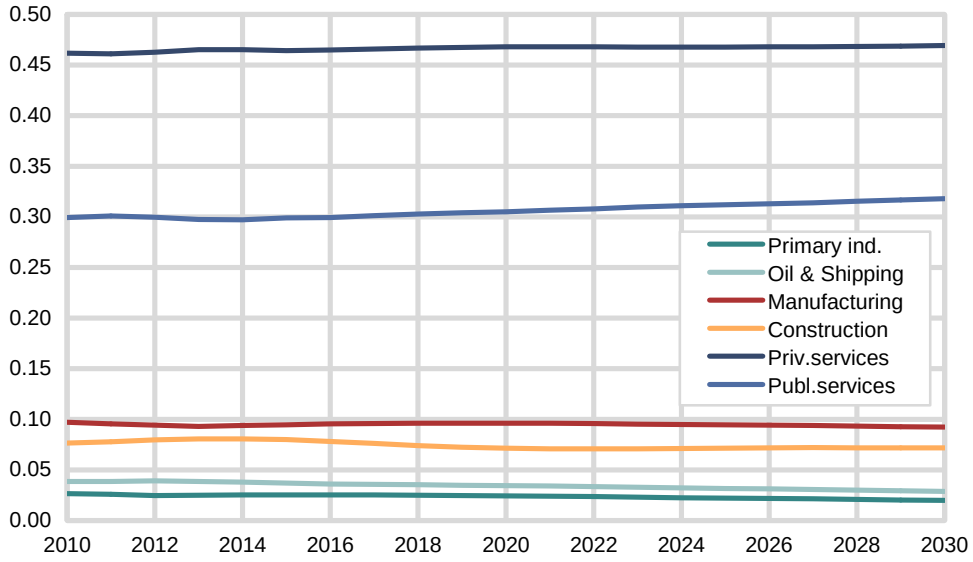
Source: Statistics Norway.

[4] Primary industries consist of agriculture, forestry, hunting and fishing and fish farming.

[5] Manufacturing includes production of consumer goods, products of input and investment, industrial raw materials, workshop products, ship and oil platforms and production and refining of petroleum products etc.

[6] Private services include services in banking and insurance, retail, domestic transport and communication including air transport, housing services and other private service activities.

Figure 5.6. Employment by sector, share of total employment



Source: Statistics Norway.

In terms of relative shares of employment very little change is expected during the coming two decades. There is a small decline in shares of employment in primary and secondary industries while services increase their share in employment. The share of employment in the public sector is expected to increase by nearly two percentage points. This increase is mainly driven by demographic factors leading to higher demand for social services (health and social care for elderly people). The share in private services is expected to increase by one percentage point. Consequently changes in the skill structure are mainly driven by a relative increase in employment in services in general. In addition there will be changes in labour demand due to changes in the skill structure within industries.

Our current projection is quite in line with Cappelen et al. (2010) showing higher growth and employment than in Bjørnstad et al (2010). One important reason for this difference is that immigration was assumed to be lower in the demographic projection used by Bjørnstad et al. (2010). Our study is based on the "middle alternative" according to the most recent population forecasts by Statistics Norway.

6. Demand for labour by educational level

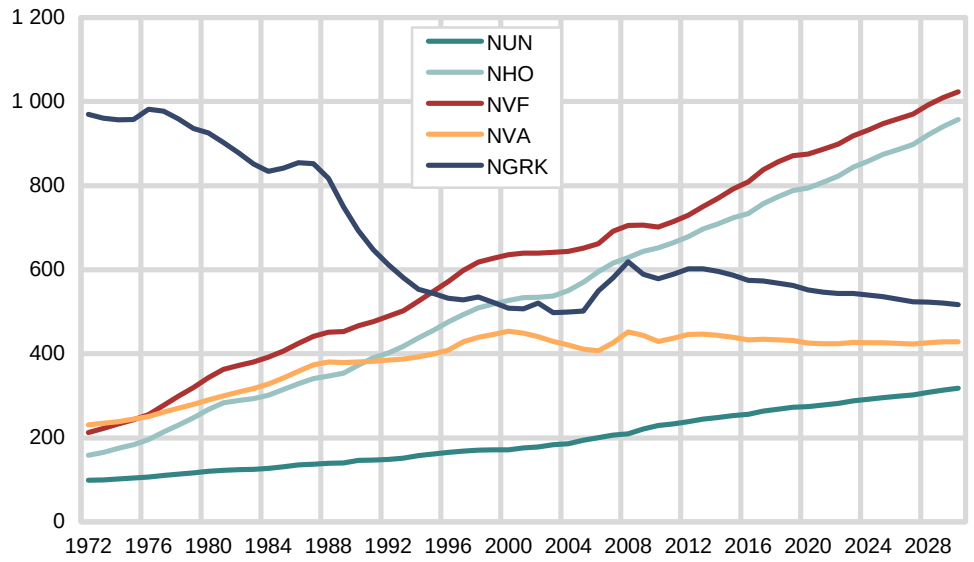
In this section, we present projections for employment by five educational groups towards 2030. These five groups are Primary education (including unknown), Upper secondary education, general programs, Upper secondary education, vocational programs, Tertiary education, lower degree, and Tertiary education, higher degree. Details regarding the aggregation are discussed in Section 3. As explained in Section 4, the macroeconomic model includes industry-specific employment disaggregated into these five educational groups. These groups are partly substitutes within each industry and the employment shares within each industry depend on relative wages and factors related to technological change such as capital stocks and deterministic trends. For government sector and primary industries we rely on exogenous assumptions regarding employment shares, see Appendix for details. In this section, we show the aggregate employment of these five educational groups and their relative wages. For each of the educational fields within these five groups, we project their employment share in every industry. Employment by these detailed educational fields is presented in Section 7.

6.1. Employment

Figures 6.1 and 6.2 show employment aggregated across all industries in the economy for each of the five educational groups in thousands and as percentage of total employment, respectively. Data for 1972-2010 are taken from the National Accounts. The number of employed persons with unknown education has grown in recent years and reflects the considerable labour immigration into Norway from EU-members in Eastern Europe. These immigrants have until recently not been registered with an education in the Register of the Population's Highest Level of Education. However, from 2011 and onwards educational information for immigrants has been collected through surveys and the number of people with unregistered educational attainment has decreased. This information has not been included in our historical data yet. Employees with unknown education are therefore categorized together with those who only have basic education in the data used for MODAG. The high level of immigration that is expected to continue for some years, will therefore lead to a larger increase in the labour force with basic education than what will actually be the case. But since immigrants are considered to have only basic education they are more likely than others to enter an educational career than if they were registered with higher education. Therefore immigrants upgrade their skills and do not belong to the group with only basic education permanently.

As we can see from Figure 6.1 the negative trend in employment of persons with primary and lower secondary education (NGRK) that was very strong from the late 1980s came to a halt by the early 2000s. In recent years this number has increased but this is mainly due to an increase in immigration. As mentioned earlier data on education is often missing for immigrants. Also the positive trend in employment of persons with upper secondary education, general programs (NVA) ended by 2000. The trend in the number of employees with upper secondary education vocational programs (NVF) has continued although the trend has been more moderate during the most recent decade. This is also the case for employees with tertiary education lower degree (NHO) while for those with higher degrees (NUN) the increasing trend have not changed much.

Figure 6.1. Employment by level of education in thousands of persons, 1972-2030



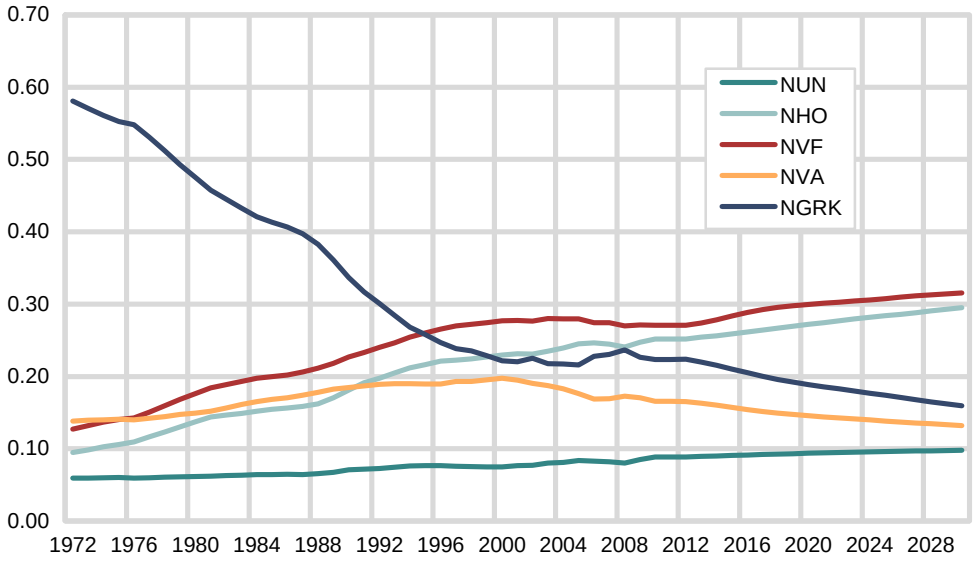
Source: Statistics Norway.

For the period 2010-2030, employment figures are generated using MODAG. Historical trends are forecasted to continue for employees with tertiary education. This is due both to changes in industry structure with increasing employment in service industries as well as changes within industries where technical change

seems to be biased in favour of those with higher education. As we shall see in Section 6.2, we do not forecast any major changes in the distribution of relative hourly wages according to education, so this factor is not driving changes in employment. This feature of our current forecast is roughly in line with previous studies, see Bjørnstad et al. (2010).

A noticeable feature of our forecast is that employment of people with Upper secondary education, vocational programs (NVF) is expected to increase during the coming decades. Even the relative share of employment is forecasted to increase according to Figure 6.2. This feature is mainly a consequence of within-industry changes. In previous studies, this feature was also present but is even stronger in our present study. The new disaggregated specification of labour in the production function, see Section 4, is mainly the reason for this change in the forecast. As we shall see one reason for this change in simulation results is due to a relative fall in wages for this group. The relative increase in employment for this educational group (NVF) comes at the expense mainly of those with basic education. The number of employees with Upper secondary education, general programs (NVA) is forecasted to be quite stable in the coming years according to Figure 6.1 which implies that the share of employment will continue to fall, see Figure 6.2.

Figure 6.2. Employment by level of education as a per cent of total employment, 1986-2030

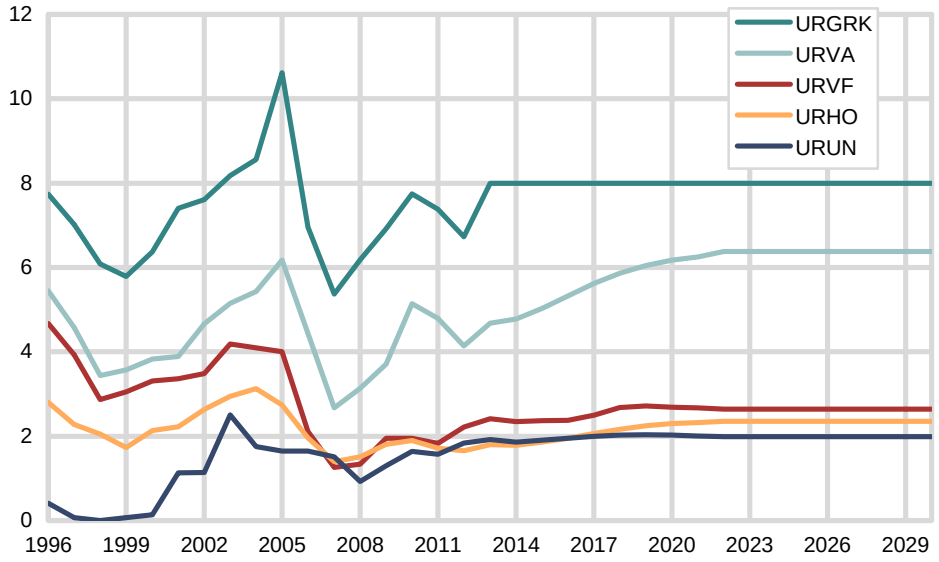


Source: Statistics Norway.

6.2. Relative wages and unemployment by education

By definition, labour supply is the sum of employment and unemployment. The education-specific unemployment rates are shown in Figure 6.3. We project a fairly constant unemployment rate for employees with basic education (URGRK), but an increase for employees with Upper secondary education, general programs (URVA). For the other groups, unemployment is increasing slightly according to our projection until 2020 and then declines somewhat. This is what generates the time profile for the total unemployment rate discussed in Section 5.2. Historically, there has been a close correlation between unemployment rates for the two groups with lower education (GRK and VA). As the GRK group has become more heterogeneous in recent years due to the fact that some immigrants with higher education are classified as having only basic education due to missing information, we think the difference between URGRK and URVA will be somewhat smaller in the future than what has been the case historically. The unemployment rates for the five groups are consistent with the macroeconomic forecasts presented in Section 5. However, they are not related closely to the gaps between supply and demand by educational field that are presented later in Section 9.

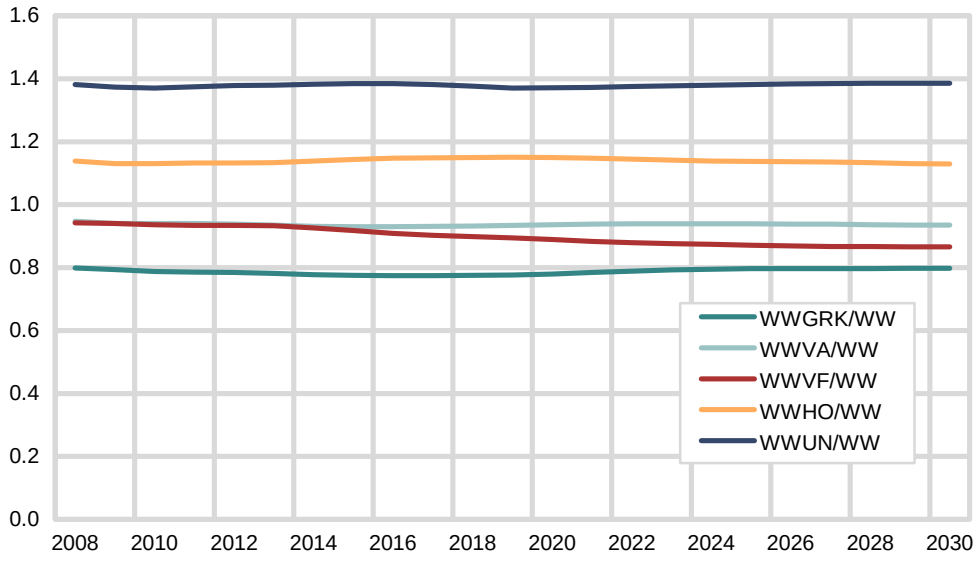
Figure 6.3. Unemployment rates by education



Source: Statistics Norway.

In MODAG, education-specific hourly wages are determined in each of the three main sectors of the economy; manufacturing, private services and public services. Wage determination in Norway is quite centralized and this feature has contributed to relatively stable wage differences in past decades. As shown in Figure 6.4, we expect relative wages to be quite stable also in the coming two decades. There is one exception and that is a decline in relative wages for those with Upper secondary education, vocational programs (WWVF) which is forecasted to decline somewhat. The reason is that the wage rate for this group has usually been quite sensitive to the general level of unemployment, but not the group specific unemployment rate. A somewhat higher level of unemployment therefore affects wages for this group relatively more than for other groups.

