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Demand and supply of labor by education towards 2030

Linking demographic and macroeconomic models for Norway

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Preface

Since the early 1990s, Statistics Norway has produced model-based projections on demand and supply of labor by education. The demand and supply side has been modeled separately, but in a consistent manner so that it has been possible to compare them. The macroeconomic model MODAG has been the core model on the demand side, and the dynamic microsimulation model MOSART has been used to project the supply of labor.

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Abstract

Because of globalization and technological progress, most OECD-countries have seen a considerable growth in the demand for labor with higher skills and educational levels the past decades. In many countries, supply has not grown correspondingly. This has resulted in increasing differences either in unemployment or in wages between high and low skilled workers. In Norway, labor supply has followed demand more closely, and unemployment and wages have stayed relatively equal. The past trends in the educational upgrading will probably continue, and further stability in the labor market requires that labor demand and supply matches also in the future. Both for future students, who must decide on education, and the authorities, who must plan the educational capacity, industrial development and welfare reforms etc., projections on demand and supply of labor by education is useful.

In Norway, Statistics Norway has produced such projections since 1993, and in this report, we present new projections towards 2030. A central tool in projecting the demand for labor is the macroeconomic model MODAG, which has a core of input-output relations to capture the interaction between the different industries. Because demand for labor is projected in each industry, the use of MODAG also leaves room to analyze the effects of inter- and intra-industry changes in demand for labor by education. In a macroeconomic model, labor as an input factor cannot be too heterogeneous with respect to education. MODAG gives projections for demand and supply of labor by education within only five aggregated educational levels/groups. Hence, a module translating demand for labor by industry into demand for labor by education at a detailed level is linked to MODAG.

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 the employed will have primary, lower secondary and upper secondary general education. According to the projections, 18 percent of the employed will have a primary or lower secondary education in 2030, as compared to 27 percent in 2007 and an estimated 63 percent in 1972. These figures include workers with unknown education. Within the group of workers with an education at a tertiary level, the projections show a high growth in demand for most of the specific educational fields, and a particularly high growth in demand for candidates in economics and administration and nursing and caregiving at a lower level of tertiary education. By 2030, the employment of individuals with an economics and administration education is expected to expand by almost 100,000 persons, making this occupational group the largest at this level. The growth in demand for nursing and caregiving personnel is caused by the growing size of the elderly population, and an assumed growth in the service standards in public service production throughout the projection period.

Since the long-term projections of the economy are based on a relatively balanced growth scenario with stable unemployment, labor supply in MODAG has been determined residually as the sum of labor demand and unemployment. Hence, the projecttions from MODAG are in their own not useful for analyzing potential mismatches in the future labor market. However, we have used the dynamic microsimulation model MOSART to project the supply of labor by four main educational levels. From a representative sample of the population in a base year, MOSART simulates the further life course for each person in this initial population by using estimated transition probabilities. In the projections, the transition probabilities are kept constant. This implies that educational propensities and labor force participation rates are constant as well.

By comparing the labor supply from the MODAG simulations with the labor supply from the MOSART simulations, we get some indications of potential imbalances in the future labor market. The projections show a higher increase in demand for labor with a lower degree tertiary education than the corresponding increase in supply. This means that it could be beneficial to increase capacity in higher education to meet increasing demand.

Sammendrag

Globaliseringen og den teknologiske framgangen de siste tiårene har ført til betydelig vekst i etterspørselen etter høyt utdannet arbeidskraft i de fleste OECD-land. I mange av landene har ikke tilbudet av høyt utdannet arbeidskraft økt tilsvarende mye, noe som har ført til økte forskjeller i ledighet og lønn mellom utdanningsgrupper. I Norge har arbeidstilbudet i stor grad fulgt utviklingen i arbeidskraftsetterspørselen, og ledighets- og lønnsforskjellene har vært stabile. Den økte etterspørselen etter høyt utdannet arbeidskraft vil trolig fortsette. For at arbeidsmarked fortsatt skal utvikle seg balansert bør da veksten i antallet med høyere utdanning også fortsette. Studenter, som skal velge utdanning, og myndigheter, som blant annet skal planlegge utdanningskapasitet, næringspolitikk og velferdsordninger, vil dermed ha nytte av framskrivninger av tilbud og etterspørsel etter arbeidskraft etter udanning.

Statistisk sentralbyrå har med ujevne mellomrom laget slike framskrivninger siden 1993. I denne rapporten presenteres nye beregninger. Beregningene går fram til 2030. Den makroøkonomiske modellen MODAG er et sentralt redskap i å lage framskrivningene. Modellen har en krysløpskjerne, som angir produktstrømmene mellom næringene i den norske økonomien. Det gjør modellen velegnet til å analysere endringer i etterspørselen etter arbeidskraft både innad og mellom næringene. I en makroøkonomisk modell har man ikke mulighet til å skille mellom mange forskjellige typer arbeidskraft. MODAG skiller kun mellom fem utdanningsgrupper/-nivåer, og det benyttes derfor en ettermodell for å beregne etterspørselen på et finere detaljeringsnivå.

Framskrivningene viser at utviklingen med økende etterspørsel etter arbeidere med utdanning fra høyskole- og universitetsnivå, samt fra yrkesfaglige studieretninger på videregående skole, fortsetter i hele framskrivningsperioden. En mindre andel av de sysselsatte har kun grunnskole eller grunnkurs fra videregående skole. I 2030 viser beregningene at 18 prosent vil ha kun grunnskole eller grunnkurs fra videregående skole, mot 27 prosent i 2007 og et anslått nivå på 63 prosent i 1972. Tallene inkluderer sysselsatte med ukjent utdanning. Også andelen med fullført allmenne fag eller økonomiske og administrative fag på videregående skole faller i perioden. Videre viser framskrivningene vekst i behovet for de fleste utdanningsretninger innen høyere utdanning. Behovet for økonomi- og adminstrasjonsutdannete og helse-, pleie- og omsorgsutdannete på et lavere universitetsnivå (bachelorgrad) øker spesielt mye. Fram mot 2030 øker antallet sysselsatte med utdannelse innen økonomi og administrasjon på et lavere universitetsnivå med nesten 100 000 personer. Denne gruppen går dermed forbi lærerne som den største utdanningsgruppen på dette nivået. Økningen i behovet for helse-, pleie- og omsorgsutdannete skyldes det økende antallet eldre, samt en antakelse om en viss vekst i standardene på offentlig leverte tjenester.

Det har ikke vært et mål å framskrive behovet for arbeidskraft under fluktuerende konjunkturer. Beregningene baserer seg derfor på en relativt balansert økonomisk utvikling, med stabil arbeidsledighet. I framskrivningene har arbeidstilbudet dermed blitt bestemt som summen av sysselsetting og arbeidsledighet. Arbeidstilbudet i MODAG-beregningene er altså bestemt fra etterspørselsiden. Disse framskrivningene er således i seg selv ikke egnet til å analysere eventuelle ubalanser på arbeidsmarkedet. I rapporten vises imidlertid også framskrivninger av tilbudet av arbeidskraft etter fire utdanningsnivåer fra mikrosimuleringsmodellen MOSART. MOSART simulerer utdanningsnivået til et representativt utvalg av befolkningen på bakgrunn av opplysninger fra et utgangsår og estimerte overgangssannsynligheter. I framskrivningene er overgangssannsynlighetene holdt konstante. Det innebærer at utdanningstilbøyeligheter og yrkesandeler også er konstante.

Ved å sammenlikne det arbeidstilbudet ifølge MODAG-framskrivningene med arbeidstilbudet fra MOSART-framskrivningene, får vi en indikasjon på potensielle ubalanser i framtidens arbeidsmarked. Denne sammenlikningen tyder på en høyere vekst i etterspørselen etter arbeidskraft med utdannelse på et lavere universitetsnivå (bachelorgrad) enn i tilbudet. Det viser at det kan være ønskelig å øke utdanningskapasiteten innen høyere utdanning for å møte den framtidige etterspørselen.

Contents

1. Introduction

During the past decades, most OECD-countries have seen a considerable growth in the demand for labor with higher skills and educational levels[1]. A large part of the increased demand has been matched by an increased supply of highly skilled labor, reflecting increased educational capacity. Nevertheless, increased wage differences in many countries[2] indicate that the supply of skilled labor has not increased enough to meet the growth in demand. While increased wage differences are most evident in countries with flexible and decentralized wage formation like the US and the UK, the difference in unemployment rates between low skilled and highly skilled labor has increased in countries with more rigid wage formation in continental Europe (see Krugman, 1994). A significant part of both the increased demand for highly skilled labor and the higher wage premiums can probably be explained by technological shifts favoring this kind of labor, cf. Katz (1993), Katz and Autor (1999) and Wallerstein and Golden (1997).

As documented by Kahn (1998) and Salvanes and Førre (1999), Norway has experienced the same kinds of shifts in the composition of labor by education, but differences in both wage and unemployment rates have been more stable. Actually, Norway seems to have experienced smaller wage differences the last decades. Kahn (1998) suggests that this is the result of the centralization of wage bargaining during the late 1980s and 1990s. On the other hand, Hægeland et.al (1999) find a clear increase in educational premiums when controlling for self-selection in higher education. Furthermore, Hægeland and Kirkebøen (2007) find a somewhat increase in the educational premiums recent years. Nevertheless, there have been relatively small changes in wage differences in Norway, probably reflecting a strong growth in the supply of labor following the increased demand.

In addition to a growing literature analyzing shifts in the composition of labor by different skills and the development in relative wages, more and improved models projecting the need for different kinds of labor 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 labor. In Norway, this type of model has been in use in Statistics Norway since 1993[3]. The commonly used models include a core of input-output relations to capture the interaction between the different industries. In addition to projecting demand for labor in each industry in a consistent way, the use of macroeconomic models also leaves room to analyze the effects of different assumptions. For example, a disaggregated model can distinguish between inter- and intra-industry changes in demand for labor by skill. In a macroeconomic model, labor as an input factor cannot be too heterogeneous with respect to education. Therefore, a module translating demand for labor by industry into demand for labor by education at a detailed level is often linked to the macroeconomic models. The manner in which this element is included differs between countries. The analyses presented in this paper have several elements in common with a European joint project managed by the European Centre for the Development of Vocational Training (Cedefop) that aims to project demand and supply for different kinds of labor for EU27, Norway and Switzerland[4].

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. According to the projections, 18 percent of the employed will have a primary or lower secondary

[1] Cf. Freeman and Katz (1995), Machin (2001) and Briscoe and Wilson (2003).

[2] Cf. Gottschalk and Smeeding (1997).

[3] Cf. Cappelen and Stølen (1994)

[4] Cf. Wilson et al. (2008)

education in 2030, as compared to 27 percent in 2007 and an estimated 63 percent in 1972.[5] When we compare these figures with projections of the work force (given constant educational propensities and labor force participation rates), we find that the projections show a higher increase in demand for labor with a lower degree tertiary education than the corresponding increase in supply. This means that it could be beneficial to increase capacity in higher education to meet increasing demand. Within this group, the projections 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 caregiving.

In section 2, we describe the main structure of the model system, while the chosen classification of labor by education is presented in section 3. Demand for labor in five educational groups in each industry and supply of labor 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 labor market prospects for the five groups of education are shown in section 6, while in section 7, we present how demand for labor is spread over the more detailed educational fields. Demographic projections for population by level of education using the dynamic microsimulation model MOSART are presented in section 8, where we also discuss alternative projections for the supply of labor by education (using MOSART) and its relationship with labor demand (from MODAG).

[5] These figures include workers with unknown education.

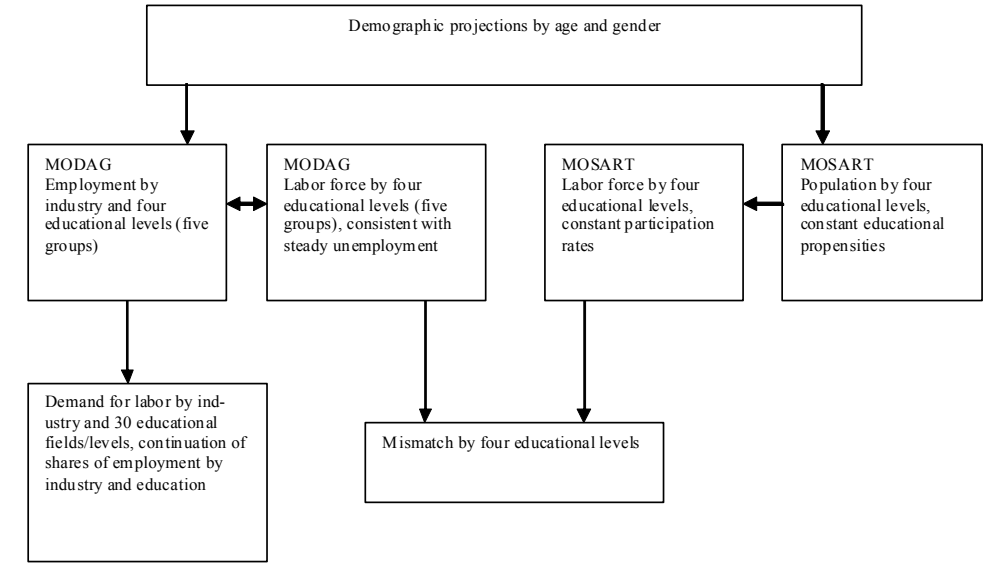
2. Main structure of the model system

The main structure of the model system used for projecting supply and demand for different kinds of labor by Statistics Norway is presented in figure 2.1. While the ordinary version of the macroeconomic input-output model MODAG, documented in Norwegian in Boug and Dyvi (2008)[6], has only one type of labor, a version of the model where labor is divided by five educational groups (four educational levels and two fields within upper secondary education) is used as the main approach for the analysis presented in this paper. The extended labor market module is documented in Bjørnstad and Skjerpen (2006).

