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Past and Future Changes in the Structure of Wages and Skills

Abstract:
The Norwegian labour market is characterized by a compressed wage structure and low unemployment. We show that these features have been the case in spite of significant technological changes that favours demand for skilled labour. Using a large scale macroeconometric model we analyse to what extent this favourable development will continue and how the composition of the labour force by skills will influence wage dispersion and unemployment for various groups in the present decade.

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1. Introduction

During the last two decades wage inequalities have increased in many OECD countries, cf. Davis (1992), Katz et al. (1995) and Gottschalk and Smeeding (1997). At the same time these countries have experienced a trend of increasing demand for skilled labour, cf. Freeman and Katz (1995). The increased skill premium combined with a relative increase in the use of skilled labour is usually explained by reference to skill biased technological change. See e.g. Berman et al. (1988) for international evidence. See also Autor et al. (1998) for the US and Salanes and Førre (1999) for Norway. However, as has been noted in a number of studies, there are exceptions to these general trends. In contrast to the US and UK, for example, there are no clear signs of increased wage inequality in many continental European countries while trends in the skill structure of labour demand are more in line with common international trends. Hence, skill biased technological changes seem to have increased wage inequalities in countries like the US and UK, and unemployment differences, or *skill mismatch*, in continental European countries like France and Germany. The usual argument, put forward by Krugman (1994) among others, is that there are institutional differences between the US and UK labour markets on one side and many continental European labour markets on the other. In the former real wages are flexible so that skill biased demand shifts increase skill premium, in the latter skill mismatch prevails because wages are more rigid.

Among others, Kahn (1998) and Salvanes and Førre (1999) document that Norway's labour market experienced similar supply and demand shifts for skills to those that occurred in other countries. However, as discussed in Kahn (1998) the Norwegian experience is of particular interest because both low unemployment and low inequality in the wage structure have been maintained during the previous two decades. This has been achieved despite that wage bargaining institutions has not been decentralized over this period. On the contrary, Kahn for example refers to this period as a period of recentralization of collective bargaining. Thus, the Norwegian experience warrants a closer study.

There are potentially a number of various factors that may have produced changes in the skill composition of the labour force. We review some of these in the next section. We then, in section 3, present some empirical features of the Norwegian economy - skill premiums[1], unemployment and skill composition of the labour force - that we use for estimating labour demand equations and wage equations for various skill groups. These equations are presented in sections 4.2 and 4.3 respectively, and are parts of a large multisectoral model of Norwegian economy that we use in order to assess the role of skill biased changes in demand when shaping future wage dispersion between skill groups as well as relative unemployment prospects. The labour market module of the multisectoral model is presented in section 4. The simulations are based on forecasted changes in the skill composition of the labour force. These forecasts take into account the high rate of entry into higher education by young cohorts that have been going on for more than a decade.

[1] In the following we use the concepts skill premium and educational premium as synonymous concepts. Skill is unobservable and we view educational attainment as an indicator of skill.

We have also conducted alternative simulations. We first increase the skill attainment somewhat, so that the share of skilled persons in the labour force increases. In the second alternative simulation we increase public consumption, and in the third we reduce the level of VAT. The background for these two shifts describes a peculiar challenge for the Norwegian economy since expected future cash flows from the Norwegian petroleum sector will bring public surpluses to unprecedented heights in the near future. At the same time Norway has close to full employment, so there is little room for increased public demand. Therefore, the surpluses have been placed in the so-called *Norwegian Petroleum Fund*, which invests in various capital instruments abroad. However, the surpluses will be incorporated into the Norwegian economy according to a specific rule. In short, the rule states that the government is to spend the real profits from the fund. Our shifts do not correspond to the rule, but are merely conducted in order to shed some light on potential implications for wages and mismatch of two alternative ways to decrease public surpluses. The baseline simulation is presented in section 5.1, and the results from the three alternative simulations are shown in sections 5.2, 5.3.1 and 5.3.2 respectively. In section 6 we give some concluding comments.