Figure 6.4. Hourly wage rates by educational group relative to the average hourly wage rate



Source: Statistics Norway.

7. Projected demand for labour by educational field[7]

In the previous two sections we explained how we used MODAG to project industry-specific employment by education, enabling us to account for changes in industrial structure that may affect demand for labour. However, MODAG does not contain any detailed information on employees' fields of education. In this section, we describe a sub-model in which employment by industry is disaggregated to specific educational fields.[8]

Bjørnstad et al. (2010) match the National Register of Employers and Employees made by the Norwegian Labour and Welfare Administration (NAV) with the Norwegian Register of the Population's Highest Level of Education - and the Central Register of Establishments and Enterprises. This match gave data on industry-specific employment by educational field from 1986 to 2006. By calculating education-specific employment shares and assuming a continuing trend in these shares, industry-specific employment was projected by field of education. The forecasting method implies that if employment of persons with an educational field in a specific industry has increased strongly in the data period, the future employment also increases, but at a slower pace.

All in all, the method of projecting employment by educational field used in this report is the same as in Bjørnstad et al. (2010). Data on industry-specific employment by educational field in the years 2009-2011 are used as a basis for the projections. At the aggregate level, the data are consolidated with the Labour Force Survey. In this way, the sub-model we use to disaggregate by educational fields is in accordance with the employment by education in MODAG in 2010 and 2011. Using these figures, we calculate employment shares by industry in 2009-2011. From 2013 and onwards, the employment shares by educational field in each industry mainly develop as in the projections from 2010. That is, we use the forecasting method described above.

The new data on employment by industry show some interesting trends. For example, the employment of persons with a lower tertiary degree in economics and administration grew strongly in all industries from 1986 to 2006. According to the new data, however, the share of employees with lower tertiary education who are educated in this field was generally lower in 2010 than in 2006. The share of employees with specialization in other fields of science has grown on a broad basis from 1986 to 2006 and has continued to grow according to new data. The employment share of engineers has continued to drop in the large service industries. In the manufacturing industries, however, the downward trend seems to have stopped. There is probably an underlying need for other competences in mainland industries, in particular persons with technical competence. In our current projection, the future increase in demand for candidates with a lower tertiary degree in economics and administration is somewhat lower compared to the 2010-projections. This has led to higher growth in the employment shares in some of the other fields at this education level.

At the higher tertiary level, the employment shares of persons specializing in economics and administration have continued to increase towards 2010, and the employment share of persons with this field of education is considerably higher than the projected number in the 2010-projections. The downward trend in the

[7]We would like to thank J. Ouren, A. Ekeland and E.M. Rossvoll for help in preparing the data used in this section.

[8] In MODAG, the employment of persons is determined by the firms' and the public sector's demand for labour. That is, the demand for labour with a particular field of education is the same as the employment of persons with this educational field. In the sub-model, we follow the same theoretical framework.

employment shares of graduate engineers have continued at a broad basis. The development in the employment shares of persons in other fields of science is more ambiguous at this level, with increasing use of persons with this field of education in manufacturing and decreasing use in the largest service industries and in construction throughout the data period.

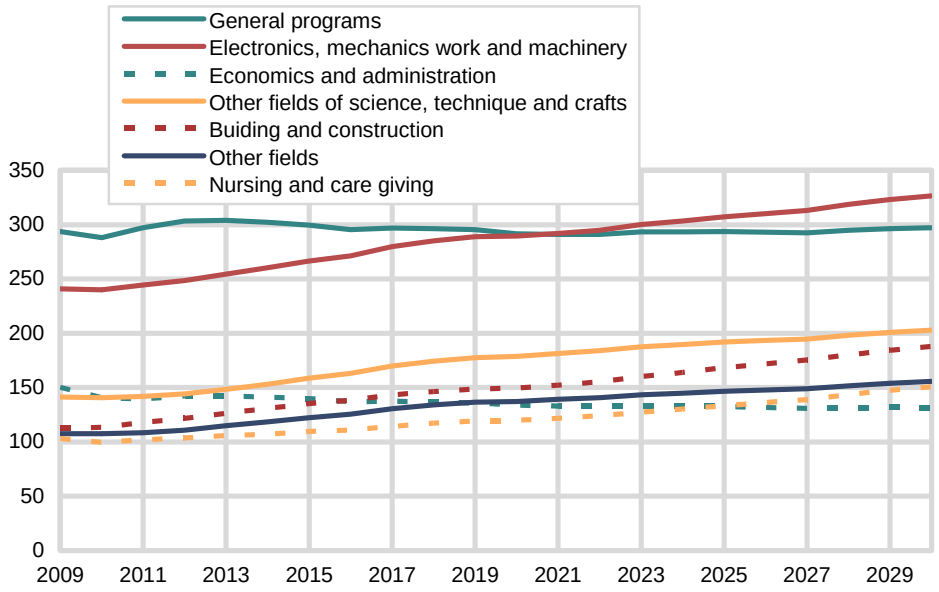
The demographic development underlying our projections has not changed much compared to the previous projections. Employment by educational field in the public sector is therefore based on the development in the employment shares from the 2010-report. This implies that the employment of persons in the health and social sector grows at the expense of persons with other educational backgrounds. But also the employment of persons specializing in teacher training or education is higher from 2016 and onwards compared to the 2010-projections. This is due to a somewhat higher anticipated size of the younger population, increasing the need for teachers. In general, the latest projections imply a stronger growth in demand for labour with tertiary education in the government sector compared to the 2010-report.

By aggregating across industries, we generate employment by educational fields from 2010 to 2030. Figure 7.1 presents the projected demand by educational field at upper secondary level in thousands of persons. The projections indicate growth in the demand for persons with a vocational education. In thousands, the growth in demand is particularly strong for persons with an education in electronics, mechanics work and machinery and in building and construction.

At the upper secondary level, we project a total increase in demand of 322,000 persons from 2010 to 2030. The employment of persons with a general education is expected to remain fairly stable. The employment of persons with an Upper secondary education general programs is projected to decrease somewhat. We project an increase in the demand for vocationally educated persons within all fields. The technical skills of a person with education in electronics, mechanics work and machinery is mostly demanded in the manufacturing industries, in building and construction and in exploration of oil and gas. Private service industries also employ this competence. This causes a sharp increase in the demand for persons having this education towards 2030. Other technical skills are also demanded by the manufacturing industries, the construction sector, and in private services. The largest service industry, other private services, is expected to increase total demand by 221,000 persons, 80,000 of them being vocationally educated. This industry makes use of workers with all fields of vocational education except nursing and care giving. The demand for workers with an education in nursing and care giving originates from the public sector.

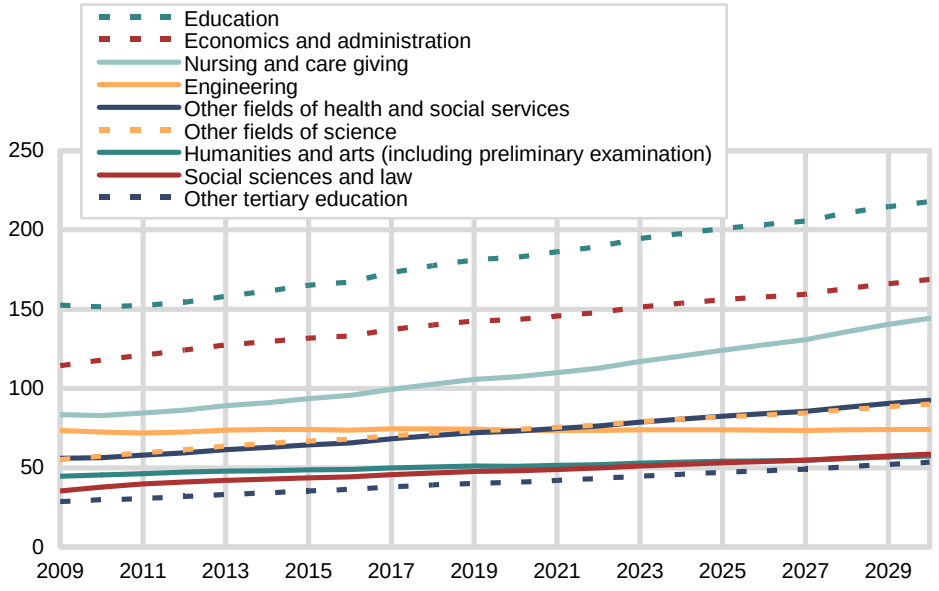
Our projection for the future demand at the upper secondary level involves a large increase in the share of demand for vocationally educated persons and a corresponding fall in the employment shares of persons with upper secondary general and economic administrative education. The employment of persons with general education is expected to fall from 25 per cent of total employment at upper secondary level in 2010 to 20 per cent in 2030, and the employment of persons with an education in economics and administration is projected to fall from 12 per cent in 2010 to 9 per cent in 2030. The demand for persons with a vocational education in electronics and mechanics work and machinery is on the other hand projected to increase from 21 per cent in 2010 to 22 per cent in 2030. The demand for persons educated in building and construction is projected to increase from 10 per cent in 2010 to 13 per cent in 2030, which is the strongest relative growth in demand by educational field.

Figure 7.1. Employment by education at upper secondary level, 1,000 persons



Source: Statistics Norway.

Figure 7.2. Employment by education at a tertiary level with a lower degree, 1,000 persons



Source: Statistics Norway.

Figure 7.2 shows the projected demand at the lower tertiary level. At this level, we project a total increase in demand of well 300,000 persons. We expect demand to grow within all fields. The demand for workers in the health and social sector and in the education sector is anticipated to be strong. The public sector is projected to increase the demand for workers with a lower degree at the tertiary level by 170,000 persons, and many of these are teachers and health and social workers. The demand for teachers is expected to increase by about 65,000 persons from 2010 to 2030. Further, the demand for persons specializing in other fields of health and social services and in nursing and social care is projected to increase by nearly 100,000 in total in the same period. The public sector is a large employer of persons with higher education. Public sector also demands persons specializing in economics and administration, social sciences, law and other tertiary education.

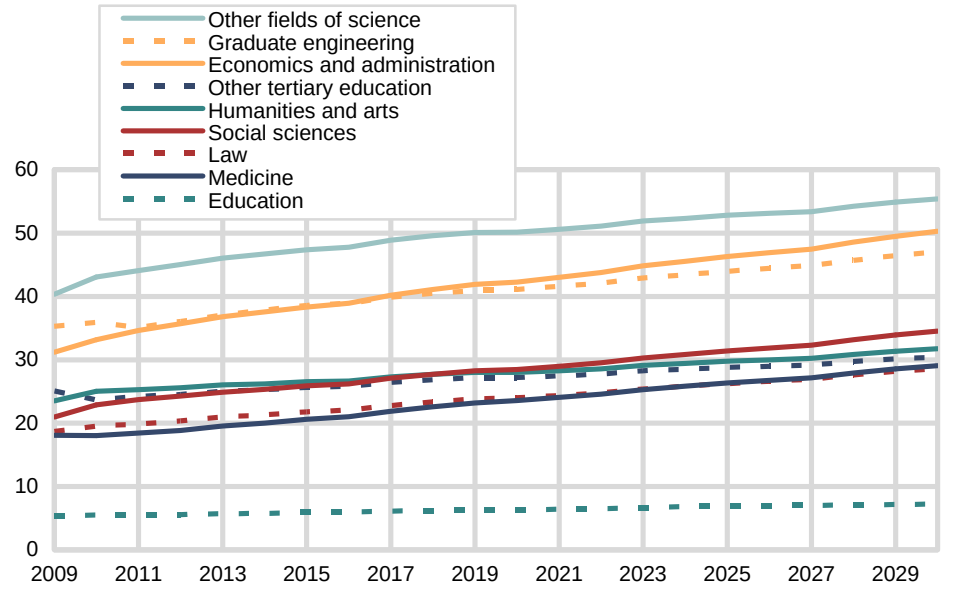
Demand for persons with a lower degree in economics and administration is expected to increase by well 50,000 persons. The employment increase mostly stems from private services, but the construction industry also employs persons

with such skills. The private service industries is expected to increase the demand for persons educated within social sciences and law, as well as for persons educated in other fields of science. Increased demand for technical skills at this level is also coming from the manufacturing industries and construction.

The projections imply that the share of workers with a lower tertiary education in nursing and social care, other fields of health and social services and in other tertiary education increases towards 2030, while engineers constitute a smaller share of workers at this skill level. The remaining educational fields are fairly stable or somewhat increasing. As we have mentioned in the beginning of this section, the employment share of engineers has fallen markedly in all private industries for many years, while the employment share of candidates with other fields of science has increased sharply. More recent data show that this development has continued and has become even more pronounced. This suggests that the need for technically skilled workers is high in the private sector, and that firms regard persons with a lower degree in other sciences as substitutes for engineers. In the projection period, we expect this substitution to continue, but not as pronounced as in the data period.

Moving on to the employment of persons at the highest educational level, Figure 7.3 presents the development in each educational field[9]. In thousands, employment increases most pronounced for persons specializing in economics and administration and in social sciences. The increase in demand for persons educated in economics and administration mostly stems from growth in private services, but also to some extent from the public sector and construction. Demand for persons with education in social sciences primarily stems from the public sector, but also private services make use of their competence. The projections suggest that the number of employees with a higher degree in economics and administration increases from 33,000 in 2010 to about 50,000 in 2030. For persons with a higher degree in social sciences, employment is predicted to increase from 23,000 in 2010 to about 35,000 in 2030.

Figure 7.3. Employment by education at a tertiary level with higher degree, 1,000 persons



Source: Statistics Norway.

The total increase in demand for persons with a higher tertiary education is projected to nearly 90,000 from 2010 to 2030. The demand for graduate engineers is forecasted to increase by well 11,000 persons. This is about the same

[9] Projections for dentists are excluded, because of poor data quality, see Section 3.

employment increase as for persons specializing in law, medicine and other fields of science. The projections imply that 19 per cent of the demand increase at this level is aimed at persons in economics and administration while 27 per cent is aimed at persons with a technical education.

Table 7.1 compares the projections made in this report to those made in 2010, see Bjørnstad et al. (2010). In the table, deviations in employment in 2010 and 2030 are shown together with projected employment levels in this report. While the deviation in 2010 is mostly associated with data improvements and the fact that 2010-figures were projected and not observed in Bjørnstad et al. (2010), changes in deviations towards 2030 are mainly due to new assessments in this new projection path, keeping in mind that total employment is projected to increase much more in the present study than in Bjørnstad et al. (2010). Consequently, deviations must increase on average. Table 7.1 shows that the employment of persons with a lower tertiary degree in economics and administration in 2010 amounted to 118,000 persons. This is 13,000 fewer than projected in 2010. In 2030, we project that there will be 169,000 employees with this field of education. This is 39,000 fewer than what we envisaged in the 2010-report.