On the demand side of MODAG, production in the different industries is dependent on the macroeconomic functioning of the Norwegian economy and on exogenous assumptions about economic development abroad, further growth in industries based on natural resources and the further growth in public services. In addition to the level of production, demand for labor in the different industries depends on technological progress and the possibility of substitution with other inputs. In a separate sub-model, the aggregate demand for labor in each industry is further spread by educational fields using exogenous assumptions about how the employment shares within each main educational group may develop. The continuation of trends observed from the past decade regarding the composition of labor is used as a standard assumption.

On the supply side of MODAG, labor force by the five educational categories are determined by linking equations for labor market participation by age and gender to the corresponding groups of individuals of working age. A discrepancy between total supply and demand, expressed by the corresponding rates of unemployment, affects wage formation. Because wages affect labor market participation rates, as well as demand for labor, this link helps in the direction of achieving consistency between the demand and supply of labor by education. However, the equilibrium correction mechanisms are not strong enough to secure a steady path for the economy and stable unemployment. Therefore, we have chosen to let the labor force in the five educational groups in the projections be determined from the demand side instead. Hence, future mismatches in the labor marked cannot be analyzed using the MODAG-based projections in itself.

Figure 2.1. Main structure of the model system



[6] An earlier version is documented in English in Cappelen (1992).

However, labor supply by education is also projected with the demographic-based dynamic microsimulation model MOSART[7]. Some degree of consistency between the two labor supply projections are secured because Statistics Norway's official demographic projections by age and gender form a common basis for them. Nonetheless, while labor supply is in line with labor demand in MODAG, educational propensities and detailed participation rates that differ by age, gender and education are assumed to be fixed in the MOSART projections. Thus, there may be discrepancies between the projections from the models regarding labor supply, and these discrepancies may be viewed as indications of potential mismatches in the future labor market.

At Statistics Norway, there is a long tradition of projecting the number of people and the corresponding supply of labor according to different types of education using MOSART. In the present version of the model, population and labor force are divided into 22 different types of education by level and field. However, due to quality problems with the MOSART module of education levels of individuals in different fields (22 education groups), at present it is only possible to compare supply and demand within the four education levels.

[7] Cf. Fredriksen (1998) for a general documentation of the model and Andreassen et al. (1993) for a specific documentation of the module for education and labor market participation.

3. Classification by education

We have chosen to diversify labor by education instead of occupation for the following reasons:

- Relatively accurate information about a person's education is available from administrative registers. 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.
- Choice of education makes data organization easier because data may be collected from administrative registers.
- Population and labor force are divided by education in MOSART, and it would have been costly to construct a model projecting labor supply by occupation.

For labor market authorities responsible for vocational training, it would be advantageous if labor 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 30 educational groups to meet the need for detailed information. The present classification by education in MOSART also entails restrictions in the short run, and the classification has to be further diversified to meet the intension of 30 educational groups. Because the current version of MOSART is not based on the most recent education classification, a resource-intensive updating of the data set for the model is necessary to create projections for the supply of different kinds of labor that are consistent with the demand side. In the present paper, the diversification of the supply of labor from MOSART is thus limited to only four main levels of classification.

The four main levels of classification and further sub-classification of the education fields are presented in table 3-1. These figures are from the Labour Survey (LFS) which generally deviate somewhat from the National Accounts figures. The levels are in accordance with the typical design of the Norwegian educational system and closely correspond with international standards for education (ISCED97). To restrict the total number of educational groups to 30, each of the three upper levels of education are divided into about ten fields. The main criterion for the division was to subdivide educational groups to present the greatest possible homogeneity within subgroups regarding supply and demand for labor.

Table 3.1. Classification by education and corresponding numbers of employed in 2006. Figures in 1000 persons. Source: Labor Force Survey (LFS), Statistics Norway

Code	Field of education	Employed in 1000
0	**Total, including unknown**	**2362.1**
1	**Primary and Lower secondary education (ISCED 0-2)**	**499.3**
2a	**Upper secondary education general programs (ISCED 3 and 4)**	**462.7**
2.1	General programs	283.7
2.2	Economics and administration	179.0
2b	**Upper secondary education vocational programs (ISCED 3 and 4)**	**607.2**
2.3	Electronics, mechanics work and machinery	188.3
2.4	Building and construction	83.5
2.5	Other fields of science, technique and crafts	95.6
2.6	Nursing and caregiving	87.6
2.7	Other fields, upper secondary education	152.3
3	**Tertiary education, lower degree (ISCED 5, lower degree)**	**591.7**
3.1	Humanities and arts, lower degree	41.9
3.2	Education, lower degree	142.1
3.3	Social sciences, business and law, lower degree	29.2
3.5[1]	Economics and administration, lower degree	116.4
3.6	Engineering, lower degree	66.2
3.7	Other fields of science, lower degree	28.4
3.8	Nursing and caregiving	72.8
3.9	Other fields of health and social services	55.3
3.10	Other tertiary education, lower degree	39.6
4	**Tertiary education, higher degree (ISCED 5, higher degree and ISCED 6)**	**177.9**
4.1	Humanities and arts, higher degree	22.2
4.2	Education, higher degree	6.1
4.3	Social sciences, higher degree	16.9
4.4	Law, higher degree	17.5
4.5	Economics and administration, higher degree	10.5
4.6	Graduate engineering	31.2
4.7	Other fields of science, higher degree	33.9
4.8	Medicine	14.5
4.9	Dental studies	6.7
4.10	Other tertiary education, higher degree	18.5
9	**Unknown**	**23.3**

[1] 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.

4. MODAG – a model of the Norwegian economy

MODAG is a macroeconomic model for the Norwegian economy developed at Statistics Norway. It is relevant for projections and policy analysis of central variables in the economy. Labor is treated as a homogeneous factor input in the standard version of MODAG. The National Accounts (NA) has provided data on hours worked, employment and hourly wage rates for various production sectors by the five education categories for the period 1972-1997. Time series for labor supply by education category were constructed using education-specific unemployment rates from Statistics Norway's Labor Force Survey. The data were used to construct a version of MODAG with education-specific sub-markets within the labor market. With new NA figures for the period 2000-2007, we have been able to update MODAG with a heterogeneous labor market. Here, we use this model to project the demand for labor by education towards 2030. 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 labor, and Boug et.al (2008) present the newest version written in Norwegian. Bjørnstad and Skjerpen (2006) describe the education-specific labor demand and wage setting. The education-specific labor supply is documented in Bjørnstad et.al (2010).

MODAG is relatively disaggregated and distinguishes between 45 different products and 21 different sectors. The model specifies a large number of final applications of the products, and these products have different prices depending on supply (home- or foreign-produced) and utilization (export or home market).

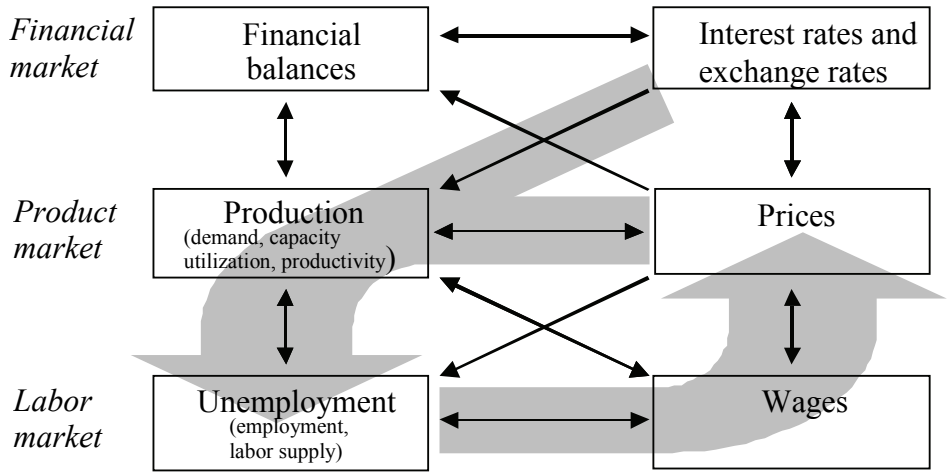
The Norwegian NA forms the conceptual framework and the empirical basis of the model. Specifically, MODAG balances all products in terms of input and output. These relationships connect – at the most detailed level in the model – the supply and usage of the products to different activities in the economy. At the same time, the input-output structure and the account-based relationships are supplemented with econometric equations describing how the agents in the economy tend to respond to different options.

While the long-term relations are based on economic theory, the dynamic adjustments towards the long run are largely quantified to fit data. Because of the sluggish nature of the macroeconomic variables, it takes some time before the effects of exogenous shocks die out and the economic development is in line with the long run relations. MODAG is thus also a dynamic model in which the effects of calculations depend on the time horizon being used. This is important to take into account when presenting results from calculations of the model.

Figure 4-1 illustrates the relationships between prices and quantities in the model's three main markets. The main structure of the model, marked by broad, grey arrows, implies that prices – along with interest rates, exchange rates and wages – determine the demand from private consumption and investment as well as foreign demand. The public use of resources is exogenous in MODAG. In Cappelen (1992), interest rates and exchange rates were exogenous. Here, the money-market interest rate in Norway and the exchange rate between the Norwegian kroner and the Euro are endogenous. While the exchange rate equation is documented in Bjørnstad and Jansen (2007), the interest rate equation is still undocumented.

At a given interest rate differential, the exchange rate between the Norwegian kroner and the Euro is determined by parity in consumption prices between the two monetary areas. 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 also strengthen the real value of the Norwegian kroner. The money market interest rate equation mimics the Central Bank behavior in the current regime of inflation targeting. Interest rates increase with a higher core inflation rate and with a lower unemployment rate.

Figure 4.1. The relationships between the price and quantity side of the different markets



In MODAG, products are imperfect substitutes. This implies that the prices firms charge for their goods can differ from those of their competitors, but these prices are taken into account in the price setting. The production is then decided by the demand for the products. The prices on home-produced goods for the export and home market is set as a mark-up on the firm's variable costs. This mark-up increases if the prices on the competing goods produced abroad increase. Price movements abroad also affect the firms' costs through imported inputs of production.

In addition, the firms' costs depend on hourly wage rates. In line with the institutional aspects of Norwegian wage formation, the model distinguishes between three main sectors when modeling wage formation: manufacturing, private services and the public sector. The relative wage change for the various industries within each of these main groups is assumed identical. By estimating wage relations for each of the five education groups in each of the three main sectors, an explicit measure of wage flexibility is obtained.

According to the wage module in MODAG, both total and education-specific unemployment rates affect wage differentials in Norway. An increase in general unemployment strongly moderates wages to workers with primary or secondary education, while those with tertiary education do not appear to give much emphasis to general unemployment in wage negotiations. On the other hand, those with a higher degree in tertiary education attach more importance to the development in unemployment among their own members. This suggests that an increase in general unemployment will help to increase wage differentials via slower wage growth for those with the lowest education. If, in addition, the increase in unemployment particularly affects less-educated persons, wage differentials will further increase. However, an increase in unemployment among those with a higher tertiary education will reduce wage differentials vis-à-vis other groups. The results also indicate that public sector workers are somewhat more preoccupied by the development in education-specific unemployment than workers elsewhere in the economy are.

In manufacturing, wage costs follow the trend in labor 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 governmental interventions, such as the wage laws in 1979, 1988 and 1989 and changes in the payroll tax rate, also play a part in annual 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, the results show that remuneration depends on the so-called alternative wage alongside the 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. Hence, for a given unemployment rate, the total long-run effect will be that the wage trend for each education category in the two service sectors follows the wage trend for the same education category in manufacturing. If the composition of labor develops identically in the three sectors, the average wage level in each sector will also develop identically in the long run.

The version of MODAG used here distinguishes between eight variable factor inputs, including five different types of labor classified by education background. The other three variable factor inputs are electricity, other energy and material inputs. In addition to the variable factor inputs, there is real capital.[8] In all industries, a distinction is drawn between workers with high and low education levels, respectively. The advantage of the disaggregated production structure in MODAG is that it can account for the considerable heterogeneity between production processes; some are labor-intensive, while others employ relatively little labor. Typically, firms' demand for various types of labor will vary across industries. For example, a production increase in a given industry could have different effects on demand for various types of labor than would an equally large production increase in another industry. Hence, changes in industry structure may have an effect on the relative demand for different types of labor at the aggregate level.