2. Wage inequality, skill composition and skill mismatch

A widespread conclusion from recent research is that skill biased technological change (SBTC) is a major factor behind the increase in wage inequality in many OECD economies. It is well documented that there has been a relative increase in employment of skilled workers despite a stable or rising skill premium. Many studies have shown that there is a correlation between skill upgrading and more use of computers and R&D expenditures, cf. Berman et al. (1994) and Autor et al. (1998). International evidence is presented in Berman et al. (1998). Thus, it is quite common to conclude that SBTC is the main cause behind changes in relative wages.

However, alternative but not necessarily contradicting explanations to this phenomenon have been suggested. We shall briefly review some of these. It may be useful to distinguish between three types of explanations

- Changes in factor demand
- Changes in factor supply
- Institutional changes in wage formation

Changes in factor demand. The SBTC-hypothesis is based on the argument that technological change is factor biased so that it increases demand for skilled labour at the expense of unskilled labour at a given relative wage between the two groups. With more or less fixed labour supply and assuming a competitive labour market, this will increase the relative wage for skilled labour. In order to explain the increase in relative wages for skilled labour from the 1970s, SBTC must have been increasing faster in recent decades compared to the 1960s unless relative changes in labour supply have also been different. We shall return to relative factor supply below. Another argument against this hypothesis is that the literature disagrees about whether technological change favours certain factors of production or certain sectors of the economy. Haskel and Slaughter (1998) strongly argues that in a multisectoral context it is the sector bias and not the factor bias of technological change that matters. Even pervasive technological change has an unclear effect on relative wages according to these authors.

Another hypothesis based on changes in factor demand, relies on a different line of reasoning. If the economy is open to trade, and relative product prices change due to changes in international competitiveness, profitability between sectors will change. If there is a reduction in the relative price on goods that are intensive in use of unskilled labour, sectors producing these goods will lower their employment. This will bring about a change in relative factor prices so that the relative wage of unskilled labour is reduced. This line of argument has most forcefully been forwarded by Wood (1994).

Both these arguments indicate that a multisectoral approach is needed when studying the effects of changes in factor demand by skill categories. This partly motivates the approach taken in this paper.

Changes in factor supply. One hypothesis is that the supply of skilled labour was increasing very fast during the 1970s due to the entrance of the "baby-boom" generation into the labour force whose educational attainment was much higher than for older cohorts. Thus, any trend in technological change that might have resulted in higher skill premiums were counteracted by changes in factor supply. During the 1980s there was no similar change in the relative supply of labour by skills. For some countries immigration may also have increased the relative supply of unskilled labour that has lead to an increase in the skill premium.

Another hypothesis put forward recently by Acemoglu (1998) is that the increase in supply of skilled labour in the 1970s increased SBTC which again lead to higher demand for skilled labour and skill premium. In this way "supply creates its own demand". The argument is that technologies are not skill biased by nature but by design. Given the large influx of skilled labour into the labour force in the 1970s, it would be profitable to design technology that used this factor more intensively than before. This line of argument can explain both the changes in relative factor demand and skill premium from 1970s to the present. The initial supply increase muted the skill premium in the 1970s, induced SBTC that later increased the skill premium because relative factor supply did not increase further in line with what happened in the 1970s.

Changes in labour markets institutions. The discussion above has been based on a competitive labour market. It is well recognised that the role of labour market institutions has changed in many OECD-countries during the two previous decades. The role of collective bargaining has been reduced and there is now more scope for wage differences between firms and individuals within firms. In some countries such as the UK, government regulation of the labour market has been a major reason for the change while in Sweden this change is more due to a unilateral initiative from the employer's side away from "corporatism". In both cases the changes occurred in the early 1980s. The levels of earning inequality were very different in these two countries but both have experienced a significant increase in inequality since 1980. As argued by Edin and Holmlund (1995) it may be difficult to conclude which factor is mainly responsible for the changes in distribution when relative demand for skilled labour is increasing at the same time as there is more decentralisation in wage bargaining.

Our study is not able to provide a clear conclusion as to which of these partly alternative and partly complementary hypotheses that are most relevant in a Norwegian context. We will however generally rule out changing labour market institutions as a major factor as the main bargaining institutions have remained roughly in place for decades. Although a recentralisation of bargaining took place in Norway during 1987-91 as claimed by Kahn (1998), Iversen (1999, Chapters 1 and 3) and Barkbu et al. (2001), the lifting of wage controls and the return to normal cycles between centralized versus decentralized bargaining may easily be interpreted as a return to status quo compared to earlier years. It is therefore of interest to note that there has not been any significant change in relative wages in Norway since 1980, cf. also OECD (1996, Table 3.1) and Bowitz and Cappelen (2001).