Table 7.1. Employment level and employment deviations between the current analysis and Bjørnstad et al. (2010). 1,000 persons

	Level in this study		Deviation from Bjørnstad	
	2010	2030	2010	2030
Primary and lower secondary education, including unknown	**579**	**517**	**57**	**135**
Upper secondary education	**1 131**	**1 452**	**-2**	**200**
General programs	288	297	-6	58
Economics and administration	141	132	-45	-18
Electronics, mechanics work and machinery	240	326	39	74
Building and construction	114	188	22	55
Other fields of science, technique and crafts	141	203	40	82
Nursing and care giving	100	151	4	9
Other fields	108	156	-57	-60
Tertiary education, lower degree	**652**	**957**	**-4**	**17**
Humanities and arts, including preliminary examination	45	57	-18	-27
Education	152	218	-5	20
Social sciences and law	38	59	4	1
Economics and administration	118	169	-13	-41
Engineering	73	74	4	-1
Other fields of science	57	90	24	34
Nursing and care giving	83	144	3	20
Other fields of health and social services	56	92	-6	4
Other tertiary education	30	54	4	8
Tertiary education, higher degree	**229**	**318**	**34**	**45**
Humanities and arts	25	32	1	2
Education	5	7	-1	-1
Social sciences	23	35	4	6
Law	20	29	0	2
Economics and administration	33	50	20	24
Graduate engineering	36	47	2	2
Other fields of science	43	55	5	3
Medicine	18	29	2	7
Other tertiary education	24	30	4	3
Total	**2 590**	**3 245**	**84**	**398**

Source: Statistics Norway.

The employment of persons with primary and lower secondary education in 2010 amounts to almost 580,000, which is nearly 60,000 more than projected in Bjørnstad et al. (2010). In 2030, we project that the demand will decline to 517,000 persons. Nevertheless, this is 135,000 more than projected in the previous report. Moreover, the demand for persons with upper secondary education is considerably higher. While projected demand for labour with general education changes little according to our projections, we project that demand for labour with vocational education increases by 322,000 persons towards 2030. Bjørnstad et al. (2010)

projected a decline in the employment of persons with general education and a smaller increase in the employment of persons with vocational education. Both factors lead to a higher employment level in 2030 for persons with upper secondary education than previously reported. The sharp rise in demand for persons with vocational education mainly comes from the private sector. While some of the traditional manufacturing industries are predicted to demand fewer persons towards 2030 than envisaged in the previous projections, the engineering industry is predicted to increase the demand for labour. In addition, the construction industry and private services demands more personnel. All these industries demand vocationally educated labour with technical competence. Also, the share of workers with primary and lower secondary education or upper secondary general education is high in these industries. This development is part of the reason why the demand for persons with primary and secondary general education is higher in our projections, despite of an underlying substitution from unskilled to skilled labour in all industries. Both factors serve to increase demand for persons with vocational education.

Compared to Bjørnstad et al. (2010), the demand for persons with lower education at tertiary level is about the same in 2010, but 17,000 more in 2030. Total demand from public sector is about the same as in the previous report, but we assume that a larger share of the demand will be for persons with tertiary education. Many of these are needed within education and health. According to our latest figures, the employment of persons with a lower degree in the education sector amounted to 152,000 in 2010, somewhat lower than projected. Towards 2030, the demand for teachers is projected to increase to 218,000. This is 20,000 more than in the 2010-projections. The increase in demand for persons with a lower degree in nursing and caring or in other fields of health and social services is also projected to be higher than in the last report. We anticipate that 25 per cent of the increase in demand for labour with lower tertiary education in 2030 is for persons with a degree in these fields, while 22 per cent is for persons with a degree in education. The share of workers with a lower degree in economics and administration is lower than projected in 2010 and considerably lower in 2030. Our projections nevertheless imply that the share of demand for persons with lower tertiary education in economics and administration is stable towards 2030, measured in percent of total demand for persons with lower tertiary education. Our projections also imply that a larger share of the demand is aimed towards persons with a lower degree in other fields of science.

The total number of workers with a higher tertiary education is slightly increased compared to the 2010-projections and the deviations in 2030 are almost the same as in 2010. The higher level of public demand for persons with higher tertiary education in these projections has increased the demand for workers specializing in medicine as well as candidates in social sciences, humanities and arts, social sciences and law, but the overall impression is that the projections at the higher tertiary level are quite similar to what Bjørnstad et al. (2010) projected.

To summarize, we anticipate a further continuation of the educational upgrade. While the demand for persons with primary, lower secondary and upper secondary general education is projected to decrease, the demand for persons with upper secondary vocational education is projected to increase sharply towards 2030. Employment of persons with tertiary education is also expected to increase, and particularly for the group with a lower degree at the tertiary level. For example, the employment of candidates holding a lower degree in economics and administration is projected to increase by 51,000 persons, while the increase in demand for candidates with a higher degree within the same field is anticipated to increase by about 17,000 people from 2010 to 2030.

8. Projected labour supply by education towards 2030 using MOSART

MOSART is a dynamic micro-simulation model that simulates the further life course for each person in the entire Norwegian population. The model is used for projections of demographic development, education, supply of labour and pension expenditures in Norway. In the past decade, the model has been extensively used in analyses of the effects of the reform of the Norwegian pension system. The MOSART model is described by Fredriksen (1998).

The life course for each individual is simulated by possible transitions from one state to another given by transition probabilities depending on each individual's characteristics. The transition probabilities are estimated from observed transitions in a recent period and are calibrated to match aggregated statistics. Normally, the transition probabilities are kept constant, and the projections then show what will happen if everything continues as recently observed. Alternative scenarios based on different assumptions may be produced. These alternative scenarios then show the robustness of the reference scenario and/or consequences of alternative policies. Alternative assumptions for labour market participation rates for elderly workers because of uncertain effects of the pension reform are often introduced. This is also the case for labour market participation rates for women and immigrants. However, none of these alternative assumptions are discussed in this report. Due to the complexity and richness in detail of the educational module described below, alternative assumptions for educational behaviour are not introduced or discussed at this stage.

Events included in the simulation are migration, deaths, births, marriages, divorces, educational activities, labour force participation, and retirement. Public pension benefits are calculated from labour market earnings and other characteristics. Education is included in the model for two reasons. First, at Statistics Norway there is a long tradition for projecting the number of persons and the labour force by education. The MOSART model has been used for these projections since the beginning of the 1990s. Secondly, education serves as an important explanatory factor for different kinds of behaviour in the simulation, especially because education may capture the effects from different events during the life course, as well as from fixed characteristics.

Because few persons start and complete a new education after the age of 30, or even younger, a higher level of education among the younger versus the older workers is one of the main driving forces in the model. With a dynamic micro-simulation model, it is also possible to take into consideration that the age for entering the labour market may range between the age of 18 and 30, and some educational activities may even take place between the age of 30 and 40. Education seems to be very important for labour market participation and the age of retirement.

Due to substantial changes in the educational system during the past decades, an extensive update and re-estimation of educational relations in the MOSART-model was completed in 2012. The work is documented by Gjefsen (2013). Educational characteristics in the model are determined by the individual's path through the educational system, defined by the following choices:

- Whether to start an educational activity
- Choice of level and field of education
- Whether to complete or not
- Whether to continue or not

In addition, the model contains a module that enables individuals' educational attainment to be updated without being registered in education. Transition probabilities are estimated on the basis of Norwegian register data from 1999-2009.

The decisions to enter, remain and complete are binary variables. Explanatory factors include gender, age, highest completed education and ongoing education.

The propensity to start an educational activity also depends on educational background. The probability of embarking on a new education increases if the individual has spent the last year in education; either the education was completed or discontinued. The probability of starting a tertiary education is high at the ages of 19 and 20, after which it decreases. After the age of 30, the probability of starting a new educational activity is relatively low.

Choice of level and field of education is highly dependent on age and earlier completed courses of study. Gender is also important for this choice. Between the ages of 16 and 18 the most usual choice is upper secondary education, while at 19 and older tertiary education is the most common choice. Those starting educational activities at master's level include both persons with upper secondary education taking a five-year degree and persons with a completed bachelor level education taking a two-year degree. In the model choice of field may be made each time an individual chooses a new type of education.

The choices of completing and continuing are closely related. The probability of completing an ongoing education is at its highest after having spent three years in general studies in upper secondary education, and for men having spent three years in short tertiary education. The probability of completing a long tertiary education is at its highest after five years. The propensity to continue in education is highest at the start, and it typically peaks at year two of an education.

Those who in the model have their educational attainment updated without being registered in education have to a large extent been students in the same fields of study earlier. The probability of having educational attainment updated is relatively high for immigrant men with unknown educational background, who have spent time in the Norwegian educational system. Those who have a low level of education have a higher probability of such updating, and the probability of updating without being registered also increases with the time previously spent in education without completion.

As mentioned above, in the reference scenario for MOSART we have assumed constant transition probabilities for the entire period. This may not be realistic because transition probabilities represent a mix between behaviour and capacity in the system. Economic factors, such as prospects for future wages, the actual rate of unemployment and expectations about the development in the labour market, may all influence decisions about education. For example, the relatively high rate of unemployment according to Norwegian standards in the beginning of the 1990s caused a significant increase in the capacity of tertiary education and the share of youths enrolling.

The projections of the population by education as a basis for corresponding projections of labour supply documented in this report are based on a representative sample of the Norwegian population that is mainly calibrated to the situation observed in 2010. Because of the fluctuating propensities to enter education over the business cycle, an average for the years 2007-2011 is used. The labour market in Norway was very tight in 2008, and the observed educational propensities in that year were probably lower than normal. The demographic assumptions are based on Statistics Norway's demographic projections from June 2012. The projections show an almost stable number of persons in the younger and middle-aged cohorts towards 2050. This result is caused by the assumptions of a total fertility rate of 1.9 and decreasing net immigration from 46,000 persons per year in 2012 to below 20,000 persons per year after 2040.

The results of the projections for the number of persons aged 16 to 74 by highest completed level of education are presented in Figure 8.1. Table 8.1 compares the observations from 2010 and projections for 2030 published in this report with the projections for the same years documented in Bjørnstad et al. (2010). Naturally, the total number of persons aged 16-74 for 2010 in this report is almost unchanged compared to the 2010-report. The minor difference is caused by the fact that the number for 2010 was based on the population projection from 2009 in Bjørnstad et al. (2010). In 2030 the total number is 127,000 higher in this report, mainly caused by higher immigration assumed in the population projection from 2012.

For the population by level of education there are significant deviations from the 2010-report, even for the 2010 numbers. These deviations are mainly caused by improved registration of the educational level for immigrants and full implementation of the new definition of level of education introduced in 2006. Until recently the level of education for immigrants to Norway has not been properly registered in Norwegian administrative registers. Immigration has increased significantly in the past years, which has caused a strong growth in the number of persons with unknown education. In the recent years, Statistics Norway has made strong efforts to collect information on the level and field of education among immigrants. This information has also been included in the data for the population in MOSART. A larger number of immigrants with registered education have particularly increased the number of persons with compulsory education in 2010. Because some of the immigrants are in possession of higher tertiary education this number has increased as well. Slightly lower numbers for persons with upper secondary education and short tertiary education in 2010 are mainly caused by the tightening of the definition of level of education discussed below.

The work including specifications of educational information among future immigrants depending on characteristics like age, gender and country of origin in the MOSART model has not been completed yet. Therefore, expectations of high net immigration to Norway in the coming years cause a strong increase in the number of persons with an unknown education from 2010 to 2030 as presented in Table 8.1 and Figure 8.1. High propensities to out-migrate for earlier immigrants cause growth in the number with unknown education to be stronger than the net growth in population. Several of the existing immigrants with registered education will be replaced by immigrants with unknown education.

Table 8.1. Population aged 16-74 by highest completed level of education. Comparisons of observations/projections in this report with Bjørnstad et al. 2010. 1,000 persons.

	2010		2030		2010 - 2030	
	2010-report	Now	2010-report	Now	2010-report	Now
Unknown education	280	85	509	599	229	514
Compulsory education	1 174	1 442	824	1 063	-350	-379
Upper secondary education	1 186	1 162	1 538	1 324	352	162
Short tertiary education	733	616	1 011	788	278	172
Long tertiary education	201	278	294	527	93	249
Total	3 574	3 582	4 175	4 302	601	720

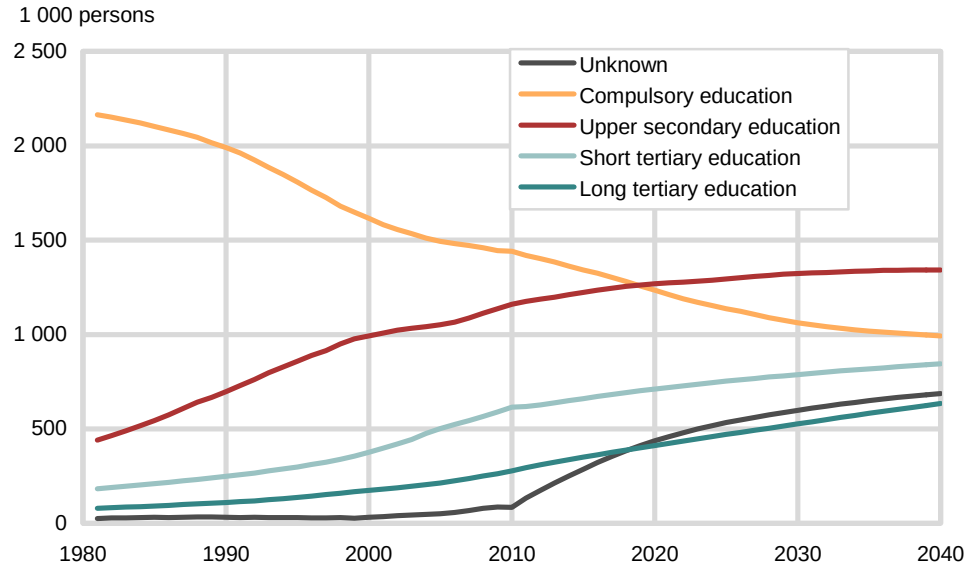
Source: Statistics Norway.

Compared to the projections documented in Bjørnstad et al. (2010) the numbers are also influenced by the shift in the Norwegian definition of the level of completed educations implemented in 2006. The definition was tightened in order to bring it into accordance with international standards. In particular, the requirements to be classified as having upper secondary education were sharpened. While completed basic courses of one or two years earlier were sufficient to be registered with upper secondary education, a completed education of three years in general programmes, or four years with vocational education, is necessary with the new definition. The number of persons with compulsory education in 2010 is also increased as a result of this shift, while the number of persons with upper secondary education is reduced. But the tightening of the definition of level of education has also affected the number of persons with completed short tertiary education. With the old

definition most persons with post-secondary non-tertiary education were classified with short tertiary education, while they are classified with only upper secondary education with the new definition. This shift has caused the total reduction in the number of persons with short tertiary education in 2010 to be larger than the reduction in the number of persons with upper secondary education.

From Table 8.1 and Figure 8.1 it is evident that the declining trend in the share of persons with primary and lower secondary education as the highest level of completed education continues from 2010 towards 2030 even though educational propensities are assumed to stay constant. While above 60 per cent of the population in the age 16 to 74 had this level of education in 1993 according to the new and tighter definition, the share had fallen to 40 per cent in 2010 and is projected to decrease further to about 25 per cent in 2030. But as presented in the figure, the decreasing trend has been weaker in the past decade than in the 1990s. Under the assumptions of constant educational propensities the downward trend will continue to diminish. Taking into account that a large part of the new immigrants will be in possession of compulsory education only, the actual decrease in the number of persons will be slower than shown in the figure.

Figure 8.1. Population aged 16-74 by highest completed level of education. 1,000 persons



Source: Statistics Norway.