In 11 of the industries, the demand for variable input factors is based on a Cobb-Douglas production function in materials, a CES-aggregate in energy and a CES-aggregate in high- and low-educated labor. Total real capital is treated as a quasi-fixed input, and Hicks-neutral technological change is represented by a linear trend.[9] The eleven industries comprise seven manufacturing sectors, three private service sectors and the agriculture sector. For seven of these sectors, individuals with vocational training at a secondary level are regarded as low-educated labor, while in the other four, they are regarded as high-educated labor. In the large private service sectors, *wholesale and retail trade* and *other private services,* employees with vocational training at a secondary level are regarded as skilled labor. This choice is based on empirical results obtained when estimating the econometric relations. The assessment of high- versus low-educated workers depends on relative wages, the stock of machine capital and production volume following a linear trend, which in the absence of observable variables, is assumed to represent skill-biased technological change (but possibly also other factors). A technical and more complete description of the demand of variable inputs in a situation with heterogeneous labor is outlined in Bjørnstad and Skjerpen (2006) and in even greater detail in Bjørnstad and Skjerpen (2003, Appendix A).

The quantification of the behavioral relations for relative labor demand shows an effect of the trend variable that is indicative of the occurrence of technical changes that favor high-educated labor and disfavor low-educated labor. The annual relative change in the relationship between hours worked by high- and low-education labor, which can be traced to the trend effect, is between 1 and 10 percent depending on the industry in question.

The economic literature has also focused on labor-capital substitution. Recent acquired capital may displace labor with low education and require the employment of well-educated labor in order to be used efficiently. Hence, an improvement in the quality of real capital could favor well-educated labor.

[8] Real capital is disaggregated into different types of capital, where the most important ones are buildings, machinery and transport vehicles.

[9] In the other industries in which the demands for variable inputs are modeled, labor is represented by man-hours, and hence, there is no possibility for substitution between different types of labor.

However, the National Accounts do not distinguish between real capital sources of different quality. The effect of an increase in machine capital differs somewhat from one industry to the next. In the food industry, wood-processing industry, engineering industry and retail trade, an increase in the stock of machine capital leads to a relative increase in hours worked by the well-educated. For the other sectors, the effect is either zero or works in the opposite direction.

The model assumes that there is no substitution between the different types of labor within the two aggregates, high- and low-skilled labor. This means, for example, that a 1 percent increase in the number of hours worked by those with a high education level translates into a 1 percent increase in the number of hours worked by educational groups that belong to this aggregate.

The effect of a production increase also differs somewhat between industries. For three of the industries, an increase in production volume produces a bias towards those with high education. This is the case for the food industry, the wood-processing industry and the industrial chemicals industry. Thus, a change in the production level resulting from domestic and foreign demand impulses will, in production sectors where the effect of a change in production differs from zero, have a direct impact on employers' assessment of high-educated versus low-educated labor.

As will be explained in section 6.2 we have chosen to keep unemployment steady in the projections. Since labor supply is the sum of employment and unemployment this assumption implies that labor supply is determined residually and follows labor demand. In MODAG, unemployment is determined residually and the labor supply is mainly decided by demographic variables and variables that capture labor market pressure.[10] Real wages after taxes also play an important role. Labor supply increases with wages. However, in the demand for labor, higher wages make labor less advantageous relative to other input factors. This results in a lower demand for labor. 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 labor, creating higher unemployment as the real wages increase through a lower net demand for labor. These two relationships jointly determine unemployment such that the real wage implied by the wage setting is consistent with the real wage consistent with the price setting and the net demand for labor. If the unemployment rate is lower than this "equilibrium" level, the wage setting will result in a higher real wage level, causing the firms to reduce the demand for labor. The level of unemployment will increase until there is correspondence between the real wage rate implied by the wage setting and real wage rate consistent with the firms' price setting and demand for labor. The reason we chose stable unemployment instead of MODAG determining labor supply, is that this equilibrium correction mechanism works sluggishly and is weak. MODAG simulations would then have generated unwanted business cycles. Instead, we wanted to analyze demand for labor in a relatively stable economic development.

Domestic demand can be split into household consumption and housing investments, investment and use of factor inputs by firms and the public use of resources. Firms decide the extent of real capital and input of production based on the level of production and relative factor prices.

The model involves a traditional Keynesian multiplier, where higher 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

[10] See Bjørnstad et al. (2010) for a detailed documentation of the labor supply in MODAG with heterogeneous labor.

aggregate demand causes a change in aggregate output for the economy that is a multiple of the initial change.

In the interaction depicted above, the firms and agents control alternative parameters. The households decide their supply of work based on wages and the level of unemployment. Negotiations between labor unions and employers' organizations set wages on the grounds of prices and the unemployment level. Firms set prices based on the wage level. Customers in the product market decide their demand and, hence, the production based on prices. The firms' demand for labor decides employment, which together with the labor supply, determines the level of employment.

The operational version of the model does not contain mechanisms that ensure full resource utilization or balance in the external account or in public sector budgets. Thus, in applying the model, the user must decide on a fiscal policy that is sustainable.

The economic relationships in an econometric model such as MODAG are estimated based on a historical data series. There is considerable disagreement on whether and to what degree such models lend themselves to analyses of the type we have carried out here. In his critique, Lucas (1976) argues that when the agents in an economy choose their actions, they do so based on optimizing behavior and rational expectations of the future. Hence, these agents will change their behavior if expectations change. When the economy changes as a result of political decisions, for example, the linkages among economic variables will also change. Economic models can be used for policy analyses only if relations in the models are determined such that they are immune to policy changes. If not, policy change will change the actual model, in which case the model is not suited to studying structural changes. Ericsson and Irons (1995) examine the extensive literature on the Lucas critique, with special emphasis on tests of the critique's empirical relevance. The authors' conclusion is that the Lucas critique is relevant in theory but has limited relevance in practice. Only a few empirical studies find support for the critique. While the Lucas critique represents a qualitatively important objection to the use of empirically specified models, experience suggests that the critique hits isolated aspects of the models hardest and that it is not important in purely quantitative terms. We are not aware of other recent studies that would challenge this conclusion.

5. Projections of the Norwegian economy towards 2030

To study the effects of economic development on the demand for labor, we have projected a path for the Norwegian economy based on MODAG simulations that extends to 2030. Our projections are based on final National Account (NA) figures up until 2006 and preliminary figures for 2007 and 2008. However, the labor market module in NA extends only to 2007. Therefore, we must start the MODAG simulations in 2008, and for that reason, 2008 figures may deviate somewhat from preliminary account figures even though we have generated residuals so that the simulated figures should match the preliminary account figures fairly well. When we started our work with the projections, we also had access to quarterly NA figures for the first half of 2009. Our focus here is on long-term development, but the projections are nevertheless reasonably consistent with the latest developments and forecasts. The path is based on a rather quick adjustment from the low growth we have observed through 2009 to a more balanced economic development where employment, wages, consumption, prices and activity grow at rates close to the prevailing trend. Table 5-1 summarizes the macro-economic development in the projections. This path does not necessarily represent our best prognosis for the actual development, but is rather a cyclically neutral path where the key macroeconomic variables move close to their long-term trend. This ensures that the effects on the demand for labor by education in our analysis result from structural rather than cyclical conditions.

After a period of very strong economic expansion, the Norwegian economy has recently experienced a marked downturn following the international financial crisis. The downturn in Norway started in 2007 with a decline in residential investment that became more pronounced throughout 2008. The downturn has mainly hit manufacturing and construction, but it also affected some private service sectors. Nevertheless, the crisis in the Norwegian economy has been mild in comparison to other countries, and it began with an exceptionally low unemployment rate of 2.5 percent. There was extensive employment growth until 2008 due to multiple factors. The increased labor demand encouraged more people to enter the labor force, resulting in higher participation rates among both male and female workers and across most age groups. In addition, the proportion of the active-age population rose. Most importantly, the expansion of the European Union on May 1, 2004 has increased the flow of foreign workers and immigrants seeking work in Norway, particularly from Eastern European countries. The cyclical upturn would not have been as persistent and strong without this substantial labor immigration.

The unemployment rate, as measured by the labor force survey, increases from 2.5 percent in 2008 to 4.1 percent in 2011 in our projections. Then, it declines slowly and stabilizes at 3.1 percent from 2017 onwards. After 2017, total value added, as measured by GDP in the mainland economy, grows at rates of 2-2.5 percent annually; wage growth varies between 4 and about 5 percent; and inflation is slightly above 2.5 percent. This gives a growth rate for real wages on average of about 2 percent on this steady state growth path. The growth in households' real disposable income is approximately ½ a percentage point higher, mostly due to increased employment (with approximately 0.5 percent annually) and increased pension payments from the demographic changes. The increased pension payments contribute to 0.3-0.4 percentage point annually to the growth in households' real disposable income. A somewhat high growth in interest payments moderates the real income growth. Because of a high growth in oil revenues, we have chosen to decrease the income tax rate gradually in the period 2011-2023 with 2.4 percentage points, and then increase it gradually again after 2025 when public expenditures on health and caregiving services increase rapidly. In 2030, the income tax rate is still 1.5 percentage points lower than in 2010.

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

	Level					
	2006	2010	2015	2020	2025	2030
Real economy, bill. NOK						
Consumption in households	882	3.4	3.3	2.8	2.6	2.8
General government consumption	413	3.5	1.4	1.6	1.8	1.9
Gross fixed investment	424	0.1	1.5	1.6	1.8	3.3
Manufacturing	247	-1.6	3.8	3.8	2.5	4.6
Residential housing	90	3.4	3.0	3.0	2.0	2.0
Public sector	61	10.7	0.4	1.2	1.2	1.2
Exports, traditional goods	271	2.9	4.0	3.1	3.9	4.0
Imports	613	6.2	4.0	3.3	3.2	3.4
Gross domestic product	2,160	0.7	2.0	1.5	0.9	1.4
Mainland Norway	1,342	1.8	2.5	2.2	2.1	2.4
Manufacturing	196	-2.7	2.4	1.4	1.9	2.1
Labor market, in 1000						
Man-hours worked	3,445,628	0.1	0.5	0.5	0.7	0.8
Employed persons	2,437	0.3	0.4	0.4	0.7	0.8
Manufacturing	281	-4.4	-0.1	0.0	-0.0	0.3
Private services	1,093	-0.1	-0.1	-0.0	0.3	0.3
Construction industry	169	-0.4	0.6	0.6	0.5	1.7
Public sector	722	3.4	1.2	1.3	1.6	1.7
Primary and lower secondary education and unknown	647	-1.6	-1.3	-1.4	-1.2	-0.9
Upper secondary education, general programs	451	-1.4	-1.3	-1.4	-1.1	-0.8
Upper secondary education, vocational programs	617	0.8	1.5	1.3	1.3	1.4
Tertiary education, lower degree	556	2.7	1.7	1.7	1.8	1.7
Tertiary education, higher degree	166	2.3	1.5	1.5	1.7	1.6
Labor force [1]	2,447	1.0	0.3	0.4	0.7	0.8
Unemployment rate, percent [1]	3.4	3.9	3.3	3.1	3.1	3.1
Labor market participation rate, percent	72.0	72.7	70.2	69.1	69.2	70.0
Prices and wages						
Wage per hour, NOK	232	3.9	4.2	4.2	4.7	4.8
Consumer price index (CPI), 1998=100	118	1.1	2.5	2.6	2.7	2.8
CPI adjusted for tax changes and excluding energy products (CPI-ATE)	114	1.0	2.5	2.7	2.7	2.8
Export prices, traditional goods	1	0.4	3.1	2.2	2.5	2.6
Import prices, traditional goods	1	-2.5	2.4	2.0	2.2	2.2
Income, interest rates and exchange rates						
Household's disposable real income, bill. NOK	861	5.6	2.3	2.4	2.5	2.6
Money market rate, level [2]	3.1	2.2	6.5	7.0	7.2	7.4
Import weighted krone exchange rate (44 countries)	92	-2.9	0.5	0.1	0.4	0.3

[1] According to Statistic Norway's labour force survey (LFS).
[2] 3 month NIBOR
From simny24.db

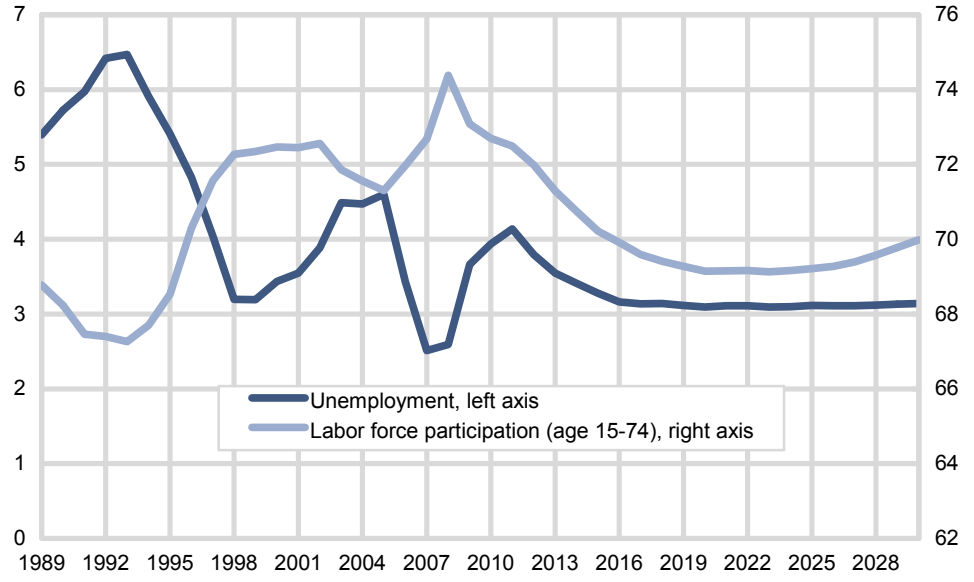
Private consumption increases by almost 2½-2¾ percent annually after 2017, a bit more than it does earlier in the projection period. With these projections, the households' savings ratio is quite stable at approximately 2 percent annually. The wage growth, combined with a relatively steady exchange rate at approximately 7.8-8.2 per euro, results in moderate deterioration of the terms of trade for the exposed sector, which expands less than the rest of the economy.