3. Some empirical background - the Norwegian case since 1972

Our data on employment and wages by educational status are closely integrated into the Norwegian national accounts system and cover the period 1972 to 1997.[2] To simplify one can think of our data simply as a disaggregation of the traditional labour market module of the national accounts. This secures consistency with other information about the input structure of each production sector of the economy. The employment data is to a large extent based on the Labour Force Survey. Employment (both hours worked and persons) and hourly wages by sector are disaggregated into five educational groups with the number of years of education in parentheses

- Primary education (less than 11 year)
- Secondary education (11-12 years)
- Vocational education (11-12 years)
- Lower university education (13-16 years)
- Higher university education (17 years or more)

Workers with secondary and vocational education are separated roughly according to whether they would be regarded as white collar versus blue-collar workers although this distinction is no longer used in official Norwegian statistics. Many studies cf. Berman et al. (1994) base their skill classification on production versus non-production employees or blue versus white-collar workers. As a skill classification based on educational status this is not very fruitful. In particular the increased use of computers and PCs has meant a significant change in administrative work affecting strongly non-production workers.

3.1. Trends in educational composition

There are systematic trends in the educational composition of employment across all sectors of the Norwegian economy irrespective of their initial educational structure. Detailed data on this is available in Table B6 - Table B10 in Appendix B. This is most apparent in Table B6 showing the share of hours worked by persons with only primary education. For most sectors there has been a reduction by 30-40 percentage points over the sample period (1972-97). The drop in employment of low educated workers has been compensated by a nearly similar increase in the employment share for people with vocational school education. The shares of employment for persons with lower and higher university education have been increasing for all sectors and roughly in parallel. In the top diagram in Figure 1, we show the number of

[2] Our data consist of both provisional figures provided by the Unit for National Accounts at Statistics Norway as well as own imputations in the cases where data are not available yet.

employed persons belonging to each educational category since the early 1970s. The change in educational composition in employment is quite marked.