On the other hand, the share of persons with upper secondary education as the highest completed level of education increased from 26 per cent in 1993 to 32 per cent in 2010 according to the new definition. Due to a rising share of persons completing tertiary education, further growth slows, and the share is projected to be slightly reduced to 31 per cent in 2030. Due to the large expansion of capacity in tertiary education during the 1990s, the number of individuals with this level of education has shown increasing growth since 2000. The number of persons with short tertiary education increased by 120 per cent from 1993 to 2010, and based on an assumption of unchanged educational propensities, it is expected to increase further by 28 per cent towards 2030. In this year, the share of individuals aged 16-74 with a lower degree tertiary education as the highest completed level of education may reach 18 per cent. The relative increase in the number of persons with a higher degree tertiary education is projected to be as high as 90 per cent from 2010 to 2030. The increase in this report is much higher than in the 2010-report and is caused by higher propensities to start and complete tertiary education at a master level than before. Even under assumptions of no further increase in educational propensities, the share of persons with long tertiary education in the age group 16-74 years are projected to reach 12 per cent of the corresponding population in 2030.

9. Comparing projected labour supply with projected labour demand

9.1. Comparisons by level of education

To compare projections of labour supply by level of education from MOSART to the corresponding demand from MODAG, it has been necessary to calibrate the numbers. One problem of comparison is caused by the different classification for the level of education used in the two models. The question is how to classify persons with education finished before 2006 by the level of highest completed education. To handle the level of education in a consistent way in a model for education like MOSART, a strict classification is chosen. This means that today's requirement for formal education is necessary to be classified for the levels of upper secondary and tertiary education respectively. The classification of employed persons by level of education in the macroeconomic MODAG is based on the National Accounts. In this classification the claims for formal education to obtain a professional education were more lenient some years ago than today. As a consequence the number of employed persons with a given level of highest completed education is higher in the National Accounts than in the data basis for MOSART.

The MOSART numbers by level of education are therefore calibrated to correspond to the National Accounts in 2010. In this calibration, the number of unemployed by level of education is also taken into account to compare the labour force numbers in MOSART with the employment numbers in the National Accounts. The labour force for a given level of education is equal to the sum of employed and unemployed with this education. In 2010, more than 60 per cent of the 94,000 persons unemployed according to the Labour Force Surveys were among persons with only primary, lower secondary or unknown education.

To compare the projections for labour supply by the corresponding projections for labour demand, it has also been necessary to adjust the MOSART-series for the unknown level of education among future net immigrants (in-migrants minus out-migrants). Until the model is improved to project the number of immigrants by education, a simple way of adjusting is to add the persons with unknown education to the ones with primary and lower secondary education. Because a part of the net immigrants to Norway is expected to have upper secondary or tertiary education, growth in labour supply for these groups may be underestimated, while the predicted development for those with only primary and lower secondary education may be overestimated. On the other hand, more persons with primary or lower secondary education in the MOSART-population compared to the definition of educational level used in the National Accounts and MODAG imply that the number of persons with this level of education retiring is larger by MOSART compared to the definition used by MODAG. The two inadequacies therefore work in opposite directions regarding the effect on future imbalances. Without more information it is not easy to tell which is the stronger.

Comparisons of supply and demand by level of education are presented in Figure 9.1. In Table 9.1 we have also compared the results in 2030 with the corresponding numbers documented in Bjørnstad et al. (2010). As mentioned above, in the year for the start of the simulations, 2010, we have taken into account that more than 60 per cent of the unemployed belonged to persons with primary, lower secondary and unknown education as the highest level of completed education. More than 20 thousand of the unemployed belonged to persons with upper secondary education. Projected deviations between supply and demand for the different educational levels may indicate that educational propensities, capacity and/or participation rates need to change to secure a balanced labour market in the future.

Table 9.1. Demand and supply of labour by level of education. Comparison in 2030 of results from current analysis with Bjørnstad et al. (2010). 1,000 persons

	Demand		Supply		Demand - Supply	
	2010-report	This study	2010-report	This study	2010-report	This study
Primary, lower secondary and unknown education	381	517	629	789	-248	-272
Upper secondary education	1 252	1 452	1 366	1 318	-114	134
Tertiary education, lower degree	940	957	790	922	151	36
Tertiary education, higher degree	273	318	254	324	19	-6
Total	2 846	3 245	3 038	3 353	-192	-108

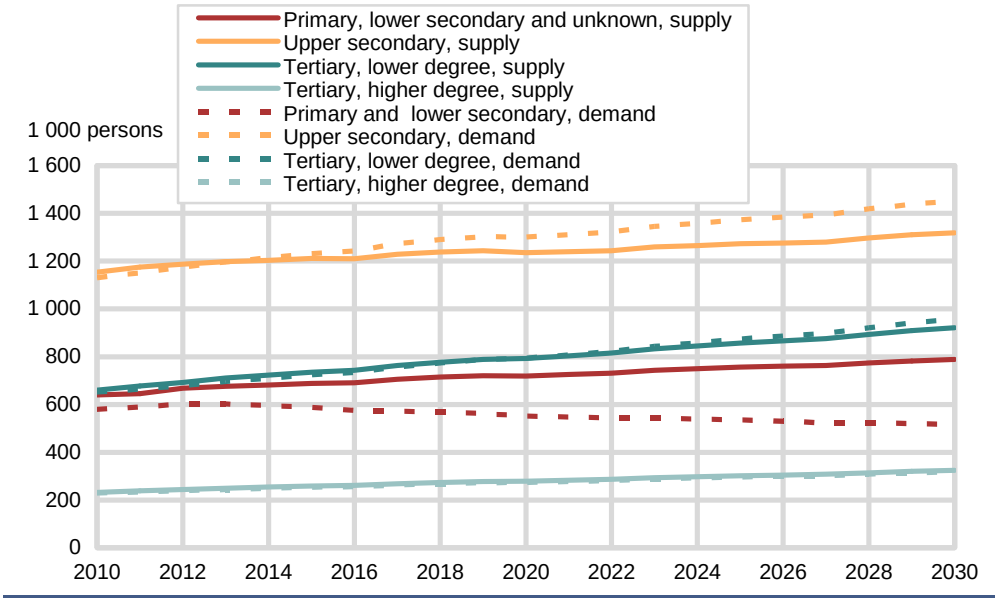
Source: Statistics Norway.

The results show a more rapid increase in demand for labour with upper secondary education as the highest level of completed education than the corresponding increase in supply. This means that it could be beneficial to stimulate start and completion of education in upper secondary education. As presented below, this especially concerns education in vocational training. In Bjørnstad et al. (2010) the projections showed stronger growth in supply than demand for this level of education. From table 9.1 it is evident that stronger growth in demand in this study is the main factor behind the shift in sign of the projected imbalance.

For tertiary education lower degree the projections also show a small excess demand from 2020 and onwards. But the gap between supply and demand is smaller than in the projections published in 2010. This is mainly caused by the updating of the educational propensities and the upgrading of the educational module of the MOSART model. This is also the main reason for a significant stronger growth in supply of labour from persons with tertiary education, higher degree towards 2030 compared to the 2010-report. But growth in demand for this group is also adjusted upwards resulting in a balanced path for supply and demand, a result quite in accordance with the former report.

As in Bjørnstad et al. (2010), demand for persons with primary, lower secondary or unknown education is projected to decrease. But due to the new definition of level of education and high immigration in recent years the numbers for both demand and supply are adjusted upwards in this report. If immigration stays at a high level and a majority of the new immigrants are in possession of only primary or lower secondary education, labour supply for this educational group may increase in the next decades. In this case immigrants may meet increasing problems at the Norwegian labour market.

Figure 9.1. Labour demand by education from MODAG compared with adjusted labour supply from MOSART. 1,000 persons



Source: Statistics Norway.

9.2. Demand and supply by field of education

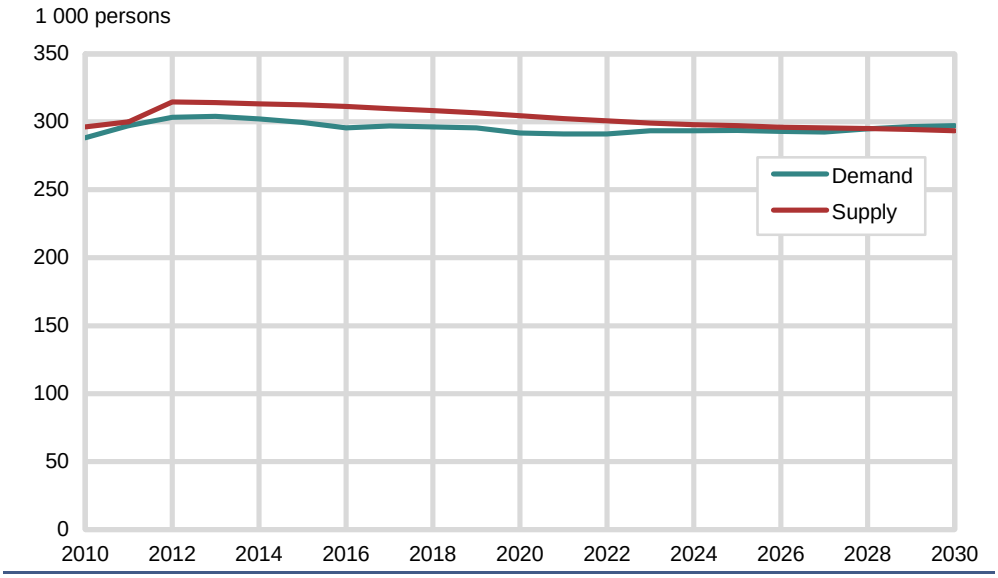
The updating and re-estimation of the module for education in the MOSART-model was not finished yet in 2010, and therefore Bjørnstad et al. (2010) did not publish projections for supply of labour by field of education. The first results from the updating of the module for educations were published and compared with projected demand for selected groups by Gjefsen et al. (2012). Since then the educational module has been further updated, and in this study we are able to present an almost complete overview comparing projections of demand for different fields of education by corresponding projections for supply. To make this comparison, labour supply by field of education from MOSART is calibrated to observed employment in 2010. For some groups the deviation between observed level of employment and the level of labour supply in 2010 is caused by the difference in the definition of educational level, but because the data for MODAG and MOSART are prepared independently, deviations may also be caused by other factors.

For persons with primary, lower secondary and unknown education in Figure 9.1 above, unemployment may be an important reason for the deviation between observed employment and the labour force. This may also be the case for persons with upper secondary education. Only a few persons with tertiary education are unemployed in Norway. On the other hand, for some groups there may be excess demand for labour in the starting point for the simulations in 2010, indicating that demand for labour was higher than observed employment. For these groups uncovered demand for labour from the Company Sample Survey made by the Norwegian Labour and Welfare Administration (2010) is used as an indicator for the imbalance in 2010. However, for most groups the number of unemployed and estimates for excess demand are small. For simplicity supply is calibrated equal to observed employment in 2010 for most of the educational groups presented below.

Upper secondary education general programs

Traditionally, there has been registered some unemployment among persons with upper secondary education general programs as their highest completed education, and the level of unemployment in 2010 is thus taken into account in the projections presented in Figure 9.2. The projections indicate that both demand and supply for this group will stay rather constant in the next decades. The projected constant number in the labour force indicates that the number of youths with this kind of education entering the labour market may continue to equal the number of elderly who retires. And in spite of some uncertainty, demand for this group also seems to stay rather constant in such a way that some unemployment may persist.

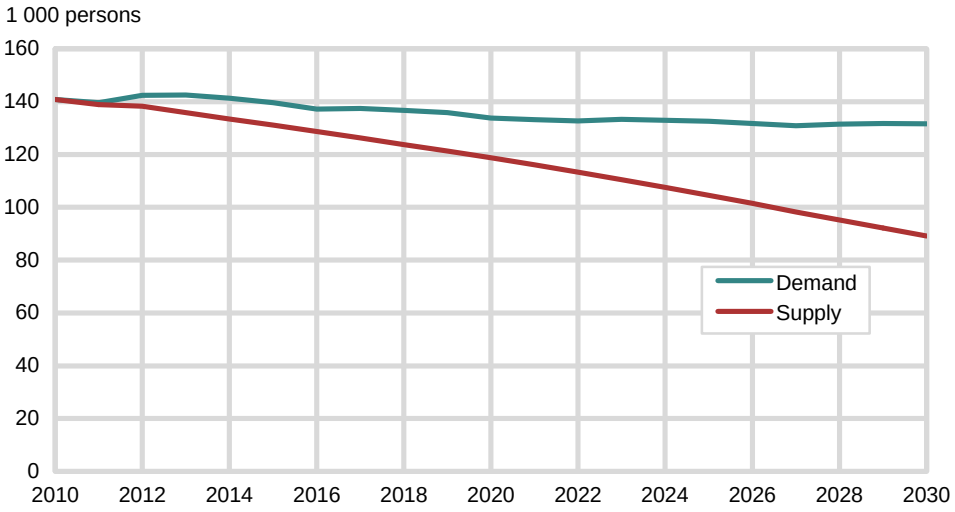
Figure 9.2. Upper secondary education, general programs. 1,000 persons



Source: Statistics Norway.

On the other hand, as shown in Figure 9.3, the number of persons in the labour force with upper secondary education in the field of economics and administration as the highest level of completed education is expected to decrease significantly because most youths with this kind of education continue with tertiary education. Demand is also decreasing. The figure indicates a slower decrease in demand relative to supply, but development in demand for this group is highly uncertain. Demand is probably met by supply of persons completing tertiary education in this field, a group where supply shows a strong increase.

Figure 9.3. Upper secondary education, economics and administration. 1,000 persons



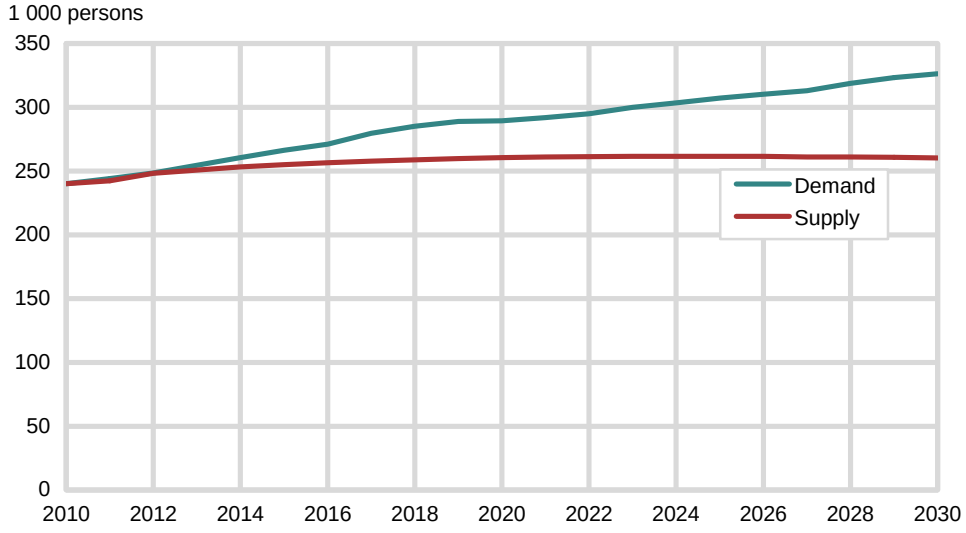
Source: Statistics Norway.

Upper secondary education vocational programs

For the educational groups presented in Figures 9.4 to 9.6, the numbers for employment in the data basis have been prepared in a more consistent way than for the projections made by Bjørnstad et al. (2010). The assumptions regarding future growth are also adjusted upwards. Due to low fulfilment of upper secondary education for these groups, the projections show increasing excess demand. For upper secondary education in electronics, mechanics work and machinery as the highest level of completed education, the number of youths entering the labour market is not larger than the number of adults retiring. For building and construction and other fields of science, supply is projected to grow slightly, but slower than demand. Taking into account that the MOSART-model may underestimate retirement among persons with upper secondary education vocational programs due to the strict definition of educational level, future excess demand for these educational groups may be more severe than shown by Figures 9.4 to 9.6. On the other hand, neglecting that some of the future immigrants may have these kinds of education, works in the opposite direction.