As mentioned in previous section and as will be explained in section 6.2 we have let the labor demand (employment) plus unemployment determine the labor supply in our projections. Hence, the labor supply module in MODAG is shut off in the simulations. The reason for this is to ensure a stable path for the unemployment rate. It would be extremely challenging to avoid large cyclical movements in the simulation if both employment and labor supply were determined by the behavioral equations in MODAG, and unemployment was determined residually.

The labor market participation rate indicates the number of people aged 15-74 years who are either employed or unemployed as a percentage of the population in the same age range. In a weakened labor market, this rate is expected to fall, as jobs are harder to find. This empirical regularity is known as the discouraged-worker effect. It will probably cause a lower participation rate in subsequent years. A substantial share of the population in Norway of working age is participating. It has among the highest participation rates in the world. However, the average age within the cohort is continually increasing, and the demographic situation will be

less favorable as we move towards 2030. Even though labor supply is determined from the demand side in our simulations, we have tried to consider these issues when constructing our projection path.

Figure 5.1. Average labor market participation rate (number of persons offering work as share of the population aged 15-74 years, right axis) and unemployment rate (left axis). Given as percentages



As figure 5-1 shows, the participation rate falls gradually from a level of about 73 percent in 2009 and 2010 to about 69 percent towards 2020. This development is fairly in line with what we would expect in light of the cyclical movements and the demographic changes during this period. Then, the fall in the participation rate stops and it even turns to increase after 2025. At the end of the period, the participation rate reaches 70 percent. The increase mainly comes from an increase in labor demand in the public health and social sector as the elderly population grows (keeping in mind that labor supply is determined by employment plus unemployment). Hence, the projection simply shows the labor supply that Norway needs in order to keep unemployment stable and at the same time deliver health and caregiving services to the growing elderly population. One might object and say that the increase in the participation rate is unrealistic since the demographic changes in itself imply a decrease in the participation rate. We have given this much thought and concluded that it might in fact be a realistic development.

There are at least two arguments for an increasing participation rate. First, labor force participation is much higher among those with a tertiary education compared to those with a primary or secondary education. Since the numbers of tertiary educated persons increase while the number of persons with less education decreases in our projections, we expect the average participation rate to increase as well. As an illustration, the number of tertiary educated persons in the age 25-74 increases with almost 390,000 from 2010 to 2020 in the projections. Their average participation rate is about 84 percent. The number of primary educated persons in the same age decreases with 258,000 during the period. Their participation rate is only about 56 percent. Our calculations show that the positive effect on average participation from the educational upgrading completely cancels out the negative effect from increased average age in the population.

Second, the population forecasts that our projections build on show a marked growth in the numbers of immigrants. Historically, the immigrants have largely come to Norway to work when there has been a growing need for labor within some sectors of the economy, as for example the building and construction sector in the period 2004-2008. Similarly, the period with an increasing demand for labor

in the public health and social sector after 2020 will probably attract many immigrants with the intention to work in that sector. With a continuously growing population of working immigrants, one could expect the average participation rate to increase as it has done previously in periods with many immigrants.

Figure 5.2. Employment by sector, 1,000 persons

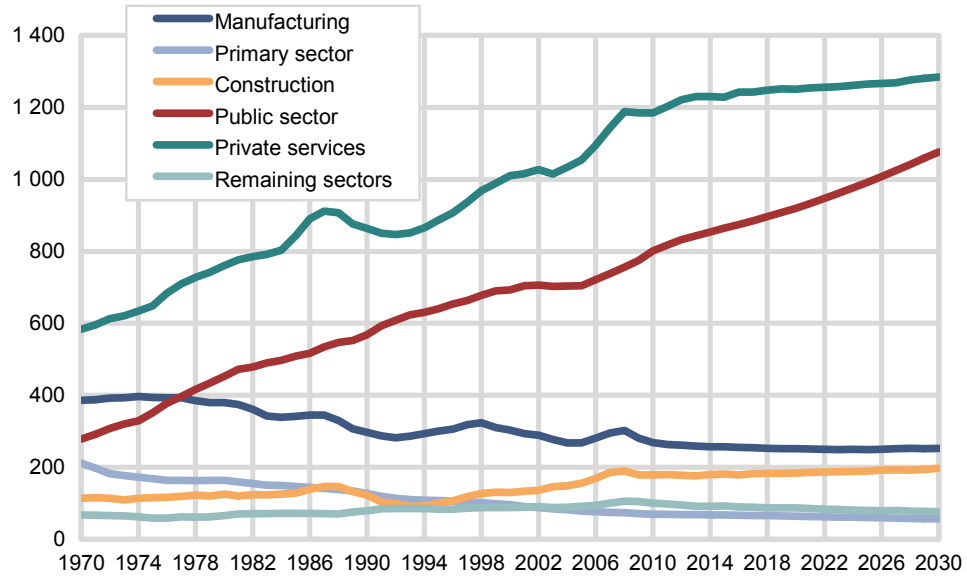
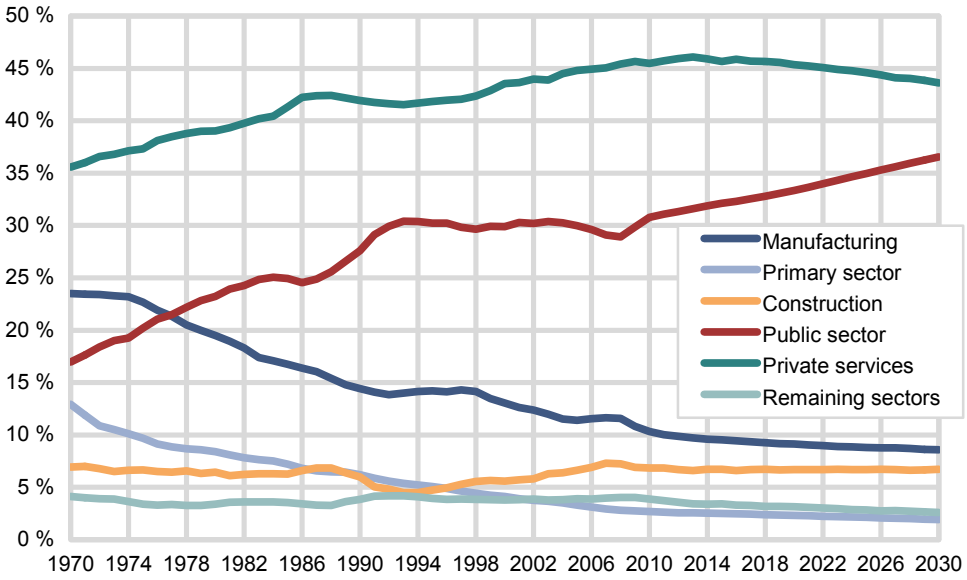


Figure 5.3. Employment by sector, share of total employment



Figures 5.2 and 5.3 respectively show employment by sectors of the economy in 1,000 persons and as a share of total employment. The sectors include the primary industries[11], manufacturing[12], private services[13], construction industry, public sector[14] and the remaining industries[15]. The extent of public activity is expected to

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

[12] 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.

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

[14] Central and local government including the military.

grow both in quantity and as a share of total employment. The public sector's share of total employment rises from 30 percent in 2009 to nearly 37 percent in 2030. This growth illustrates the demand for public health and caregiving services as the population of elderly people grows.

Even with an assumption of lowered income tax rates, it is possible to finance this future growth in public expenditures through the Government Pension Fund – Global, at least towards 2025. After 2025 we have assumed gradually increases in the income tax rates again. The fund will probably increase its size considerably during the projection period. The Norwegian government has adopted a fiscal rule that the deficit in the government sector, corrected for oil and gas revenues and cyclical conditions, should be approximately four percent of the value of the pension fund in the beginning of the budget year. This corresponds to the expected real surplus of the fund. The rule implies that the fund is expected to grow with future oil and gas revenues and that it never declines in real terms. Table 4-2 shows the government deficits together with the fund revenues and fund value in our projection path. We have assumed that the dividends and reassessments from the fund is 5.75 percent annually, measured in foreign currencies. With an import price growth of approximately 1¾ percent, the real profit from the fund is about 4 percent. Most of these profits are assumed withdrawn from the fund in order to finance the government deficit. However, since the net revenues to the government from Norwegian petroleum activities will be invested in the fund and some of the profits will be re-invested, it will still grow throughout the whole projection period. We have assumed that the oil price stays around $80 per barrel in the period towards 2015, and then increases gradually to $100 per barrel in 2030.

The petroleum production in Norway has already reached its peak, and is expected to decline further the years ahead. The revenues from the petroleum activity will thus decline during the projection period. Therefore, the possibility of financing the rapid increase in public pension expenditures after 2020 with the Government Pension Fund – Global abates. We have not assumed much increase in public spending before 2020 either, because the public deficits during the current downturn in the economy are much higher than the sustainable level of 4 percent of the fund and because we have chosen to reduce the income tax rate instead. If we had assumed constant tax rates and increased standards in public services, the financial burden on public budgets after 2020 would be much higher than it is in our projections. The reason for this is that the total costs of higher standard grow as the population in need for public services grows after 2020. Therefore, even though the growth in public employment continues during the entire period, the growth in standards in public services is very small during the projection period, cf. figure 7.1.

The growth in households' disposable real income remains relatively high through the entire projection period. The growth in demand for private services also stays at a relatively high level. However, because of the growth in the public sector, the private service sector measured as a share of total employment will decline. The primary industries and manufacturing are projected to continue their downward trend. The remaining industries also reduce their activity, especially in the extraction of crude oil and natural gas. The construction industry, on the other hand, is expected to expand somewhat.

[15] Among the remaining industries are the extraction of crude oil and natural gas, foreign shipping and production of electric energy.

Table 5.2. Government account in billion kroner, current prices. 2008-2030 are model-simulated projections.

	Non-oil government deficit[2]	Net revenues from petroleum activities	Dividends and reassessments from the Pension Fund – Global	Government Pension Fund – Global at the beginning of the year	Non-oil government deficit in percent of Government Pension Fund – Global at the beginning of the year
2007[1]	1	316	-75	1,783	0.1
2008	72	426	-47	2,002	3.6
2009	197	300	263	2,300	8.6
2010	165	278	266	2,671	6.2
2011	192	305	327	3,059	6.3
2012	196	333	418	3,508	5.6
2013	206	323	184	4,072	5.1
2014	206	326	226	4,376	4.7
2015	211	325	310	4,724	4.5
2016	217	324	324	5,152	4.2
2017	223	314	324	5,581	4.0
2018	242	301	315	5,992	4.0
2019	254	301	338	6,363	4.0
2020	270	297	409	6,743	4.0
2021	291	297	438	7,175	4.1
2022	310	298	469	7,614	4.1
2023	328	298	513	8,065	4.1
2024	347	273	552	8,540	4.1
2025	363	250	571	9,011	4.0
2026	375	232	628	9,460	4.0
2027	386	219	694	9,939	3.9
2028	403	206	660	10,458	3.9
2029	425	216	637	10,911	3.9
2030	440	201	698	11,328	3.9

[1] Report No. 1 to the Storting (2008-2009) The National Budget 2009
[2] 2008-2030 numbers include deficits in local governments

6. Demand for labor by educational level

In the next section, we present projections for employment by educational field towards 2030. In order to construct these projections, we use a three-step procedure. First, with the help of the macroeconomic model MODAG (described above), we project industry-specific employment disaggregated into five educational groups (at four different educational levels). Second, for each of the educational fields within these five groups, we make projections for their employment share in each of the 21 industries. Third, we combine the results of the first two steps by multiplying the shares with employment in each industry according to the MODAG projections. In this section, we focus only on the labor market projections from MODAG (i.e., employment, labor supply, unemployment and wages for each of the five educational groups). When we disaggregate into educational fields in the next section, we are only able to present projections for employment.