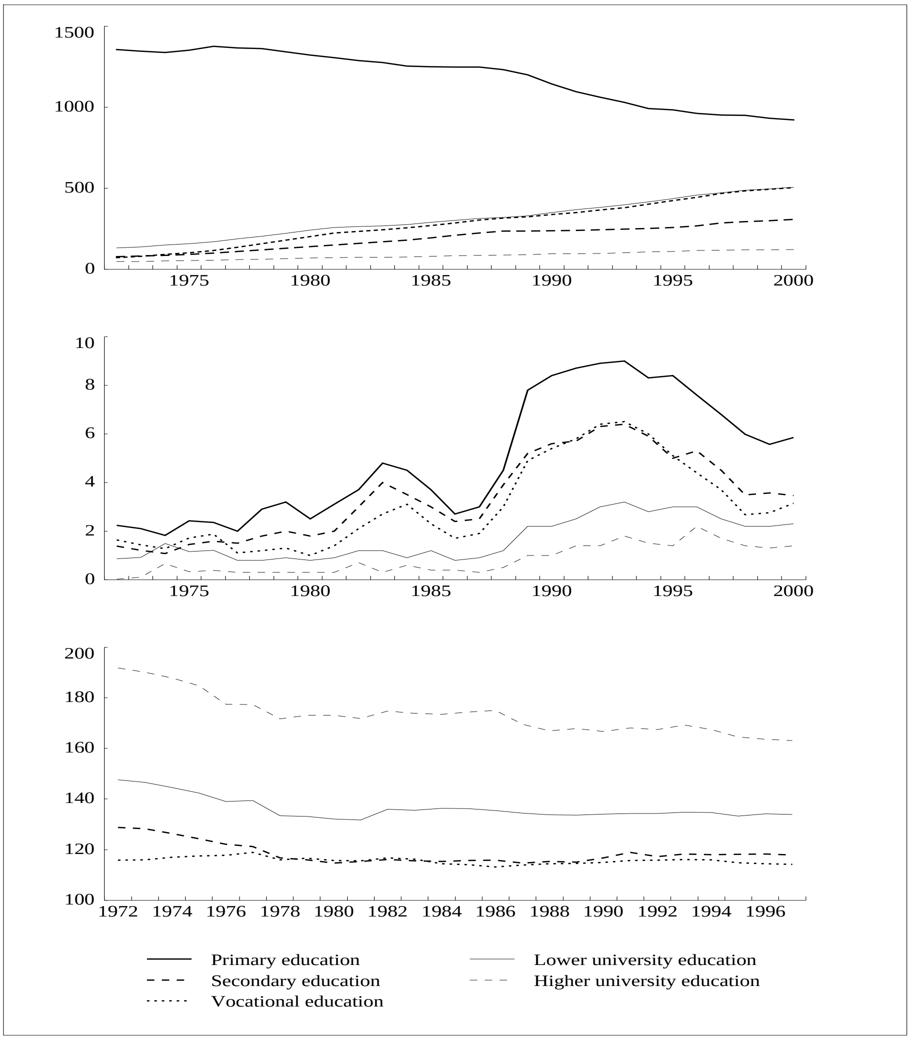

Figure 1: Historical figures. Top: Labour supply in 1000 persons. Middle: Unemployment rates in per cent. Bottom: Educational premiums per hour (primary education = 100)

The educational composition of the labour force has changed roughly in line with the structure of employment. Unemployment rates for the five educational groups have developed in quite a parallel way, cf. middle diagram in Figure 1. Persons with little education are systematically facing more serious unemployment problems compared to those with higher education. However, while there were hardly any unemployed persons with higher education before the mid 1980s, this has been the case in more recent years. When the rate of unemployment came down after the substantial increase from 1987 to 1993, it did so more for people with low education than for the highly educated employees. Thus relative unemployment has increased for employees with higher education. There is a slight trend upwards in unemployment among all educational categories, but this trend is much less pronounced than in many European countries where the increase in unemployment during the 1970s has proved very persistent. The total unemployment rate in Norway has recently varied between 3-3.5 per cent which is roughly one percentage point higher than 25 years ago when it was at its lowest in the post-war era.

3.2. *Wage inequality*

As referred to above, it is well documented that the wage distribution in Norway has not changed very much during the last two decades and is among the most equal in OECD, cf. OECD (1996, Table 3.1). An econometric study based on micro data for full time employed persons for 1980 and 1990 concludes "..that the earnings profiles almost overlap and thus that the increase in returns to education observed in many countries in the 1980s has not taken place in Norway.", cf. Hægeland et al. (1999). Bottom diagram in Figure 1 shows a similar picture using our aggregate data on hourly wage rates for the five educational groups. Although we are not able to control for seniority and cohort effects in our data, the picture is roughly in accordance with microeconometric evidence. The differences in skill premiums and wage levels between industries referred to by Hægeland et al. are also clearly visible in our data.

Looking at the bottom diagram in Figure 1 there was a significant reduction in the skill premium for persons with university education during the 1970s. This was a period with very centralized bargaining in addition to being the hey-days of government incomes policies, cf. Bowitz and Cappelen (2001). During the 1980s relative wages are roughly constant except that the recentralisation of wage bargaining during the end of the decade seems to have lead to somewhat less dispersion of wages. This change took place both within the manufacturing sector and most private service sectors but not in the public sector where educational premiums are the lowest.

4. Some main features of the labour market module in the model

MODAG, the macroeconometric model used in this analysis, is constructed in order to mimic the Norwegian economy. The model is based on a fairly detailed input-output core and specifies 21 private industries and 7 public sectors, cf. Table A8 in Appendix A and Cappelen (1992) for a general presentation of the model. The government sectors are quite important for the present study as roughly half of all employees with university education work in these sectors. However, employment in the government sectors are exogenous in the model, thus our results will to a large extent depend on assumptions with respect to changes in government budgets.