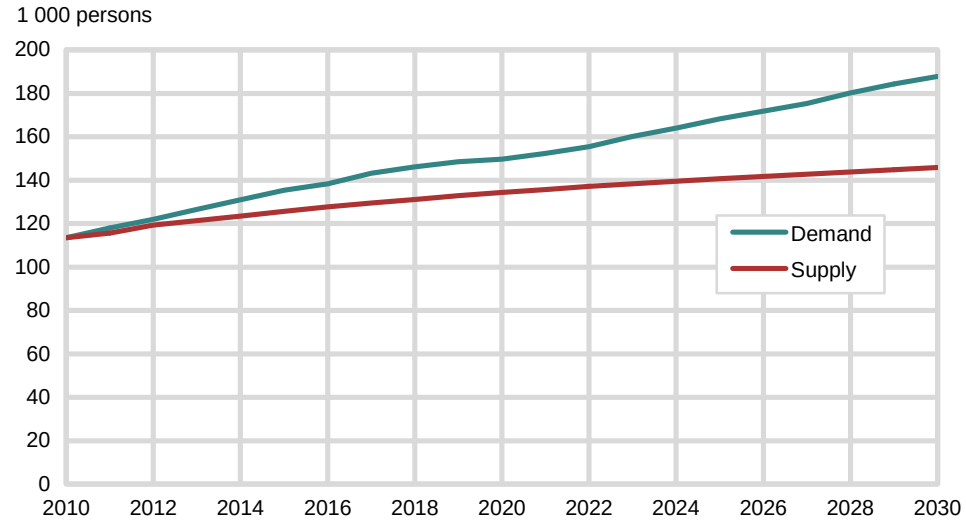
The different definition of educational level in the data basis for the MOSART-model compared to the data basis for MODAG especially makes it difficult to use the approach from this study to compare projections for supply and demand for persons with upper secondary education in nursing and care giving. Demand for this group is projected to increase by more than 50 per cent from 2010 to 2030, and this growth is quite consistent with the projections made by the assumptions from the reference scenario in HELSEMOD, documented in Roksvaag and Texmon (2012a). Upper secondary education in nursing and care giving in HELSEMOD is defined in a broad way, including persons with former education as auxiliary nurses with only one year of education from upper secondary school. It is therefore difficult to compare the projections from this model with the projections from MOSART where a strict definition is used.

Figure 9.4. Electronics, mechanics work and machinery. 1,000 persons



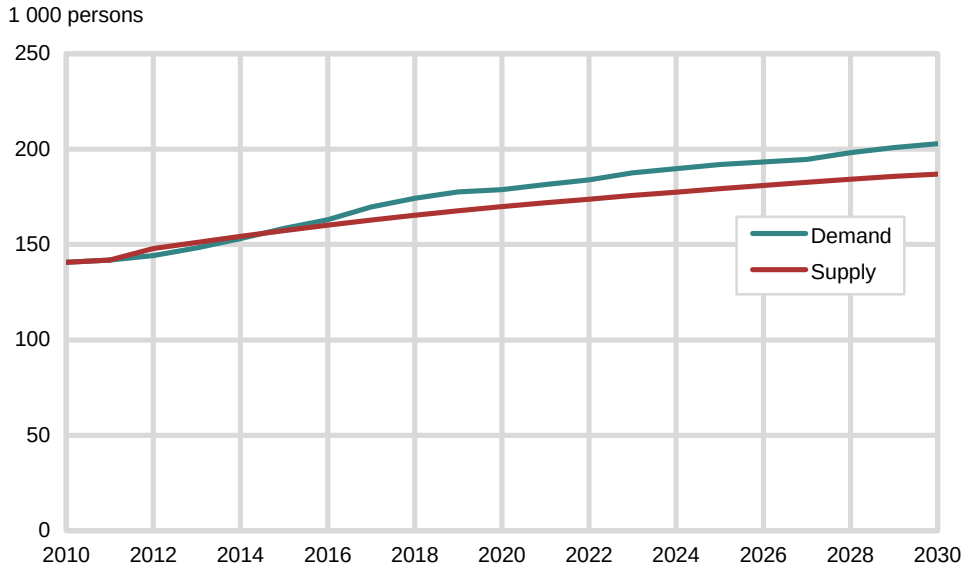
Source: Statistics Norway.

Figure 9.5. Building and construction. 1,000 persons



Source: Statistics Norway.

Figure 9.6. Other fields of science, technique and crafts. 1,000 persons



Source: Statistics Norway.

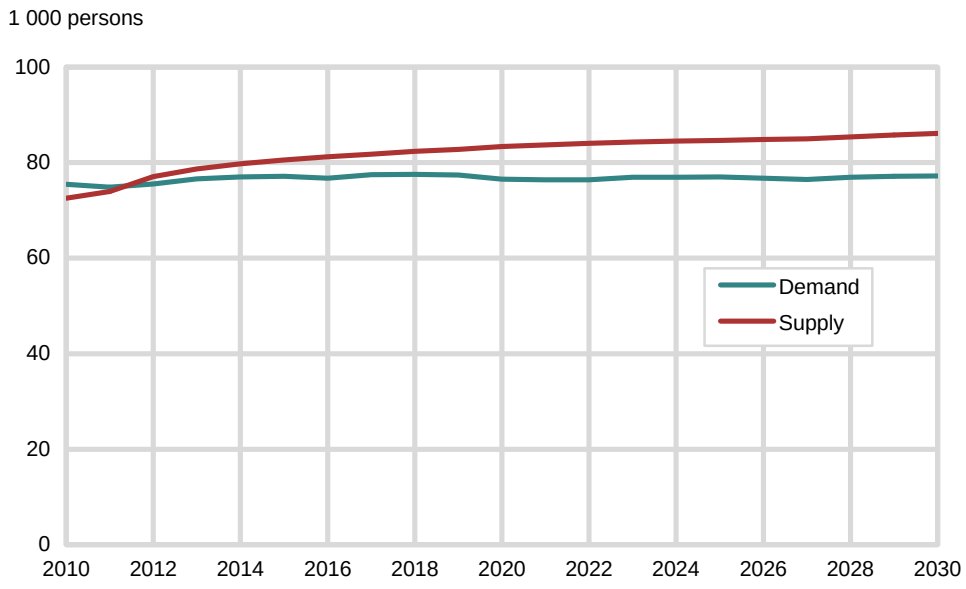
Because elderly workers with the former education as auxiliary nurses are not included among those with upper secondary education in MOSART, replacement demand caused by retirement is highly underestimated, and growth in supply is thereby overestimated. Figures for supply of labour with education in nursing and care giving from upper secondary school are therefore not included in this report because they are misleading regarding the future situation for supply of labour for this group compared to the projections by HELSEMOD.

Engineering and other fields of science

According to the Company Sample Surveys prepared by the Norwegian Labour and Welfare Administration, the companies in the autumn of 2010 reported uncovered demand for about 9,500 persons with education in engineering and other fields of science. For engineering, lower degree and graduate engineering the uncovered demand is taken into account in this starting year for the projections in Figure 9.7 and 9.8. Compared to the earlier projections for demand presented in Bjørnstad et al. (2010) and repeated by Gjefsen et al. (2012), growth in demand is now projected to be slightly weaker. Except from a small predicted growth from 2011 towards 2015, demand for persons educated in engineering lower degree is projected to stay almost constant towards 2030. However, for graduate engineering, demand is projected to increase by more than 11 thousand persons from 2010 to 2030.

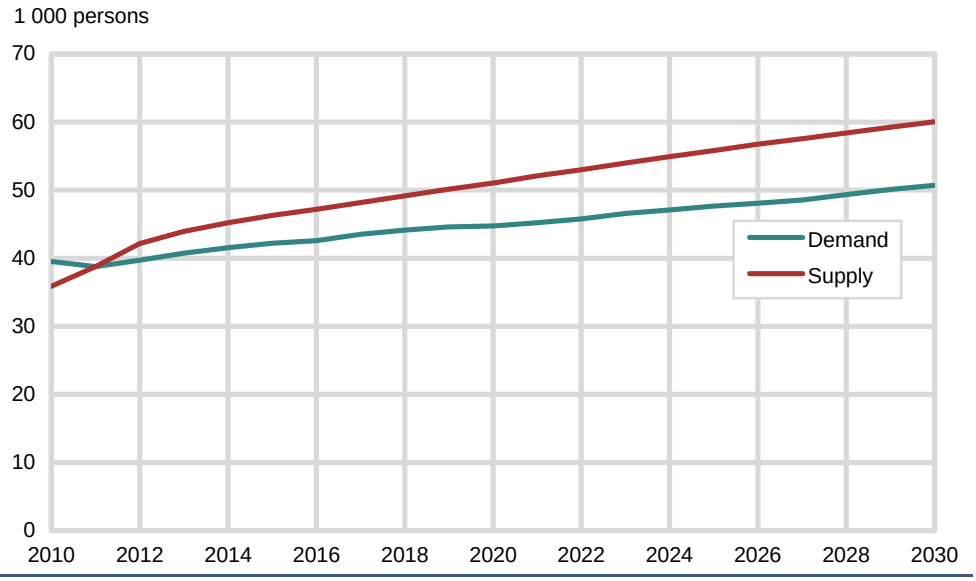
Probably due to somewhat stronger growth in demand than supply of persons educated in engineering for several years, the companies have found that persons educated in other fields of science may be close substitutes. So the share of persons with these educations has increased significantly in many industries during the last decade. In lack of detailed knowledge about how demand for engineers and other social sciences will be composed, we have assumed that the past trends will continue. As presented in Figures 9.9 and 9.10, this assumption leads to a rather strong growth in demand in the coming decades, especially for persons educated in other sciences lower degree.

Figure 9.7. Engineering, lower degree. 1,000 persons



Source: Statistics Norway.

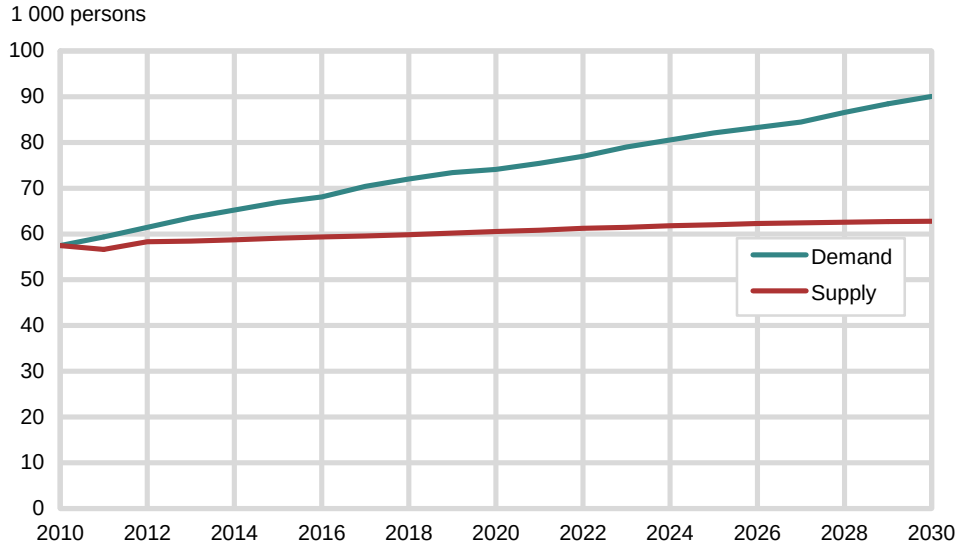
Figure 9.8. Graduate engineering. 1,000 persons



Source: Statistics Norway.

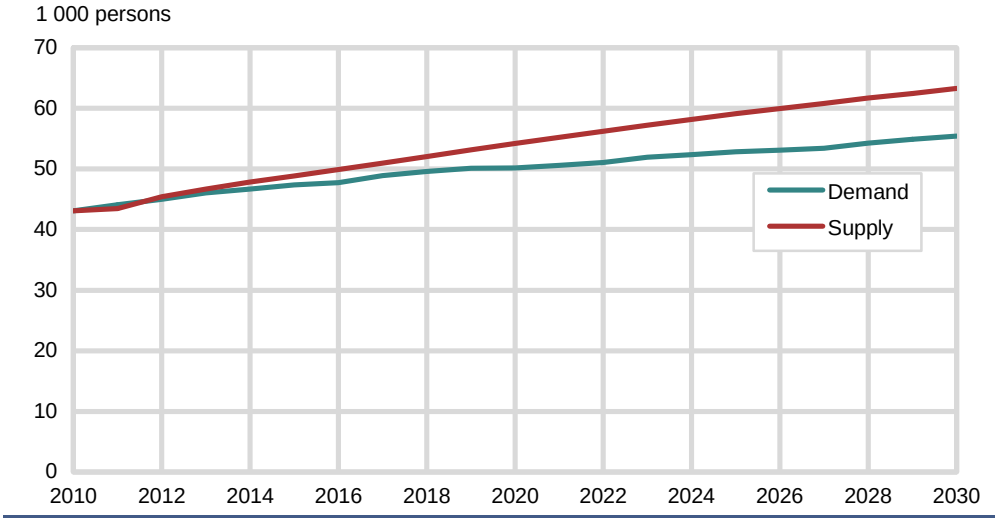
The latest updating of the data for the MOSART-model indicates a somewhat larger intake and faster completion of education in engineering and other fields of science of higher degree than before. Higher immigration of persons with these educations is also included in the data basis for MOSART in 2010 and 2011. Growth in supply for these educational groups is therefore shifted upwards, and especially in years closely after 2010. When growth in demand is shifted downwards and growth in supply is shifted upwards, the projections now show a higher supply than demand for engineering lower degree, graduate engineering and other sciences higher degree. Because these four groups are close substitutes, we have added them up in Figure 9.11. The curves for supply and demand then almost coincide. If the larger intake and faster completion of studies in engineering and other sciences continue, this may secure a more balanced growth between demand and supply for these groups than what has been the case for several years. According to the Company Sample Survey from the Norwegian Welfare and Labour Administartion from spring 2013 uncovered demand for persons educated towards engineering and other fields of science is reduced to about 4,600. At the same time, about 3,000 persons with this kind of education were registered as unemployed.

Figure 9.9. Other fields of science, lower degree. 1,000 persons



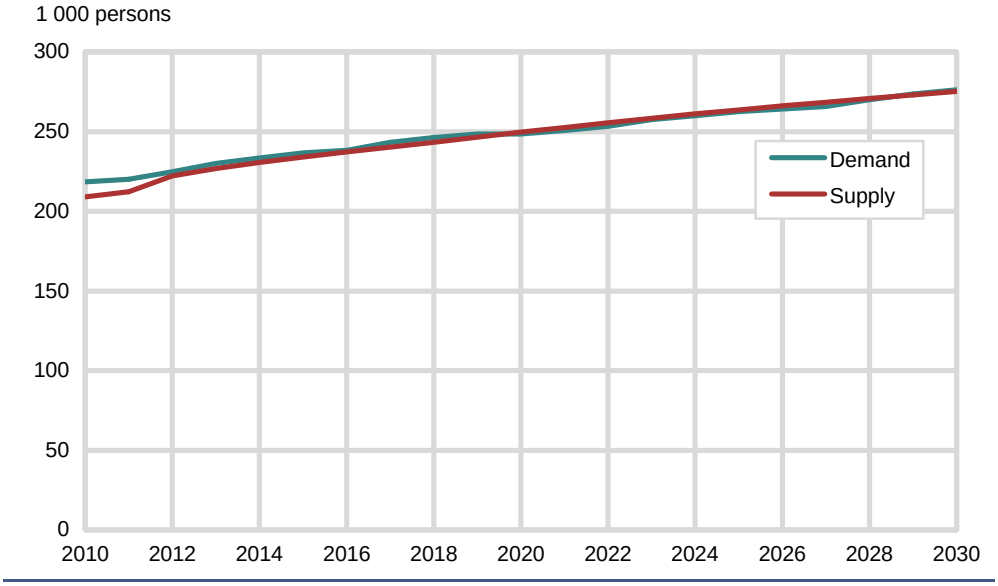
Source: Statistics Norway.