6.1. Employment

Figures 6-1 and 6-2 respectively show employment aggregated across all industries in the economy for each of the five educational groups in thousands and as percentages. Data for the period 2000-2007 are from the National Accounts (NA). The number of employed persons with unknown education grew from about 40,000 in 2000 to 180,000 in 2007. The growth was particularly high in 2006 and 2007 and reflects the considerable labor immigration into Norway from EU-members in East Europe. These immigrants have largely not been registered with an education at the Register of the Population's Highest Level of Education (PHE).

The considerable growth in the group with an unknown education level in the last years is somewhat problematic when projecting the future demand for labor because we also must project the future employment path for this heterogeneous group. In the estimated labor demand equations in MODAG, this group was included with primary and lower secondary education. Therefore, we have chosen to do the same in our projections. In the figures, we show employment numbers for this group both with and without workers with unknown education, but only during the period 2000-2007.

NA data with an educational distribution of the labor market extends only from 2000. In figures 6-1 and 6-2 however, we have chained these numbers with the data used in Bjørnstad and Skjerpen (2006). They used an older version of MODAG but had the same disaggregated labor market as in the version used here. In their analyses Bjørnstad and Skjerpen used provisional figures provided by the Unit for National Accounts at Statistics Norway, and they relied on their own imputations in the cases where data were not available to obtain figures for the period 1972-1997. They then used MODAG together with ordinary NA figures to generate data on employment and wages by education for 1998-2000.

Although the five educational groups were the same in their study and in the present study, the education classification practice has changed since then. The main difference is that, in the data set we use here, the number of employees with only primary or lower secondary education is much lower. The two data sets overlap in 2000, where 877,000 employees were categorized as primary or lower secondary educated in Bjørnstad's and Skjerpen's data set, and only 607,000 employees were in this group according to the new NA figures. The number of employees with general secondary education has increased from 301,000 to 490,000 the same year, and the number of employees with vocational education at the secondary level is now 582,000 as compared to 494,000 in Bjørnstad's and Skjerpen's data set. In figures 6-1 and 6-2, we have held these year 2000 differences constant in absolute terms and added them to Bjørnstad's and Skjerpen's data for the period 1972-1999. This correction generates only a small deviation in the total numbers of employees compared to NA figures (without an

education distribution, which is available for this whole period). The deviation is generally less than 1 percent of total employment.

As we can see from the figures, there seems to have been a gradual shift in the negative trend in employment of persons with primary and lower secondary education from the mid 1990s, and a similar shift in the positive trend in employment of persons with upper secondary education, particularly those with vocational programs. The shifts seem to be enhanced around 2000. During the period 2000-2007, employment in these two groups has been stable when measured as a share of total employment. We believe that these trend shifts are due to specific problems regarding the registration of immigrants' education. Many new citizens have likely been registered with only primary education when they, in fact, might have had vocational training.

For the period 2008-2030, employment figures are generated with help from MODAG. However, MODAG has an endogenous description of the employed as either skilled or unskilled in only 11 of the 21 industries. In these industries, we assume the same percentage growth as in all sub-groups taken together. For instance, the percentage growth in the number of primary- or lower secondary-educated workers in a specific industry is identical to the percentage growth of unskilled workers in the same industry. Similarly, the percentage growth of tertiary-educated workers is identical to the percentage growth of skilled workers in the industry. Those with a secondary general education are categorized as unskilled. On the other hand, when measured in numbers of workers, those with a vocational education are mainly treated as skilled. They are classified as unskilled in 7 of the 11 industries, but in *wholesale and retail trade* and *other private services* – the two largest industries in the private sector – they are categorized as skilled. In ten industries, demand for labor is modeled as either one homogeneous input factor or it is exogenous. In either case, we have assumed that the historical trends in education-specific employment shares continue during the projection period.

Figure 6.1. Employment by level of education in thousands of persons, 1986-2030

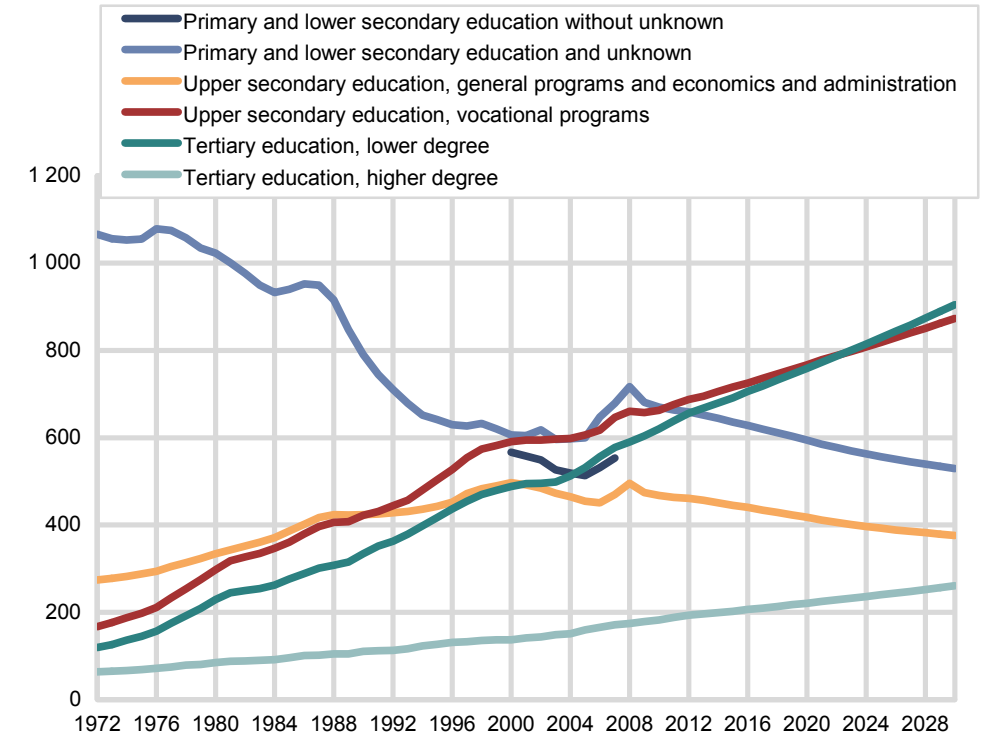
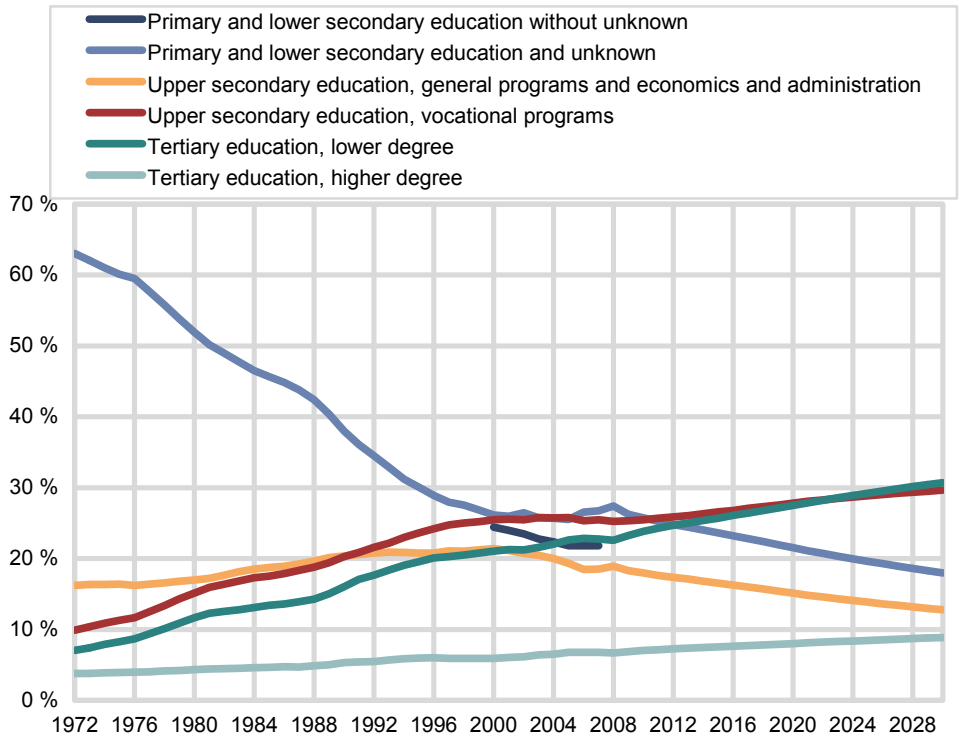


Figure 6.2. Employment by level of education as a percent of total employment, 1986-2030



According to our projections, past trends of increasing employment for skilled labor will continue. Analogously, demand for less-educated workers will decline. Hence, we assume that the relatively flat development in the employment of primary- and secondary-educated workers will shift in the years ahead. While about 27 percent of the employed had a primary or lower secondary education in 2007, this share declines to 18 percent in 2030. Employees with an upper secondary vocational education increase in percentage points from 25 to 30 in the same period. As explained above, employees with an upper secondary vocational education are mostly regarded as skilled labor, and employees with an upper secondary general education are unskilled labor. Therefore, those with general programs are expected to decline in numbers in the future, even though they have been increasing in number until 2000. We believe that this group will decline from 19 percent of the total employment in 2007 to 13 percent in 2030.

6.2. Labor supply and unemployment by education

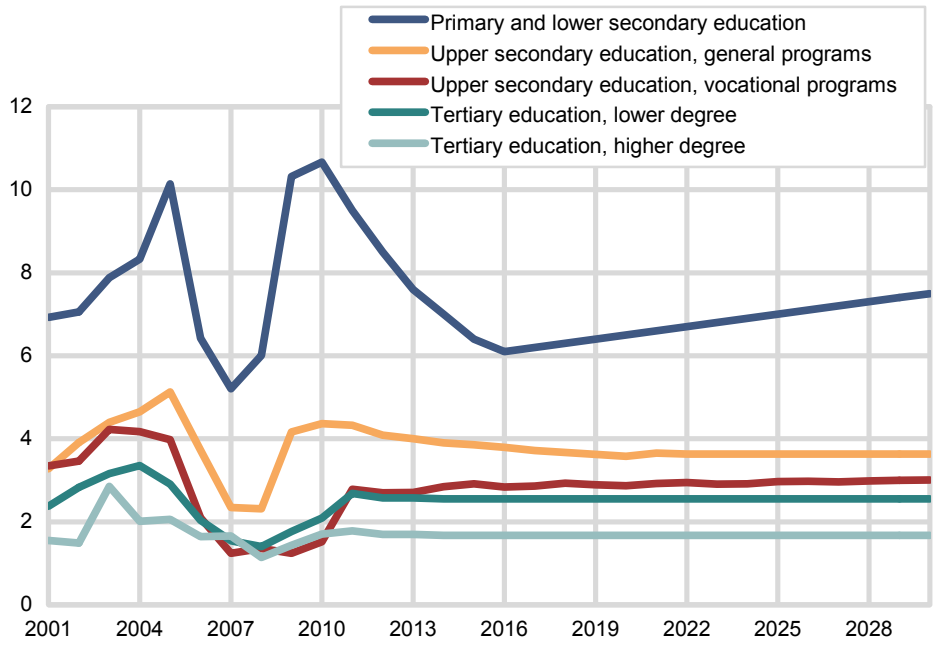
By definition, labor supply is the sum of employment and unemployment. Although MODAG with heterogeneous labor contains behavioral equations for most of the labor supply, we have chosen to let the demand for labor plus unemployment determine the labor supply, while we also keep education-specific unemployment at a steady level. Otherwise, we run the risk of getting unrealistic and even negative unemployment numbers when simulating in MODAG. Nevertheless, in each education group the development of the wedge between the modeled labor supply and the implied labor supply from the demand side may serve as a reality check. However, the wedge constitutes a quite large and increasing group of workers, since both the number of foreign employees[16] and employees with unknown education is not part of the modeled labor supply. In addition, there are residuals to the education-specific labor supply that capture further differences in education classification between the modeled employment and employment calculated from the modeled labor supply (labor supply minus unemployment). Hence, the wedges will not serve as good measures on the reality in the labor supply projections. Instead, they are necessary in order to classify the

[16] Employees that are not part of the Norwegian population.

foreign employees and the workers with unknown education into each of the five educational groups. This leaves us unable to examine any mismatches in the labor market, but in the next section, we compare these implied labor supply series with the labor supply from MOSART, where the education-specific labor supply is determined by assuming constant participation rates and educational propensities. This comparison will be a better reality check on the implied labor supply in our projections. Hopefully, the comparison can guide policy makers and future students to close the gap.