We now present a very simplified and condensed version of the macroeconometric model used in our simulations in order to explain some of the main channels through which skill-biased imbalances work. Assume that demand for skilled labour (N_s) relative to unskilled labour (N_{us}) depends negatively on relative wages for these two groups (W_s/W_{us}) and positively on technical change represented by a trend t that we may interpret as SBTC. We can write this relationship as:

$$(1)\quad \frac{N_s}{N_{us}} = f\left(\frac{W_s}{W_{us}}, t\right).$$

By definition employment equals labour supply (*S*) minus unemployment (*U*), hence relative employment may be written as:

$$(2)\quad \frac{N_s}{N_{us}} = \frac{1-u_s}{1-u_{us}} \frac{S_s}{S_{us}},$$

where the *u*'s are unemployment rates. Combining equations (1) and (2) and defining *s* as the share of skilled labour in the total labour force, we have:

$$(3)\quad \frac{1-u_s}{1-u_{us}} = \left(s^{-1}-1\right) f\left(\frac{W_s}{W_{us}}, t\right).$$

Equation (3) simply tells us that if there is SBTC (a positive effect of higher *t*), the skill premium will have to increase if relative unemployment is to be constant unless there is an increase in the share of skilled persons in the labour force denoted by *s* in (3). Note that it is relative unemployment rates and not their difference that is important for this result.

Although we estimate wage curves[3] for each of the five educational categories, we simplify using only the skilled-unskilled distinction:

$$(4)\quad W_s = P\,Q\,g_s(u_s, u), \quad g'_{s1}, g'_{s2} < 0,$$

and

$$(5)\quad W_{us} = P\,Q\,g_{us}(u_{us}, u), \quad g'_{us1}, g'_{us2} < 0,$$

where u_s and u_{us} are the skill-specific unemployment rates and where *u* is the average unemployment rate, *P* is producer price and *Q* is average labour productivity by sector. Thus the wage equations states that in the long run the labour share of value added depends negatively on both skill-specific and average unemployment. While the wage curve representation encompasses several theories on wage setting[4], we assume that wages in this particular specification are set in negotiations between labour unions and employers' representatives at a national level as well as at a decentralized level.

Solving for relative wage rates per hour, and assuming that the effects of the average unemployment rate are the same for both skill-groups, yields

$$(6)\quad \frac{W_s}{W_{us}} = g\left(\frac{u_s}{u_{us}}\right), \quad g' < 0\,.$$

According to (6) there is a negative relationship between relative wages and relative unemployment rates for the two skill-groups. If wages are affected by education-specific unemployment rates, skill premium adjusts to skill mismatch. However, if there is no such

[3] See e.g. Layard et al. (1991, chapter 6).

[4] Competitive labour market, bargaining between labour unions and firms, and efficiency wages, see Blanchflower and Oswald (1994).

effect skill mismatch is likely to prevail, at least until supply adjusts accordingly. The exact degree of labour market flexibility depends on the parameters, the substitution possibilities and the price elasticities. Notice also that demand shifts, such as skill-biased technological changes, affect wage inequality only through skill mismatch in the long run in this model. This assumption is plausible when the labour force is endogenous. Layard et al. (1991, chapter 6) show that only supply-side factors, such as costs of attaining education, affect relative wages and unemployment, while demand conditions do not. In steady state, the skill premium is equal to the cost of attaining that skill.