Figure 9.10. Other fields of science, higher degree. 1,000 persons



Source: Statistics Norway.

Figure 9.11. Engineering and science, total. 1,000 persons

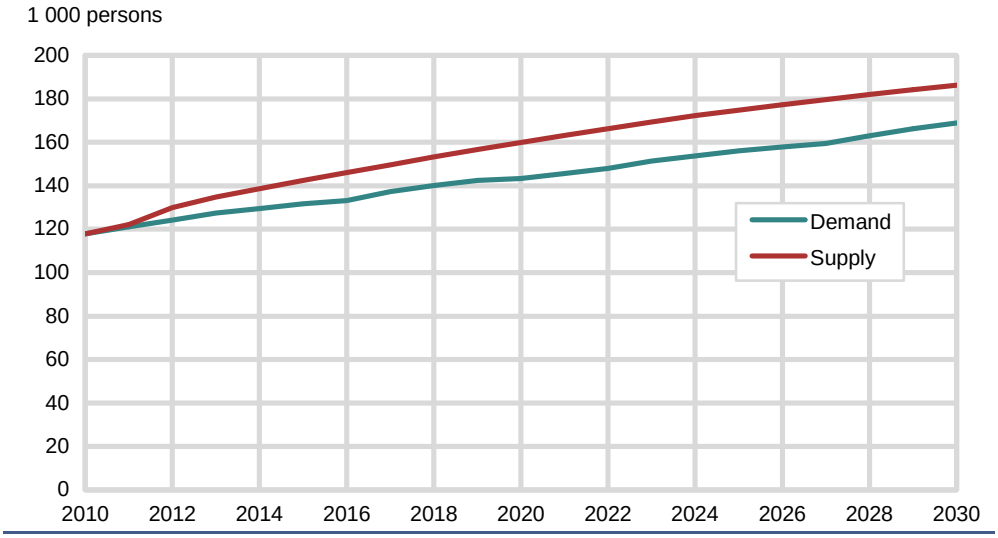


Source: Statistics Norway.

Economics and administration, social sciences, law, humanities and arts

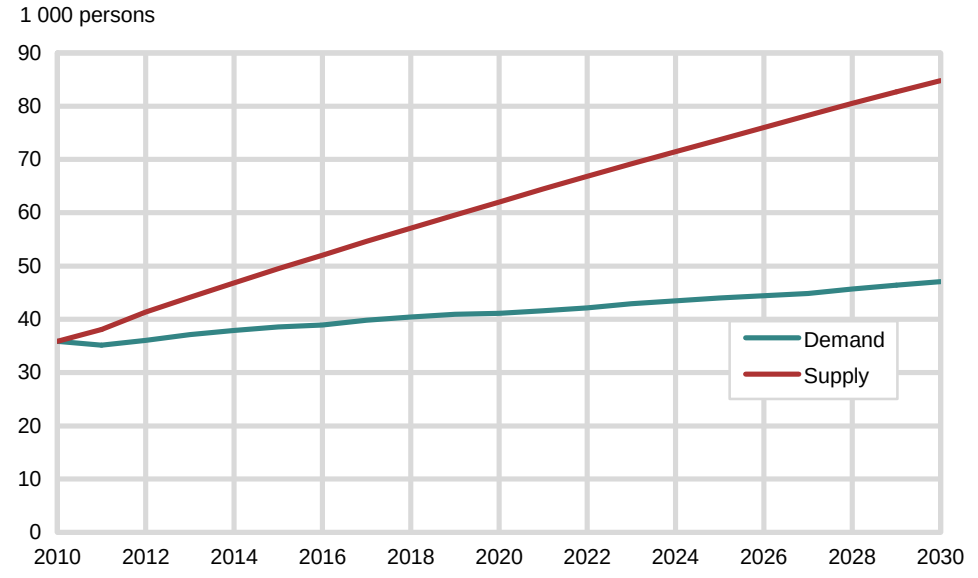
Common for the educational groups economics and administration, social sciences, law and humanities and art is a strong expansion of the educational capacity during the 1990s. The cohorts with these educations entering the labour market are therefore much larger than the cohorts retiring, causing a relatively strong growth in supply. Growth in demand for these groups, and especially for persons educated in economics and administration, is stronger than for most other groups. But in spite of this, the projections show a stronger growth in supply than demand towards 2030 for all these groups. Of course there may be some arbitrariness regarding growth in demand for persons with a higher degree versus a lower in the different fields of education, but this point does not change the general view that supply increases faster than demand.

Figure 9.12. Economics and administration, tertiary education, lower degree. 1,000 persons



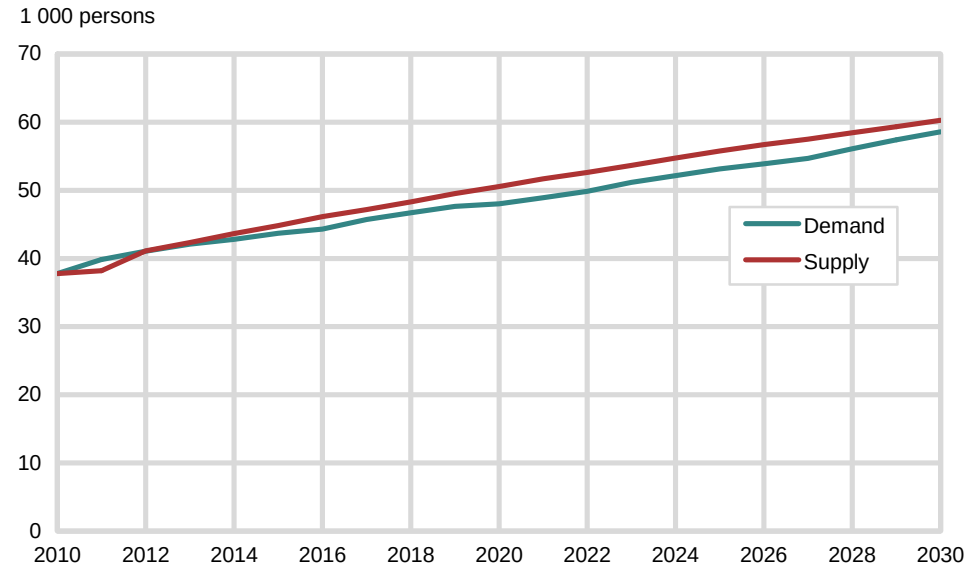
Source: Statistics Norway.

Figure 9.13. Economics and administration, tertiary education, higher degree. 1,000 persons



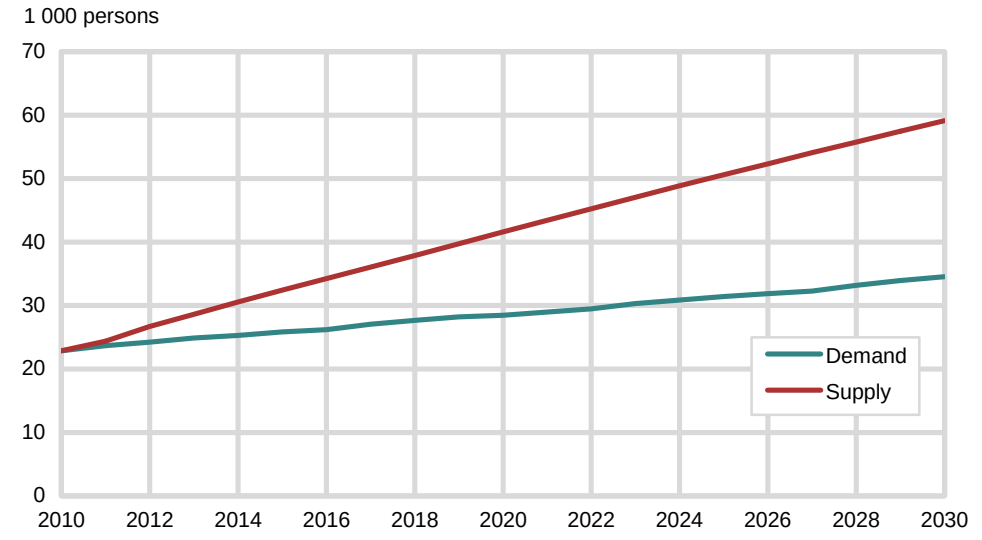
Source: Statistics Norway.

Figure 9.14. Social sciences, business and law, lower degree. 1,000 persons



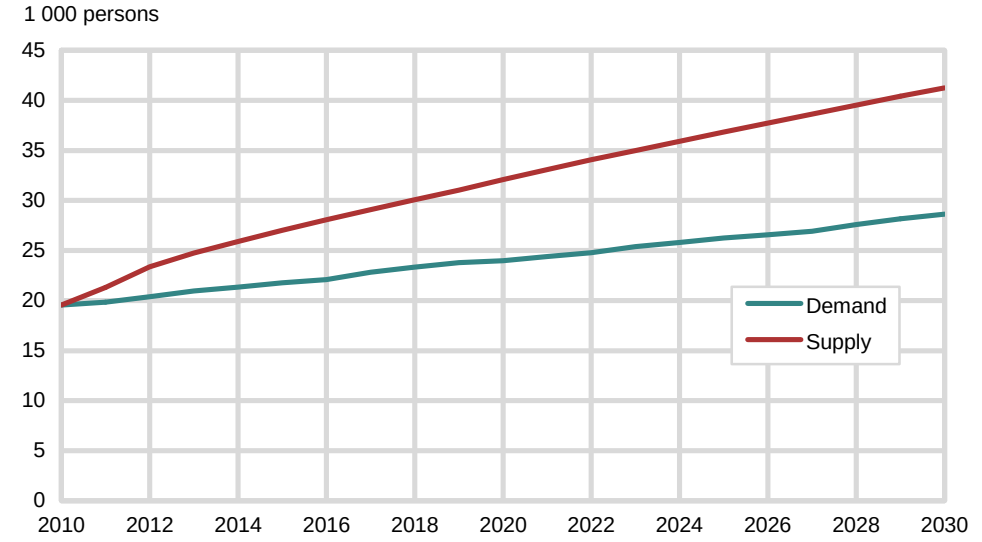
Source: Statistics Norway.

Figure 9.15. Social sciences, higher degree. 1000 persons



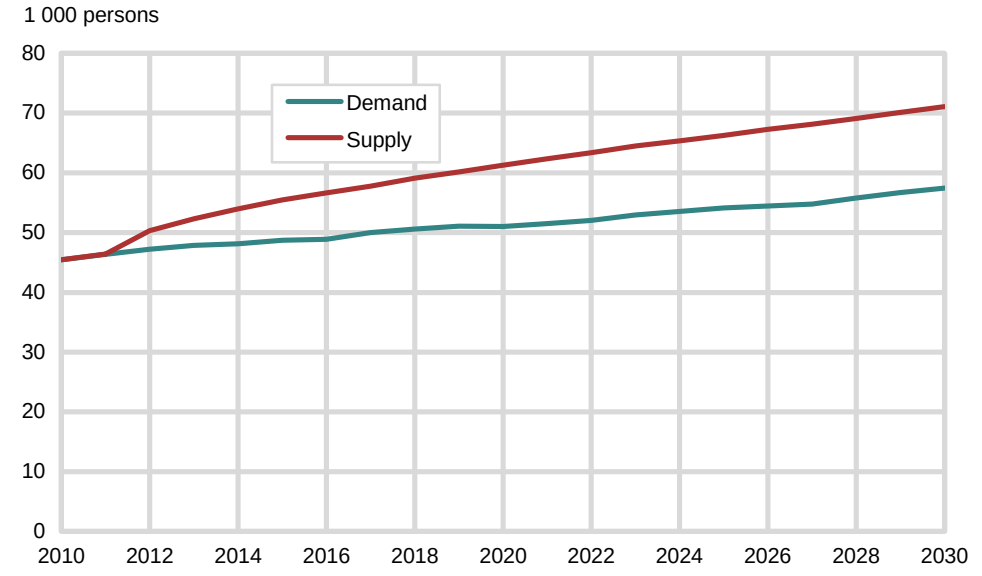
Source: Statistics Norway.

Figure 9.16. Law, higher degree. 1,000 persons



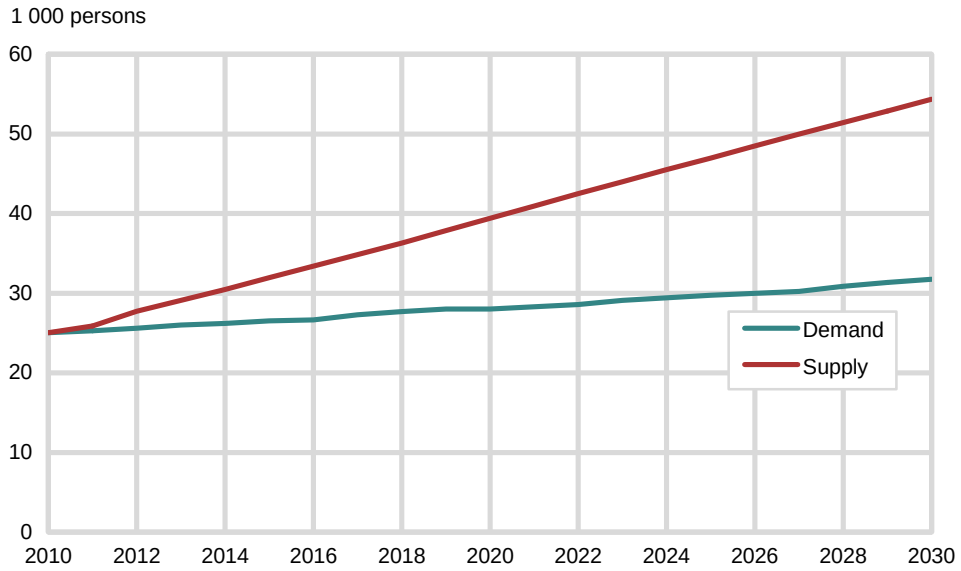
Source: Statistics Norway.

Figure 9.17. Humanities and arts, lower degree. 1,000 persons



Source: Statistics Norway.