The exogenous education-specific unemployment rates are shown in figure 6-3. The figure shows that we assume constant unemployment rates among all educational groups except the group with primary and lower secondary education. In this latter group, we assume a slight increase in unemployment in the years ahead. The reason for this assumption is that we believe that these workers will be less employable as the group declines in numbers.

Figure 6.3. Unemployment by education, percent of labor supply



6.3. Wages

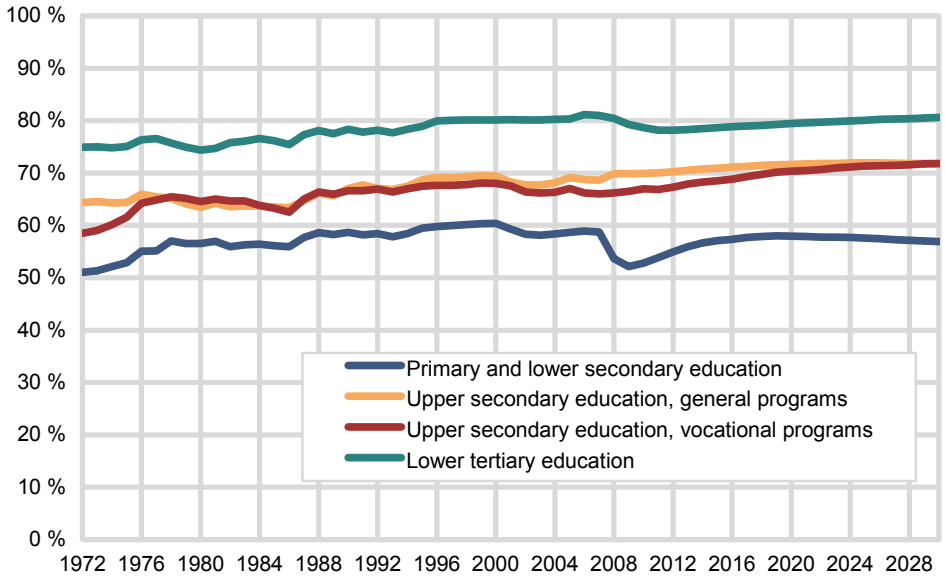
In the labor module in MODAG, education-specific hourly wages are determined in each of the three main sectors of the economy – manufacturing, private services and public services. Wage determination in Norway is quite centralized and has resulted in relatively stable wage differences in the past decades. However, as we can see from figure 6-4, which shows hourly wages relative to workers with higher tertiary education, all other groups have gained somewhat in relation to this group.[17] After some years with volatility in relative wages in the beginning of the simulation period, past trends of decreasing wage differentials reemerge. Wages to primary- and lower secondary-educated workers seem to be an exception. Their wages seem to decline somewhat in the simulation period compared to all other groups.

The marked increase in unemployment among primary and lower secondary education during the years of the economic downturn following the international financial crisis explains most of the volatility in relative wages in the first years of the simulation period. Overall, one might say that wage differentials stay relatively

[17] In the figure, data for the period 1972-2000 from Bjørnstad and Skjerpen (2006) are used to chain the NA numbers in 2000-2007. The numbers for 2008-2030 are from the MODAG simulations.

stable during the simulation period. After all, the changes are relatively small, a fact that also reflects the balanced labor market we have assumed in the simulations, with exogenous education-specific unemployment rates.

Figure 6.4. Hourly wages by educational group, percent of hourly wages to workers with higher tertiary education



7. Demand for labor by educational field

In the previous sections, we explained how we use MODAG to project industry-specific employment by education, thus enabling us to account for changes in industrial organization that may affect demand for labor. However, MODAG does not contain any detailed information on employees' fields of education. In this section, we describe a sub-model in which employment in private industries is distributed among specific educational fields.

In order create this model, we match the NAV National Register of Employers and Employees (the EE-register) with the Norwegian Register of the Population's Highest Level of Education (PHE). The EE-PHE match gives us data on industry-specific employment by educational field back to 1986. By calculating education-specific employment shares and assuming a continuing trend in these shares, we are able to project industry-specific employment by field of education.

The PHE-database includes many individuals with unknown education, and a number of individuals in the EE-register are not assigned an industry. Therefore, the number of matches is far less than the number of employees according to NA. Therefore, we project the employment share of each educational field in each separate industry rather than projecting the number of employees directly.

This method implies that employees with either an undeclared education or industry (without information on education) are assigned educational fields in the same proportion as among those where we have both education and industry information. Although this probably is an erroneous assumption, the EE- PHE match is the best industry-level data we have been able to obtain.

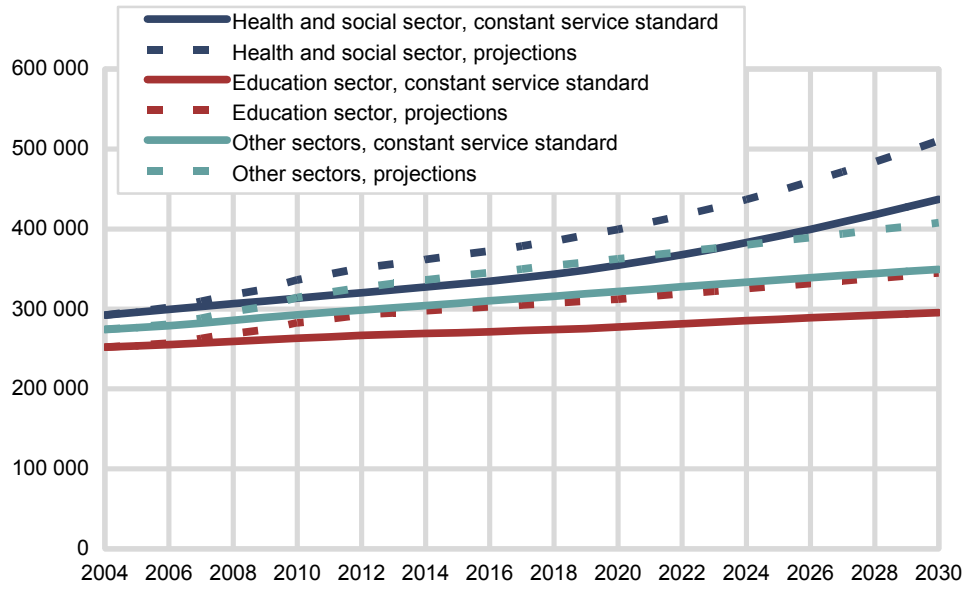
At a national level, the Labor Force Survey (LFS) gives data of much higher quality. Therefore, to ensure a more accurate level of employment by educational field at a national level, we make a correction to our aggregated employment figures according to the deviation from LFS in 2006, which was the last year with LFS data at the time we did the correction. The correction was quite small. We have chosen to keep the correction constant in absolute values.

The correction is made on NA figures. However, these figures are only available from 2000. In order to show time series extending from 1986 in the same graph as the projected series, we have also made a correction to an aggregation of the matched EE- PHE series. Because these series are chained with the LFS-adjusted NA numbers in 2000, we hold the percentage deviation in 2000 constant for the period 1986-1999. In absolute terms, the deviation in 2000 was quite large for some groups. Assuming a constant correction in absolute values would imply a very large percentage deviation for those groups that have experienced considerable growth.

In the public sector, we distributed the employment into educational fields according to information from three other projection models at Statistics Norway. First, we used a model named MAKKO to further distribute employment in three public subsectors: *health and social sector*, *education sector* and *other sectors*. The objectives of MAKKO (cf. Nielsen, 2008) are to project the effects from demographic development on demand for labor in production of 12 different kinds of individual services mainly produced in the public sector. In addition to demographics, demand for labor depends on assumptions about standards, user propensities and productivity. An increasing number of elderly persons in the population for example, implies increasing demand for workers in the health and social sector. Service standards are measured by the number of working hours per user of each service. We have assumed identical growth rates in service standards in each of the three public subsectors.

In figure 7.1, we compare our projections of employment in man-hours in the three public sectors with projections based on constant service standards. The projections for total employment growth in the public sector in the years following the international financial crisis suggest strong growth in service standards for the beginning of MAKKO's simulation period. After 2012, the scope of growth in standards is assumed to be small because of the tighter financial constraints in public budgets and because of a growing population of elderly people demanding services, as explained in section 5. The projected employment in the public health and social sector is for example 10 percent higher in 2012 than in the MAKKO simulation with constant service standard. Then the growth in standard abates. In 2020 employment is 13 percent higher, and in 2030 it is 17 percent higher.

Figure 7.1. Employment in man-hours in three public sectors



In order to distribute employment in the public health and social sector and the public education sector on educational fields, we next used two models called HELSEMOD[18] and LÆRERMOD[19], respectively. However, because HELSEMOD and LÆRERMOD do not give demand projections for all educational fields, our projections for those not included are based on continuations of past trends, measured in shares. The same strategy is used for those distributed among other public sectors according to MAKKO. The numbers of workers included in HELSEMOD and LÆRERMOD amount to a relatively stable share of the total employment in their respective sectors.

On assignment from the former Ministry of Health and Social Affairs and the former Ministry of Church, Education and Research, Statistics Norway has been responsible for the maintenance and development of HELSEMOD since the beginning of the 1990s. The actual set of calculations with HELSEMOD consists of projections for 18 separate groups and 2 rest groups. Four of the groups have secondary-school education, and 12 educational groups are educated at a tertiary undergraduate level. Most of the undergraduate education lasted for three years after completing secondary school. Four groups who were educated at universities are also included in the model. To systemize the projections, the health and social sector is divided into 12 activities. The employment of individuals with the 20 specified educations that are outside the health and social sector is included in a

[18] HELSEMOD is documented by Stølen et al (2002) and the results from the latest projections are published in Texmon and Stølen (2009).

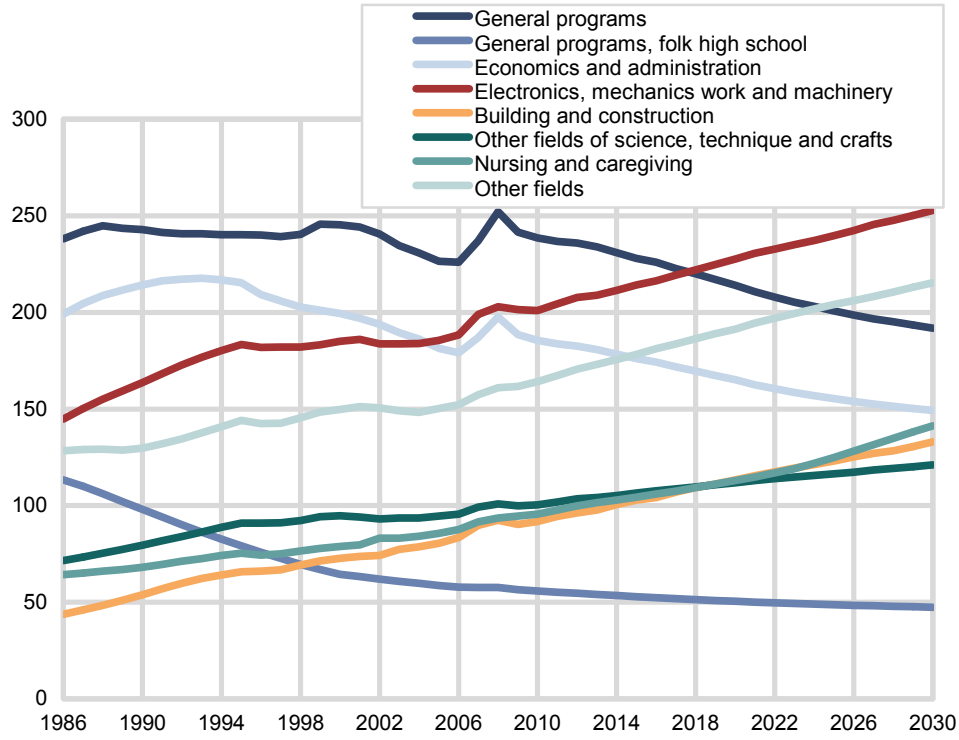
[19] The structure of LÆRERMOD corresponds very close to HELSEMOD documented by Stølen et al. (2002), and the results from the latest projections are published in a white paper from the Ministry of Education (St.meld 11, 2008-2009).

remaining sector. Separate assumptions about demand are made for each activity. Demographic projections combined with observed propensities for use of the different services by age and gender are thus taken into account as well as assumptions about economic growth during the period of projection.

LÆRERMOD is a similar model and has been used by Statistics Norway to project supply and demand for four groups of teachers on request from the Ministry of Education. In LÆRERMOD demand is projected for kindergartens, for four sectors of education and for employment of teachers outside the educational field. The most recent projections are from 2008.

We next present the demand for labor by educational fields towards 2030 in further detail but aggregated across all sectors in the economy. Figure 7.2 shows the projected number of employees by educational field at upper secondary level in thousands of persons.