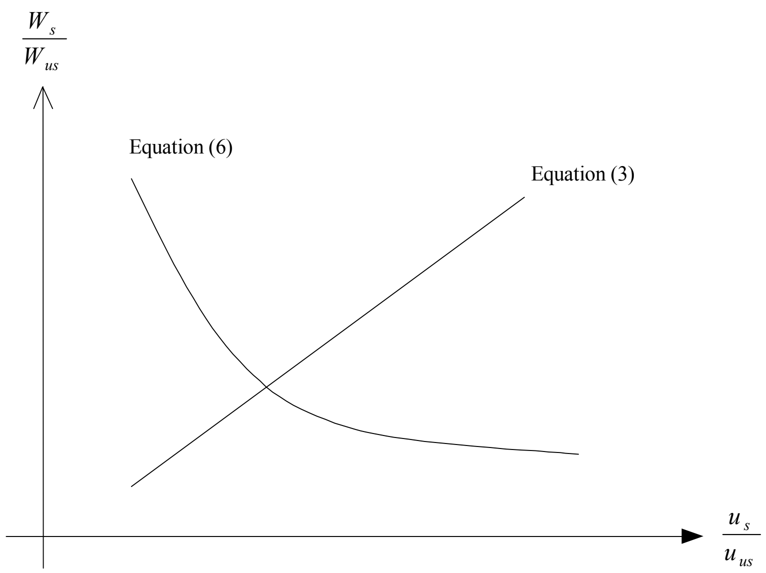

Figure 2: Determination of relative wages and unemployment

Figure 2 illustrates the determination of relative wages and relative unemployment according to equation (3) in section 2 and equation (6). Skill biased technical change (SBTC) will shift the demand curve for labour implying an upward shift in the curve marked Equation (3) in Figure 2 leading *ceteris paribus* to a higher skill premium and lower unemployment for skilled persons. A relative increase in the share of skilled persons in the labour force (increase in s in equation (3)) will act like a downward shift in (3) and lead to a lower skill premium and higher relative unemployment for skilled persons. This is somewhat in line with the Norwegian experience since the early 1970's. As mentioned earlier, both total labour demand and the skill composition in the government sector are exogenous in the model. An increase in government employment can be analyzed as a reduction in s because of the skill intensity of labour demand in the government that leads to a reduction in the available skilled personnel for the private sector.

The slope of curve (6) depends on the wage responsiveness to skill-specific imbalances in wage settlements. If relative wages are sensitive to skill mismatch the curve is steep, i.e. a small change in relative unemployment rates will increase skill premiums much. On the other hand, if the curve is flat, skill-specific imbalances are nearly ignored in wage bargaining and skill mismatch is likely to prevail longer than otherwise. We have depicted a convex curve indicating that skill-specific imbalances receive relatively more attention in wage settlements when the unemployed to a considerable extent are unskilled workers as compared to when both skilled and unskilled experience high unemployment rates.

4.1. Labour supply

Supply of labour is mainly demographically determined in the model, but it also depends on the relative attractiveness of being employed versus being out of the labour market. Furthermore, participation depends on labour market tightness[5] and on welfare schemes like possibilities for retirement and public assistance. However, in the current version of the model there are no effects of labour market imbalances such as mismatch (unemployment differences between educational groups) and premiums on education-specific labour supply. This implies that the educational composition of the labour force is exogenous in the model and the variable s in equation (3) above is a parameter independent of relative wages and unemployment.

4.2. Labour demand

Heterogeneous labour demand is modelled within a dynamic system framework. Each industry is modelled separately, contrary to Lindquist and Skjerpen (2000) where parameter restrictions between industries are utilized when estimating a dynamic system of cost shares based on a translog cost function. The long-run solution is based on cost-minimisation assuming a Cobb-Douglas production function where the variable inputs are (i) materials (ii) a CES-aggregate of labour, (iii) a CES-aggregate of energy which depends on the use of electricity and fuel. The real capital stock is treated as a quasi-fixed input. The CES-aggregate of labour is a function of man-hours worked by skilled and unskilled. Hence, the five educational categories are aggregated into two skill-groups. The precise definition of skilled and unskilled varies somewhat between industries. Primary and secondary educated workers are always treated as unskilled and those with university education are skilled. However, whether vocational educated workers are skilled or unskilled is mainly based on empirical results. The skill composition is modelled econometrically in the manufacturing sectors and in some of the private service sectors, while for some private sectors and the government sectors the skill composition is exogenous. For an overview of all sectors in MODAG and the modelled sectors confer Table A8 in Appendix A. Detailed results from the estimation are given in Appendix A.

The CES-aggregates of labour and their dual price indices contain unknown parameters that must be estimated. This is done at an initial stage based on static models. The econometric equations are based on cost-minimisation given fixed levels of the CES-aggregates. In the CES-aggregate of energy the distribution parameters are from the outset allowed to depend on the stock of machine capital (at the beginning of the period) and a deterministic trend. The estimation results are given in Table A6 in Appendix A. The distribution parameters in the CES-aggregates of labour depend on machine capital and trend as well as the production level, i.e. we do not impose homotheticity. The estimation results are given in Table A7. For

[5] The model states that unemployment has a clear negative effect on labour market participation.This implies that there is a discouraged worker effect in the model.

some of the industries the elasticity of substitution has been assigned an assumed value in order to obtain theory-consistent parameter values. The trend effect comes out as positive in all industries in which skill composition is endogenous. The estimated sign of this parameter is consistent with skill-biased technical change, which *ceteris paribus* implies an increase in the demand for skilled relative to unskilled. With respect to the effects of production and capital, there is heterogeneity between the industries. In some industries these changes favour skilled labour, whereas they in others favour unskilled labour.