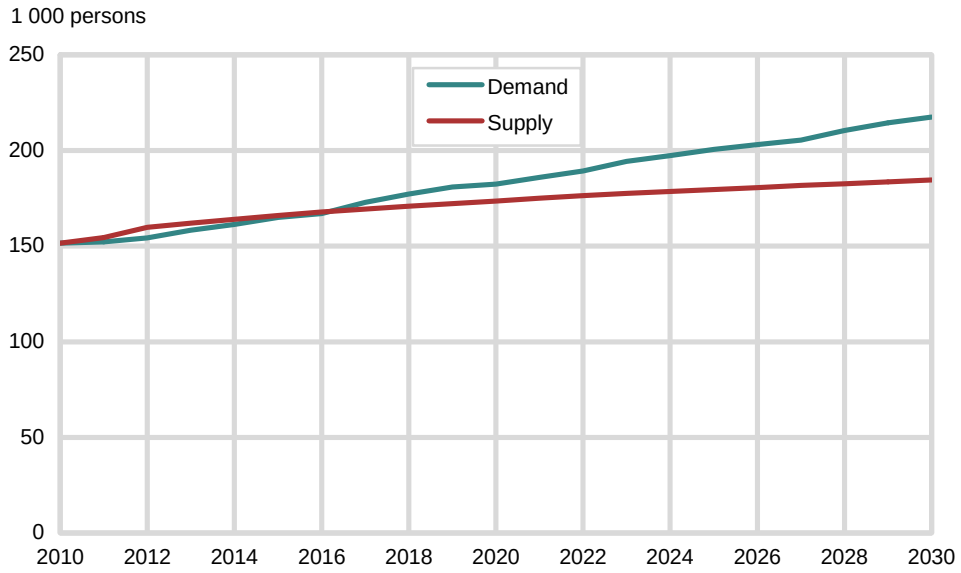
Figure 9.18. Humanities and arts, higher degree. 1,000 persons



Education and health

Teachers with lower degree include pre-school teachers, specific teachers, and general teachers in upper level of secondary education. Unfortunately, in the data used for both MOSART and the demand side, teachers with a master degree from universities are mainly classified according to their field of education, and not as teachers. A more sophisticated preparation of the data is necessary to illuminate the labour market for this group, as done in the projections made by a more detailed model for teachers (LÆRERMOD) documented by Roksvaag and Texmon (2012b).

Figure 9.19. Teachers lower degree. 1,000 persons



Source: Statistics Norway.

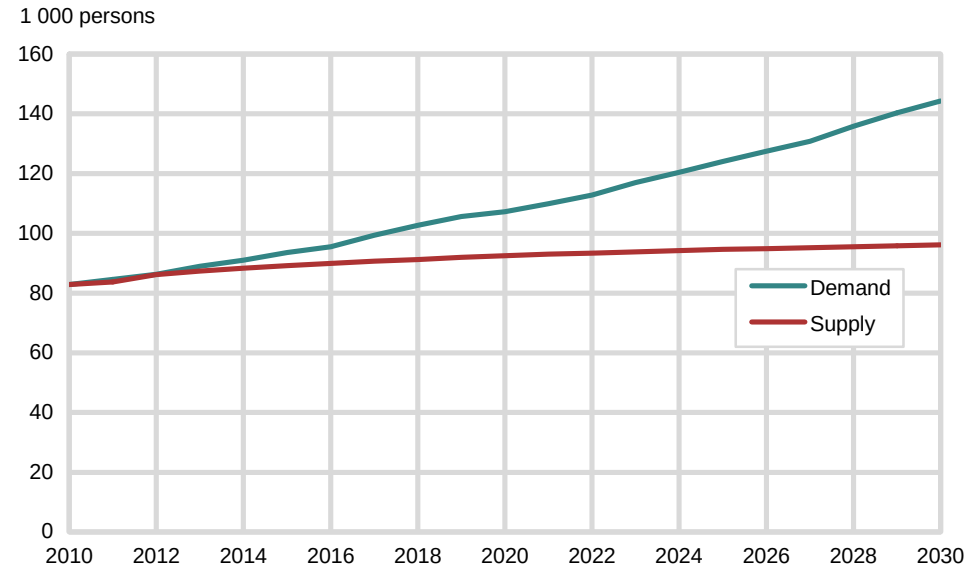
Although there are some differences between the two analyses regarding the assumptions for teachers with lower degree, the new projections are quite consistent with the former, both at the demand side and the supply side. The assumptions made for the future growth in demand for teachers in this report is weakly stronger than the reference scenario in LÆRERMOD. Based on assumptions of constant educational capacity and probabilities, growth in supply diminishes because many of the teachers (especially the general teachers) are approaching the age of retirement. From an approximately balanced situation in

2010 further growth in demand combined with a slower and diminishing growth in supply means an increasing shortage of teachers as shown in Figure 9.19.

Compared to Statistics Norway's more detailed model for labour market projections regarding personnel educated towards health and social services (HELSEMOD), documented by Roksvaag and Texmon (2012a), the projected growth in supply presented in this report is somewhat smaller. The main reason is probably that the educational propensities for nursing in the MOSART-model are somewhat smaller than consistent with the assumptions in HELSEMOD. In the projections with this model we have assumed full utilization of the existing educational capacity. On the demand side, the assumptions made in this report indicate a slightly stronger growth compared to the high growth alternative in HELSEMOD. However, this is consistent with the observed trend that nurses with lower tertiary education have substituted auxiliary nurses in the past decades. No such substitution is included in the main alternatives for HELSEMOD, and the model may thus underestimate the future excess demand for nurses, while it overestimates the future lack of auxiliary nurses.

For the other groups with tertiary education lower degree directed towards health and social services, the projections presented in Figure 9.21 show that future demand and supply approximately balance. This is also approximately in accordance with the more detailed projections made by HELSEMOD, showing future excess demand for some groups, while supply may increase more than demand for others. Medical doctors only constitute a minor group of total employment, and the uncertainty with using the approach from general models when making projections are relatively large compared to the partial approach used in HELSEMOD. Therefore we have chosen not to present the results for this group here. On the supply side the results from HELSEMOD and MOSART for this group are quite consistent. On the demand side assumptions of a stronger growth than in HELSEMOD may lead to projected excess demand, while future supply and demand for medical doctors are approximately in balance with the assumptions from the reference scenario of HELSEMOD.

Figure 9.20. Nursing and care giving. 1,000 persons

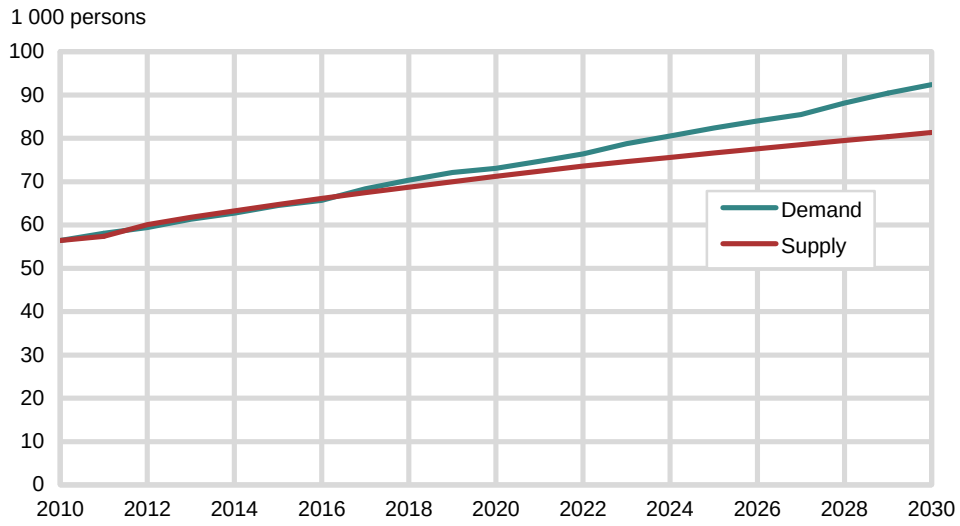


Source: Statistics Norway.

Education in dental studies is even a smaller group than medical doctors. In addition to the weakness caused by large relative uncertainty, the preparation of data for the share of employed in the different industries has been too simple for this group. The distribution is made by using information about wage-earners from

administrative registers. Because most dentists in Norway are self-employed, their share of employment has been underestimated.

Figure 9.21. Other tertiary education in health and social services, lower degree. 1,000 persons



Source: Statistics Norway.

10. Concluding remarks

Model based projections of future demand for and supply of labour by education is an ongoing project at Statistics Norway. The models are continuously modified and developed further, and new data are taken into account. Data from different sources are consolidated and used within a model system that enhances consistency of these data. The projections from this model system are uncertain both because the projection period is quite long and because they are based on highly debatable assumptions even if many of them are supported by econometric studies. Therefore, the results must be used with caution.

To our knowledge, no other projections are made using a macroeconomic model with heterogeneous labour, for example where relative labour demand depends on relative wages and where relative wages depend on mismatches in the labour market. In this report, mismatch is studied by comparing projections for labour demand with projections for labour supply according to a dynamic microsimulation model assuming constant educational propensities and participation rates.

The results show that the past trends with increasing demand for highly educated labour and lower demand for those with less education will continue in the coming two decades. This mismatch seems to be most pronounced for the demand for labour with upper secondary education vocational programs. Furthermore, when studying the labour demand projections by educational fields, demand increases for all fields within tertiary education. However, the growth is particularly strong for candidates specializing in economics and administration and nursing and care giving. Especially for nurses, but also for teachers, labour supply will not match demand unless growth in demand will be much smaller than assumed or educational capacity is increased and students choose to fill this capacity. Alternatively, one may expect immigrants to fill some of the projected vacancies. Information on the educational background of immigrants has improved recently but the skills of future immigrants are a particular problem for our study. This is an issue where more research is needed.

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Appendix

In each industry, employment both in terms of hours worked and the number of people is disaggregated into 5 categories by level of education. The translog-system which is part of the factor system shown in Figure 4.1 aggregates these 5 categories to 3. The group called unskilled labour (acronym US) consists of the two groups with minimum education (acronym GRK) and Upper secondary education general programs (acronym VA). The skilled group relating to tertiary education consists of two groups as well. One group is Tertiary education, lower degree (HO) and the other group is Tertiary education, higher degree (UN). In the econometric model the two aggregates are specified for each industry and exogenous rates split these into the two subgroups.

Formally, let NUS_i be the number of people who are unskilled in industry i and $NGRK_i$ the number of people with primary education only. Then we have

$NGRK_i = \sigma_{GRKi} * NUS_i$

By construction $NVA_i = NUS_i - NGRK_{i.}$. For the disaggregation of skilled labour into the two groups HO and UN we use a similar disaggregation.

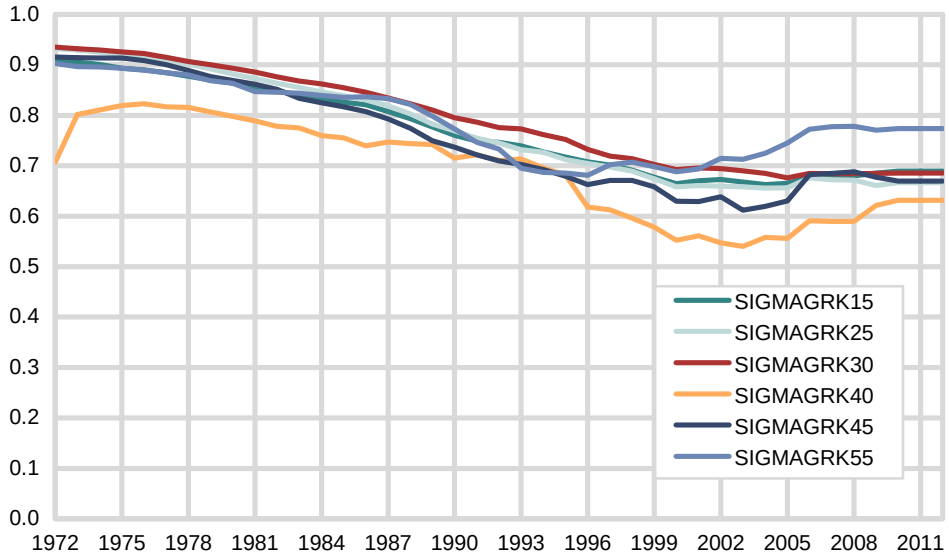
In what follows we describe how these σ's have developed historically and how we have prolonged the trends in the baseline simulation to 2030. The numbers linked to each series in the figures A.1 to A.9 below indicate the number used in the classification of industries in MODAG according to table A.1.

Table A.1 The industry classification in MODAG

Industry name	Industry code
Agriculture and forestry	10A
Fishing	13
Aquaculture	14
Manufacturing of consumer goods	15
Manufacturing of miscellaneous goods	25
Manufacturing of paper, chemicals &metals	30
Petroleum refineries	40
Manufacturing of machinery etc.	45
Construction	55
Banking and insurance	63
Production of oil and natural gas, etc.	64
Shipping services	65
Electricity production	71
Domestic transport services	74
Wholesale and retail trade	81
Housing services	83
Information technology services	84
Other private services	85
Real estate services (excl housing)	86
Local government services	90K
Central government services, civilian	91S
Military services	92S

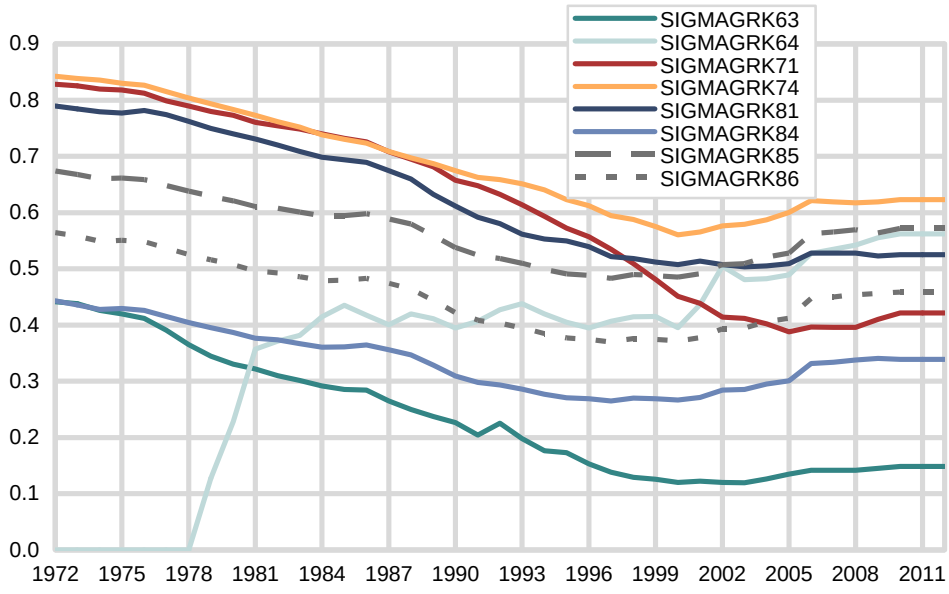
Figures A.1 and A.2 show that employees with minimum education as share of all unskilled generally have been falling from the early 1970s to the late 1990s. During the most recent decade or so these shares have been relatively stable and some have even been increasing. This increase is most likely due to the fact that we have placed employees with no educational information in this minimum education group, among whom we mainly find immigrants. Net immigration has increased a lot since 2004 in particular when the EU was enlarged eastwards. Currently, we only have actual information until 2010, so the data for 2011 and 2012 are simply extended data using 2010 as a benchmark which is also the benchmark year of the model and the input-output structure. There is also a potential break in the data between 2007 and 2008 due to changes in industrial classification.

Figure A.1. Share of GRK in unskilled labour by industry. Manufacturing and Construction



Source: Statistics Norway.