Figure 7.2. Employment by education at upper secondary school level, 1,000 persons



The figure indicates growth in the employment of persons with vocational education. The demand for persons with specialization in electronics, mechanics work and machinery and in other fields is predicted to show the strongest growth. For these fields, employment is projected to increase by nearly 65,000 persons from 2006 to 2030. In 2030, workers with an education in electronics, mechanical work and machinery may constitute the largest group of vocational education at the upper secondary level, with a share of nearly 30 percent. This group, together with the group of other fields, may then make up over half of the vocationally educated workers at upper secondary level. The demand for candidates with specialization in electronics, mechanical work and machinery primarily originates from the service sector and the building and construction industry, while the demand for candidates specializing in other fields originates from the public sector as well as the private service sector. Furthermore, the employment of persons with specialization in both nursing and caregiving and building and construction clearly increases throughout the prediction period.

The employment of individuals with general education programs and economic and administrative education at the upper secondary level is, on the other hand,

predicted to fall on the order of 45,000 and 30,000, respectively, during the projection period. Accordingly, the employment shares of individuals with general education programs at upper secondary level are projected to fall from 12 percent of total employment in 2006 to about 8 percent in 2030. For candidates in economics and administration at upper secondary level, the employment share falls from nearly 8 percent in 2006 to a little more than 5 percent in 2030. This development is connected with vocational training being regarded as specialized labor in some of the large private services industries, while general education programs and economic and administrative education at this level are mainly regarded as unskilled in the labor market.

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

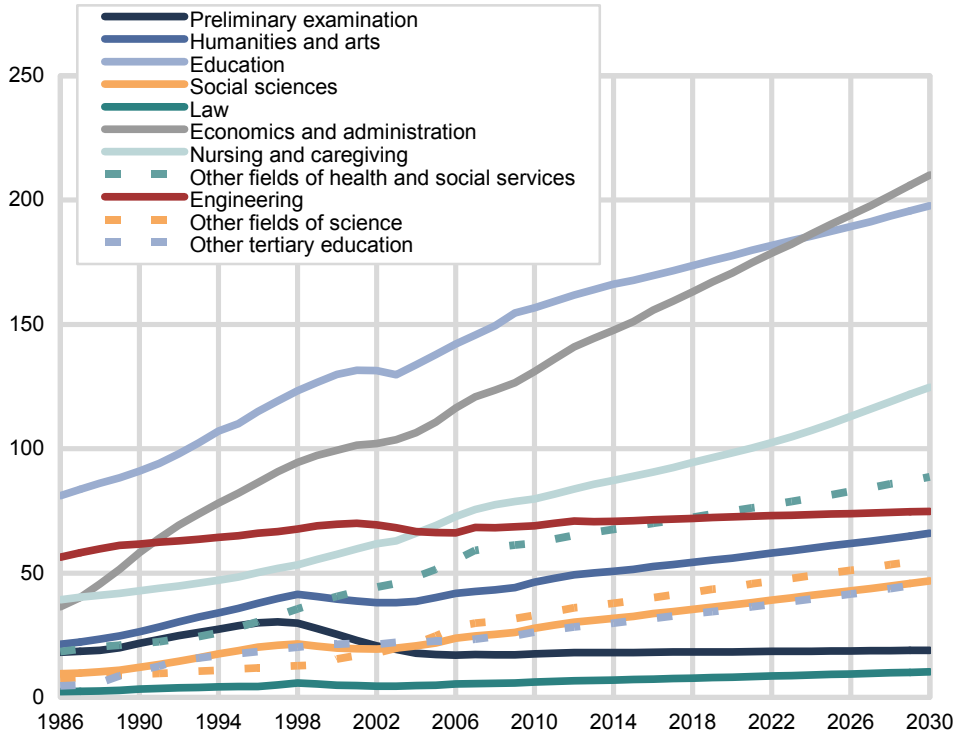


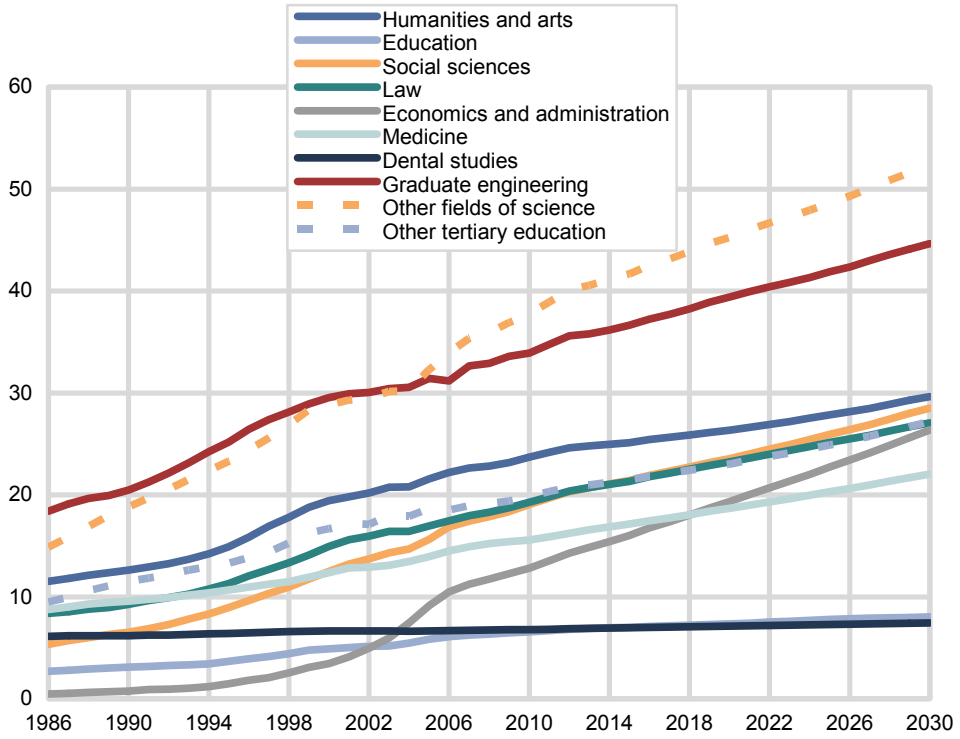
Figure 7.3 shows the development in demand for labor among the fields at a lower tertiary level. The figure indicates employment growth within all fields, particularly for candidates specializing in economics and administration. By 2030, the employment of individuals with this qualification is expected to expand by almost 100,000 persons, making this occupational group the largest at the lower tertiary level. More than one in five individuals holding a lower degree at the tertiary level is specialized in economics and administration in this year. The demand for this type of skilled labor may especially grow in the service industry, but the banking and insurance industry, public sector and the manufacturing industry all demand a large share of the candidates in economics and administration.

There is also a strong increase in demand for teachers and health personnel from the public sector. Moreover, the service sector employs many teachers, and this development is assumed to continue. The employment of persons specializing in education is projected to increase by about 55,000, while the employment of persons specializing in other fields of health and social services and in nursing and caregiving is projected to increase by about 85,000 in total. In addition, the demand for skilled labor specializing in science (excluding engineering) is projected to expand by nearly 30,000 people, increasing its share of total employment of candidates with a lower tertiary education from 5 percent in 2006 to 6 percent in 2030. This demand increase mostly stems from the service industry. Employment of candidates with specialization in humanities and the arts is also predicted to

increase by about 25,000 from 2006 to 2030. The demand increase for this occupational group also primarily stems from the service sector.

Moving on to the employment of persons at the highest educational level, figure 7.4 shows the development in each educational field.

Figure 7.4. Employment by education at a tertiary level with higher degree, 1,000 persons



Demand increases markedly within most fields at this level. The growth is most pronounced among individuals specializing in other fields of science, with an employment increase of nearly 20,000 persons. There is also a strong demand for graduate engineers. Counting these two fields together, it may be necessary that 35 percent of the employees at the tertiary level in 2030 hold a degree in science and engineering; in addition, the service sector clearly has the most demand for these skills. In the oil and gas industry, which employs a considerable share of the graduate engineers, the demand for engineers is assumed to fall. This decrease is connected with the production decrease we anticipate in this industry.

The growth in the employment of candidates with specialization in economics and administration has been pronounced in the observation period 1986-2006. We also expect a marked increase for this type of skilled labor in the projection period, mostly stemming from the service sector. From a share of 6 percent of employees with a higher degree at the tertiary level, employment of persons specializing in economics and administration increases to about 10 percent in 2030. The employment growth of teachers, on the other hand, is predicted to be relatively modest in the following years, while the employment of dentists is expected to stay constant.

In Bjørnstad et al. (2008), we published labor demand projections towards 2025. It is interesting to compare the projections made in this report to those made in 2008. This comparison is performed in table 7-1, where deviations in employment in 2006 and 2025 are shown. As mentioned earlier in this section, the aggregated employment figures are corrected to match the employment base levels in LFS in 2006. In the previous report, the aggregated employment figures where corrected to match the LFS data in 2004, and the 2006 figures were forecasts. Therefore, some of the deviations in the published employment levels for different educational

groups are due to employment changes between 2004 and 2006. There have also been definitional and classification changes between these two reports. Particularly the requirements to be classified as upper secondary education are tightened. In the previous report, completion of the first year in high school was enough to be classified as upper secondary education. In this report, one must complete three years of schooling in high school. This classification change causes a huge decrease in the number of workers with upper secondary education and a similar increase in the numbers with primary and lower secondary education. Therefore, deviations in the employment levels in 2006 between the two reports, will capture both forecasts errors and classification changes. Nevertheless, changes in deviations towards 2025 are mainly due to new assessments in this new projection path, keeping in mind that total employment is projected to increase more in the present report than in Bjørnstad et al. (2008). Consequently, deviations must increase on average.

Tabele 7.1. Employment level and employment deviations between the current analysis and Bjørnstad et al. (2008). 1,000 persons

	Level			Deviation from Bjørnstad et.al (2008)	
	2006	2025	2030	2006	2025
Primary and lower secondary education	**499**	**408**	**381**	**261**	**313**
Unknown	**23**	**23**	**23**	**8**	**21**
Upper secondary education	**1,070**	**1,213**	**1,252**	**-264**	**-191**
General programs	226	201	192	-3	-5
General programs, folk high school	58	49	47	-28	-24
Economics and administration	179	155	149	-45	2
Electronics, mechanics work and machinery	188	240	253	-33	29
Building and construction	84	123	133	-20	-44
Other fields of science, technique and crafts	96	117	121	-58	-97
Nursing and caregiving	88	125	141	-26	-7
Other fields	152	204	215	-50	-44
Tertiary education, lower degree	**592**	**865**	**940**	**-15**	**-15**
Other tertiary education	23	41	46	1	-5
Preliminary examination	17	19	19	-7	-7
Humanities and arts	42	61	66	-2	-13
Education	142	187	198	-3	16
Social sciences	24	42	47	-9	-24
Law	5	9	10	0	-9
Economics and administration	116	190	210	2	-1
Engineering	66	74	75	33	17
Other fields of science	28	50	56	-30	5
Nursing and caregiving	73	110	125	14	29
Other fields of health and social services	55	81	89	-13	-25
Tertiary education, higher degree	**178**	**252**	**273**	**-3**	**-13**
Humanities and arts	22	28	30	2	1
Education	6	8	8	0	0
Social sciences	17	26	29	-2	-9
Law	17	25	27	1	-3
Economics and administration	11	23	26	2	7
Other fields of science	34	49	52	-2	-11
Medicine	15	20	22	0	3
Dental studies	7	7	7	3	3
Other tertiary education	19	25	27	-3	-6
Graduate engineering	31	42	45	-5	1
Total	**2,362**	**2,762**	**2,870**	**-13**	**113**

Despite the fact that the number of workers with primary and lower secondary education is much higher than in Bjørnstad et al. (2008), we see that the deviation increases by more than 50,000 persons from 2006 to 2025. This means that the decline within this group is less severe now than it was in the previous report. The reason for this change is that we have assumed a smaller decline in the number of workers with one year of schooling from high school than others with primary or lower secondary education. We find a similar negative deviation among the group with upper secondary education in 2006, because this group no longer includes those with one year of schooling from high school. However, the deviation is less

negative in 2025. This suggests that the increased total employment compared to Bjørnstad et al. (2008) comes from increased numbers with either primary or secondary education, reflecting the increased number of immigrants in our current projections.

Compared to Bjørnstad et al. (2008), and adjusted for the deviations in 2006, we have increased the projected numbers of workers with education at an upper secondary level in economics and administration, electronics and nursing and caregiving. We believe that the number of individuals with economics and administration education had a relatively unrealistic fall in Bjørnstad et al. (2008). The increase in the number of individuals with nursing and caregiving education is due to an increase in total employment in this sector. Furthermore, we have decreased the projected number of workers with education in building and construction and in other fields of science, technique and crafts, and we have increased the number with mechanics and machinery education.