Figure A.2. Share of GRK in unskilled. Private service industries and Petroleum

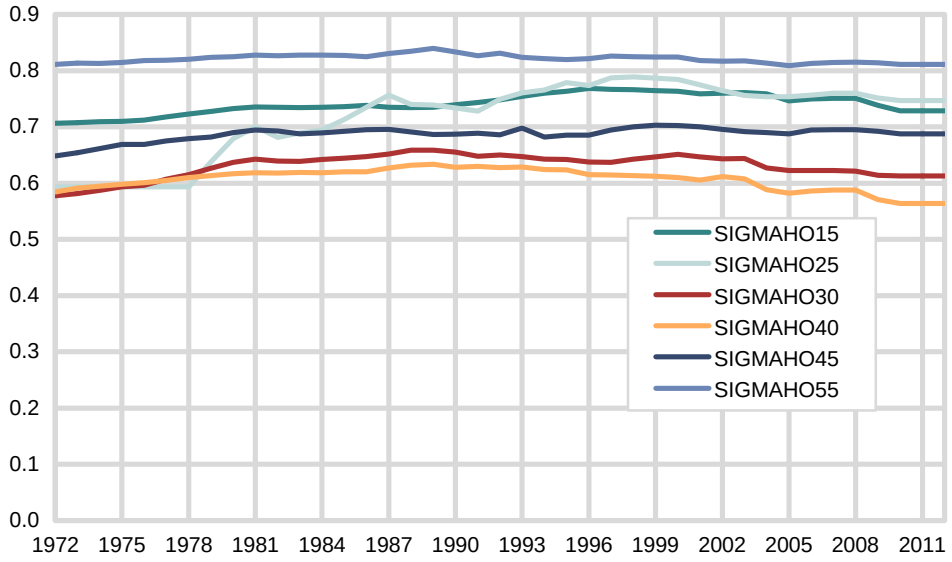


Source: Statistics Norway.

In our baseline simulation we have in general kept the various sigma (σ) by industry in these two figures constant.

The next two figures show similar rates for the group of employees with the highest education (upper and lower tertiary education). Figure A.3 shows the rates for various industries in manufacturing and in the Construction industry. In general, these rates are quite stable except for Refineries (industry 40) but this is a very small industry in number of employees (only a few thousands). There is some decline also in the shares for Manufacturing of metals (45) and Miscellaneous manufacturing (25). But a rough baseline assumption is to keep these rates constant to 2030.

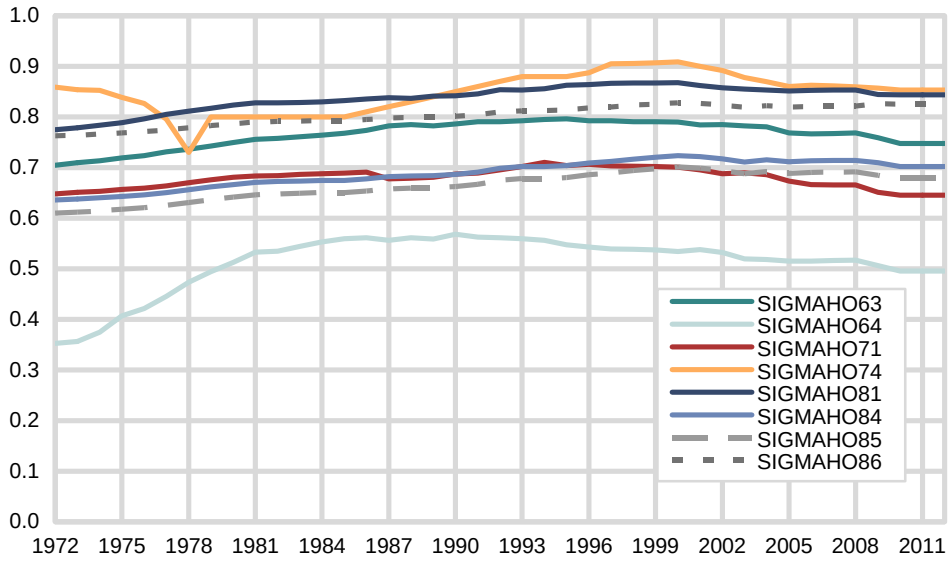
Figure A.3. Share of HO in total high skilled. Manufacturing and Construction



Source: Statistics Norway.

Figure A.4 shows the shares of lower tertiary educated employees in private service industries and the petroleum sector. Again the main impression is one of stability but with some tendency of decline in Banking and financial services (63), Petroleum (64), and Hydroelectricity (71). For these industries we will assume a slightly falling trend in the shares. The others are assumed constant in the baseline.

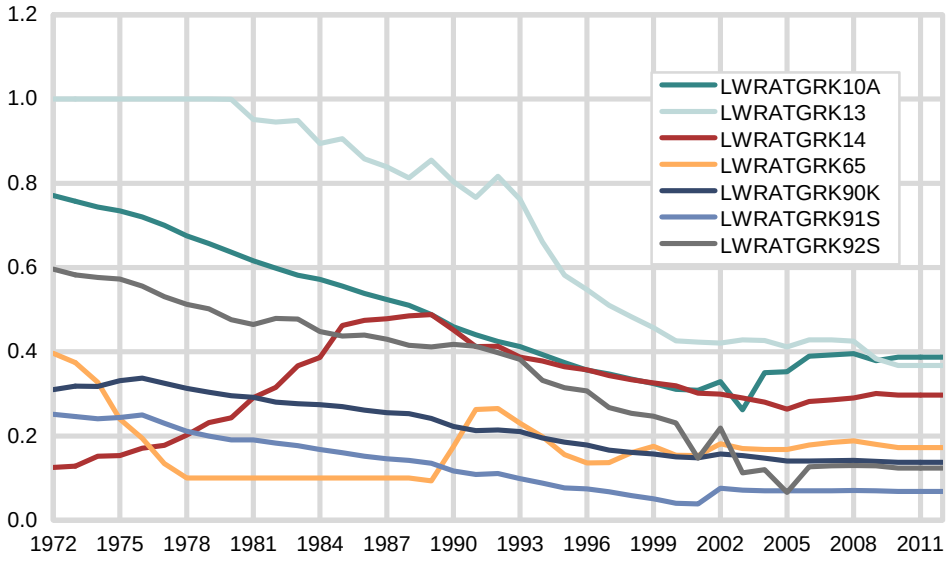
Figure A.4. Share of HO in total high skilled. Private service industries



Source: Statistics Norway.

We now turn to our assumption for industries where we do not have any econometric model for employment by education. These industries are Agriculture and Forestry (10A), Fishing (13), Aquaculture (14), International shipping transport (65) and three government sectors, Central government, civilian (91S), Central government, military (92S), and Local government (90K). Here we disaggregate total hours by industry using exogenous shares for the educational groups. Figure A.5 shows the shares of hours worked by employees with basic education as share of total hours worked in each of these industries.

Figure A.5. Shares of hours worked by employees with basic education (GRK) by industry

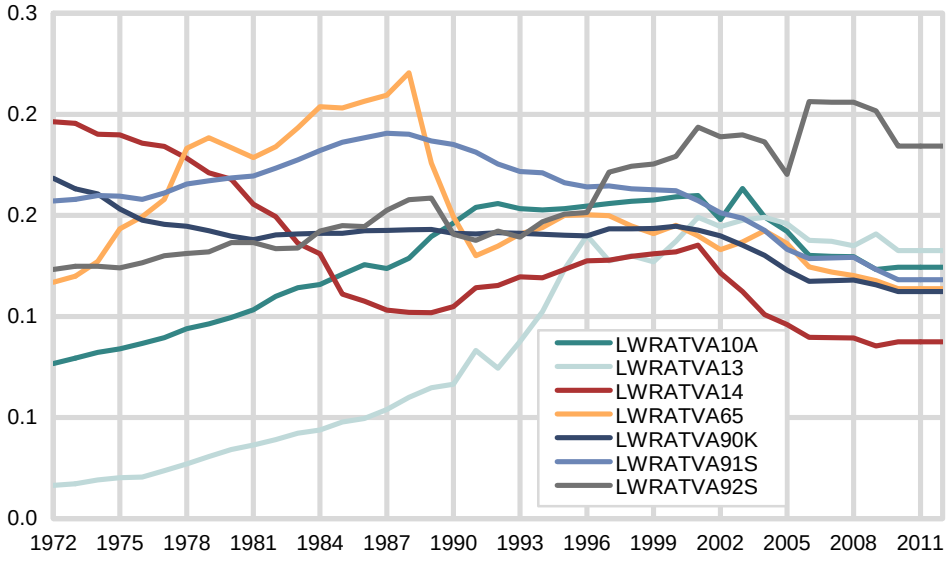


Source: Statistics Norway.

As we have seen from the previous figures, there has been a general decline in the shares of hours worked or number of employees with only basic education (GRK). The downward trends seem to have come to a halt in recent years. So a constant share of hours worked by employees with basic education is reasonable in the baseline scenario.

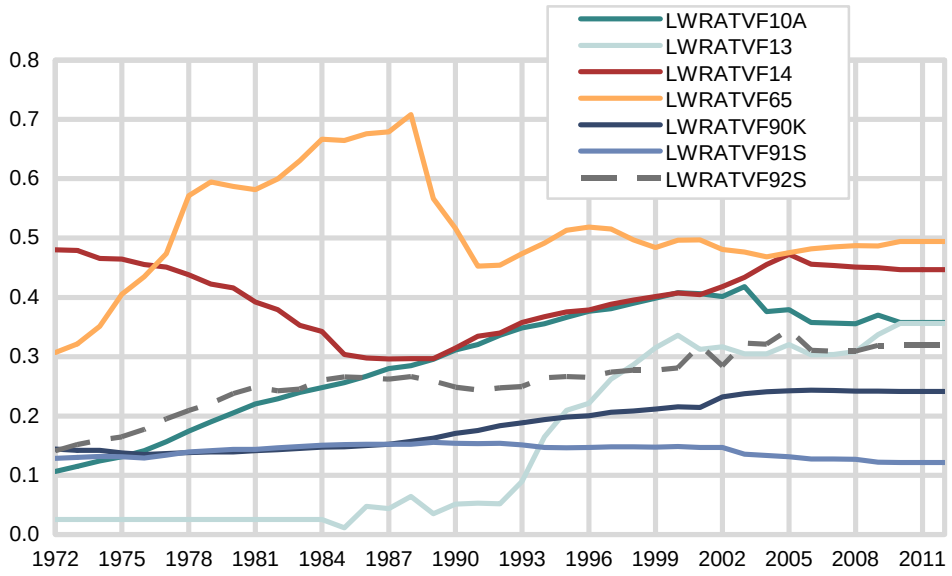
We proceed to look at the shares of hours worked by employees with Upper secondary education general programs (VA). Here the pattern is much more diverse with no general trends clearly visible across all industries. There is a tendency for the shares to increase during the 70s and 80s but then to decline from sometime during the 1990s, except for employment in the military (92S) where the share has been increasing most of the time. This is due to the share of conscripts in the military service that traditionally has consisted of young men with basic education. For this industry a constant share seems to be a reasonable assumption while the share should perhaps decline somewhat in the two civilian government sectors (90K and 91S). The shares in the primary industries are also declining moderately.

Figure A.6. Shares of hours worked by employees with Upper secondary education (VA) by industry



Source: Statistics Norway.

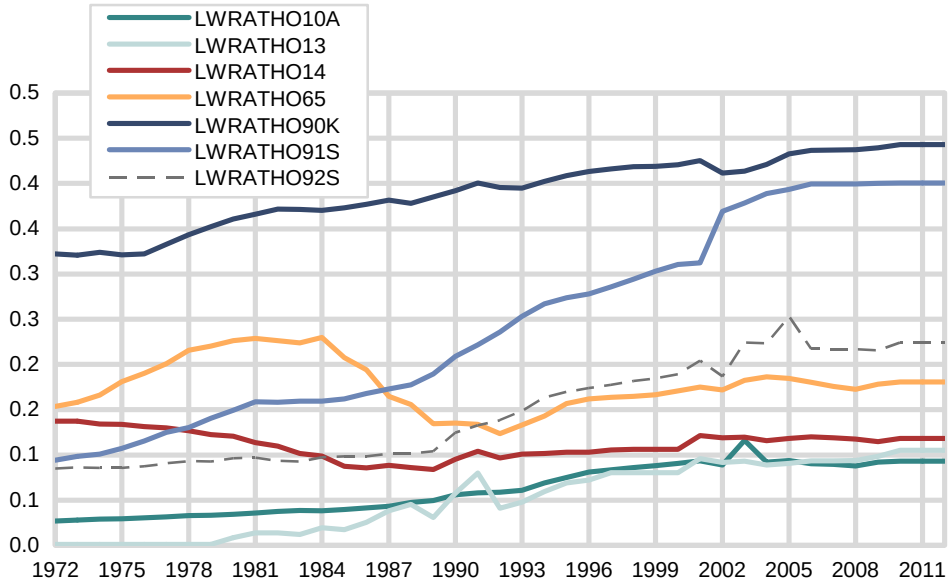
Figure A.7. Shares of hours worked by employees with vocational education (VF) by industry



Source: Statistics Norway.

Figure A.7 shows the shares of hours worked for employees with vocational education. There are clear trends in many of these shares over the whole sample period. From around 2000 the shares have been quite stable so that roughly constant shares are a reasonable assumption to make in the baseline scenario.

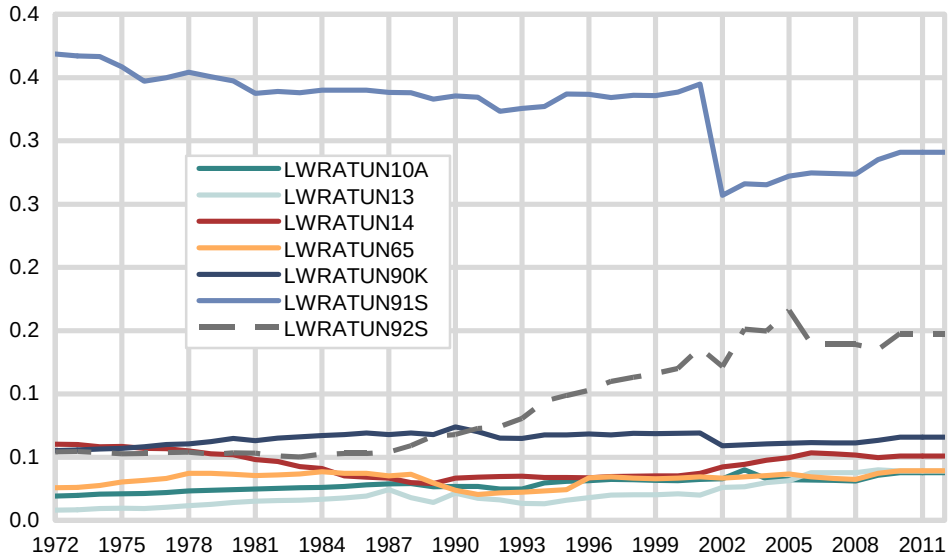
Figure A.8. Shares of hours worked by employees with lower tertiary education (HO) by industry



Source: Statistics Norway.

For employees with Tertiary education lower degree (HO) we can observe increasing trends in total hours worked in most industries over time with Aquaculture (14) and International shipping (65) as two exceptions. Shares have been more stable from 2000 and onwards so that constant shares may serve as a first approximation in the baseline scenario. The shift in the government sector in 2002 is related to the institutional change for hospitals that was changed from Local government (90K) to Central government (91S).

Figure A.9. Shares of hours worked by employees with upper tertiary education (UN) by industry



Source: Statistics Norway.

Finally, Figure A.9 shows the shares of hours worked for employees with Tertiary education, higher degree (UN). The trends are slightly positive in some industries with low shares but fairly constant shares may be a good first approximation. Note again the institutional change between 91S and 90K in 2002.

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