The total number of workers with tertiary education is slightly reduced compared to Bjørnstad et al. (2008), and the deviations in 2025 are almost the same as in 2006. When it comes to those with a lower tertiary education, we have increased the number within education and nursing and caregiving. This is due to a generally higher growth within all public services because of less constraint on fiscal balances. In Bjørnstad et al. (2008) many workers with an education within engineering at a lower tertiary level were erroneously categorized as other fields of science in the data period, and hence, also in the projection period. This error is corrected now, and we see that the number of engineers is increased with 33,000 persons in 2006. The number of workers with other fields of science education is decreased correspondingly. Furthermore, Bjørnstad et al. (2008) showed an unrealistic decline in the numbers with education in other fields of science at this level. We have now kept the numbers at more or less the 2006 level. At the same time, we have reduced the growth in workers with an engineering degree.

At a higher tertiary level, and compared to the deviations in 2006, we have increased the number of graduate engineers, with 6,000 in 2025. However, because there were 5,000 fewer graduate engineers in 2006 than projected in Bjørnstad et al. (2008), the level in 2025 is about the same as in the previous report. Furthermore, the negative deviation among social scientists and other scientists in 2006 increases towards 2025. Hence, the relatively high growth among such scientists in the previous projections is somewhat reduced.

To summarize, the development in employment by educational field is reflected by a further continuation of the educational upgrade. While the employment of persons with primary and secondary general education is projected to decrease, the employment of persons with upper secondary vocational education is projected to increase as well as the employment of persons with tertiary education. The employment increase is particularly strong for the group holding 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 almost 100,000 persons, while candidates holding a higher degree within the same field are anticipated to increase by about 16,000 people during the 2006-2030 period.

8. Population and labor supply by education towards 2030 using MOSART

MOSART is a dynamic microsimulation model used for projections of demographic development, supply of labor and pension expenditures in Norway, and it is described by Fredriksen (1998). In the past decade, the model has been extensively used in the analyses of effects of the reform of the Norwegian pension system.

From a representative sample of the population in a base year, the model simulates the further life course for each person in this initial population. The life course 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 (sensitivity analyses) and/or consequences of alternative policies.

Events included in the simulation are migration, deaths, births, marriages, divorces, educational activities, labor force participation and retirement. Public pension benefits are calculated from labor market earnings and other characteristics included in the simulation. Education is included in the model for two reasons. First, at Statistics Norway, there is a long tradition of projecting the number of persons and supply of labor by education, and MOSART has been used for these projections since the beginning of the 1990s. Second, education serves as an important explanatory factor for different kinds of behavior 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 different level of education among the younger and older workers is one of the main driving forces in the model. With a dynamic microsimulation model, it is also possible to take into consideration that the age for entering the labor market may range between the age of 18 and 30, and some educational activities may take place between the age of 30 and 40. Education seems to be very important for labor market participation and the age of retirement.

In addition to the general outline by Fredriksen (1998), a more detailed description of the education module of MOSART (in Norwegian only) is given by Andreassen et al. (1993). Each person makes the following education-related decisions:

- To enter education
- To enter a specific field
- To remain in education
- To complete education

The decisions to enter, remain and complete are binary. Explanatory factors include gender, age, highest completed education and ongoing education. Choice of field may be made each time an individual chooses a new type of education and may include all the forms of education listed in table 1. The choice set depends on earlier completed courses of study. Gender and age are also important in making this choice.

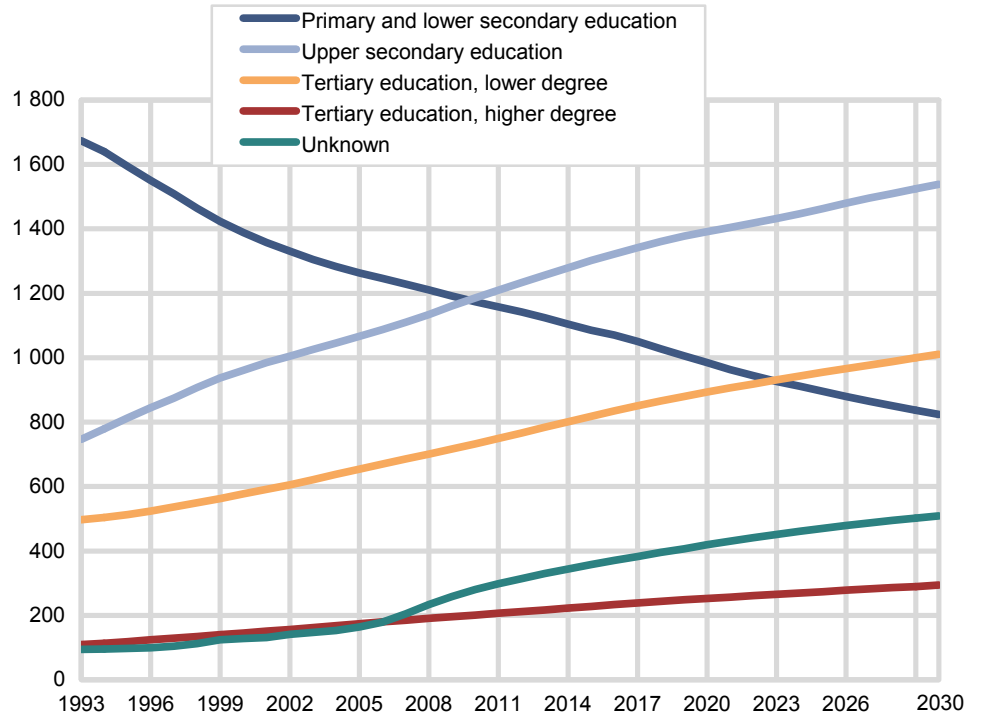
As mentioned above, in the reference scenario for MOSART we have assumed constant transition probabilities for the entire period. This may not be realistic because transition probabilities represent a mix between behavior and capacity in the system. Economic factors, such as prospects for future wages, the actual rate of

unemployment and expectations about the development in the labor market, may all influence the decisions. 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.

Projections of the population by education as a basis for corresponding projections of labor supply in this report are based on a representative sample for the Norwegian population that is mainly calibrated to the situation in 2008. Because of the fluctuating propensities to enter education over the business cycle, an average for the years 2004-2008 is used. The labor 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 2009. A total fertility rate of 1.9 and net immigration decreasing from about 40,000 persons per year at present to about 20,000 persons per year after 2040 suggest that the size of the younger and middle-aged cohorts stabilizes towards 2050.

The results of the projections for the number of persons aged 16 to 74 by level of education are presented in figure 8-1. In order to bring the Norwegian definition of completed educations into accordance with international standards, the definition was tightened in 2006. Specifically, the requirements to be classified as having upper secondary education were sharpened, causing a significant decrease in the number of persons with this level of education and a corresponding increase in the number of persons classified with primary and lower secondary education. A declining trend in the share of persons with primary and lower secondary education from the past decades continues, but to a weaker degree. While 54 percent of the population in the age range 16 to 74 had this level of education in 1993, the share had fallen to 35 percent in 2008 and is projected to decrease further to 20 percent in 2030.

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



On the other hand, the share of persons with upper secondary education increased from 24 percent in 1993 to 33 percent in 2008. Due to a rising share of persons completing tertiary education, further growth slows, and the share is projected to reach 37 percent 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 increased by more than 40 percent from 1993 to 2008 and is expected to further increase by 44 percent towards 2030. In this year, the share of individuals with a lower degree tertiary education aged 16-74 may reach 24 percent. The relative increase in the number of persons with a higher degree tertiary education is even larger, with 54 percent from 2008 to 2030. The share of persons with this level of education aged 16-74 may then reach 7 percent.

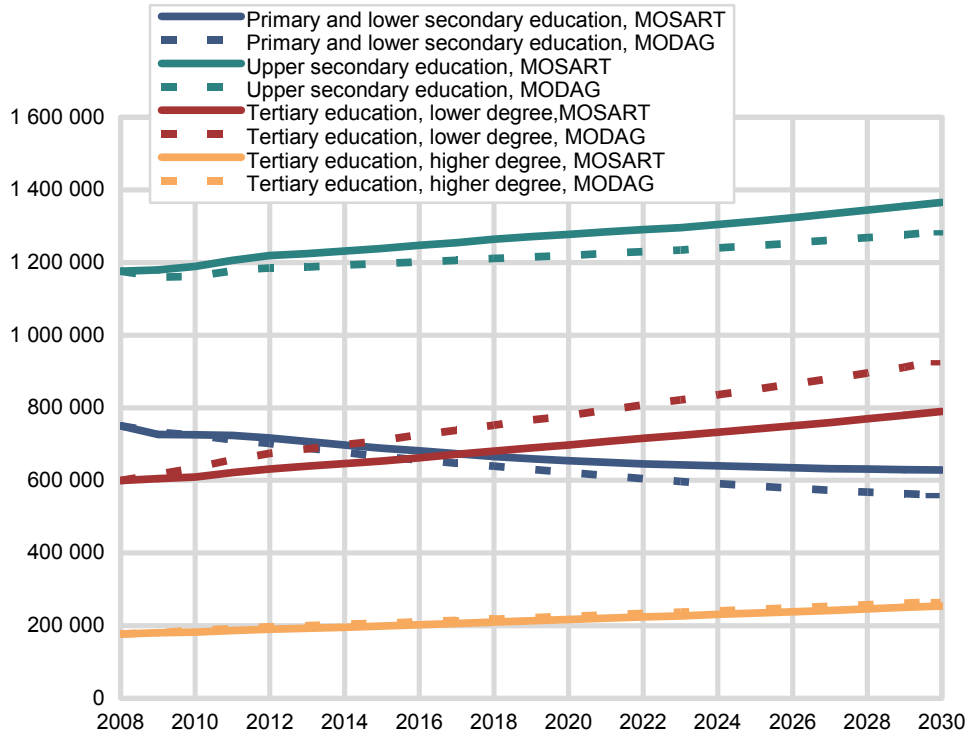
The level of education for immigrants to Norway is only weakly recorded in Norwegian administrative registers. In a situation where immigration has increased significantly in the past years and is expected to stay at a higher level in the years to come relative to the situation before 2005, the projections with MOSART show a significant increase in the number of individuals with unknown education levels.

8.1. Comparing labor supply with labor demand

Because the labor supply projections from MODAG in section 6 is determined from the demand side (with stable unemployment), a comparison with the corresponding labor supply projections from MOSART is an implicit analysis of potential mismatches in the future labor market. In order to make this comparison we must aggregate the groups identically. There are two aggregation differences. First, while the large and growing group of mainly immigrants is classified with unknown education according to MOSART, those with an unknown education are included among those with primary and lower secondary education in MODAG. Second, there are two groups with upper secondary education in MODAG and only one in MOSART. In figure 8-2 we make the comparison by adding those with an unknown education from MOSART to those with primary and lower secondary education, and by aggregating across the two groups with upper secondary education from MODAG. In addition we adjust the level of the labor supply by education in MOSART to the observed level in the base year of MODAG (2008) to ensure an identical starting point. Deviations between the two labor supply projections indicate that educational propensities (and capacity if necessary) and/or participation rates need to change to secure a balanced labor market in the future.

The results show a more rapid increase in demand for labor with a lower degree in tertiary education than the corresponding increase in supply. This means that it could be beneficial to increase capacity in higher education somewhat to meet the excess demand. For higher degree in tertiary education, supply and demand seem to stay more balanced. Furthermore, the projections show a smaller growth in the demand for workers with upper secondary education compared to supply, and the decrease in demand for primary educated workers are more pronounced compared to supply. Hence, in order to avoid future mismatches in the Norwegian labor market, the projections show a need for a more rapid educational upgrade compared to what follows from constant education propensities and participation rates.

Figure 8.2. Labor supply by education from MODAG compared with adjusted labor supply from MOSART



9. Concluding remarks

Even though results like the ones in this report are published from time to time, the model based projection on future demand and supply of labor by education made by Statistics Norway is an ongoing project. The models are continuously modified and developed further, and new data are taken into account. The projections are extremely uncertain, both because the projection period is very long and because they are based on highly discussable assumptions. Therefore, the results must be used with precaution.

Nevertheless, judged by the response, there seems to be important that such quantitative projections are made. Compared to similar projections in other countries, the models used in the projections in this report are more developed for the purpose. To our knowledge, no other projections are made using a macroeconomic model with heterogeneous labor for example, where relative labor demand depends on relative wages and where relative wages depends on mismatches in the labor market. Indeed, the labor supply module in the model is shut off, and labor supply is projected to follow labor demand. However, we plan to turn the labor supply module back on and use the complete model for sensitivity analysis and to study changes in mismatch in alternative scenario analysis.

In this present report mismatch is studied by comparing implied labor supply projections at steady unemployment, with labor supply projections according to a dynamic microsimulation model assuming constant education propensities and participation rates. The results show that the past trends with increasing demand for highly educated labor on behalf of labor with less education will continue. This mismatch seems to be attached to an access demand for labor with a lower degree in tertiary education. Furthermore, when studying the labor 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 caregiving*.

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