Using the parameters from Table A4 and Table A5 we can construct time series of the CES-aggregates and their prices and accordingly treat them as observed variables. The dynamic factor demand system at the upper level is formulated in equations (A1)-(A3) in Appendix A. To estimate the long-run price effects we do not utilise equations (A1)-(A3) but a simpler procedure based on the so-called factor-share method. An advantage of this simpler procedure is that right signs and reasonable magnitudes are automatically imposed. The rest of the long-run parameters and the short-run parameters (including the adjustment coefficients) are then estimated conditionally on these calibrated values. The estimation results of the long-run parameters are reported in Table A2. These parameters are functions of the parameters of the Cobb-Douglas production functions. In Table A3 we therefore also report the deduced result for the latter set of parameters. For most sectors we have increasing returns to scale, the highest scale elasticity is 1.51. The marginal elasticity of output with respect to the CES-aggregate of labour varies between 0.12 and 0.5. In the last column we have included the estimate of the effects of Hicks-neutral technical change. For a substantial part of the industries the estimate of this parameter is zero.

The estimates of the short-run parameters and the adjustment coefficients are reported in Table A4 and Table A5, respectively. Most of the estimated adjustment coefficients are rather small which implies a rather slow dynamic adjustment to changes in the exogenous variables. In some of the industries wrong sign was obtained when estimating the adjustment coefficients unrestricted. Hence some of these parameters have been assigned a fixed value.

The factor demand system has been estimated using data from 1972-1997. To reveal the properties of the model we have carried out the following post-sample simulation experiment over the period 1997-2020. The exogenous variables have been extended by using results from simulations of the reference version of MODAG in which labour is modelled as a homogenous input factor. The wages of the two skill groups are hence forced to grow at a common (year-specific) rate. Thus we carry out a partial reference simulation in the case of heterogeneous labour. Relative to this reference simulation we have made an alternative simulation where production, capital, prices of other inputs than labour and trend are unaltered after 1997, while the wages are as in the reference simulation. The results from this simulation are presented in detail in Table C1 in Appendix C. With one exception (sector 50) the effects on unskilled and skilled labour are positive and negative in every year, respectively. Thus the expected development in production, capital, technology and non-labour input prices favour skilled labour. However, the magnitude of the deviations varies substantially between the different sectors. The largest effects are found for sector 43. As can be seen from Table A7 an increase in production or capital will in sector 50 both *ceteris paribus* favour unskilled labour, but the trend effect goes in the opposite direction and is in addition very strong.

The simulation implies that by year 2010 the effect of the factor bias elements contributes to an increase in the aggregate share for skilled labour of 11 per cent increasing to 17 per cent by 2020. This may not appear to be very much but one should take into account that this applies to the total economy. The effect on the skill structure of private industries only is nearly the double of figures referred to above. Thus the estimated labour demand equations imply that over time there is a substantial increase in demand for skilled labour at constant relative wages. We now turn to analysing how these changes have influenced on wage setting before we study this effect within the total model (MODAG) taking into account both effects of labour supply by skill-groups, and the adjustment through wage bargaining.

4.3. Wages

Wages in Norway are for a large part set in negotiations between unions and employers' representatives. Occasionally the Government has also participated in the wage setting process, either explicitly or indirectly through the income policies. In order to maintain international competitiveness wage-growth in manufacturing is leading in the negotiations for wages in public and private services. This common understanding of the appropriate way to carry through wage negotiations has existed since the World War II. These institutional conditions are preserved in the model specification. For example, we assume that wages are set in negotiations between unions and employers' representatives and that wages in public and private services follow the wages in manufacturing.

We have estimated the long-run wage curves for each of the five educational categories and for each of the three sectors; manufacturing, public services and private services. However, short-run dynamics may affect the estimates on long-run relationships if not modelled properly. Therefore, our reference point is the stylized aggregated wage-equation in equilibrium correction form, which enables us to determine both long-run and short-run determinants of wages jointly[6]. In addition, because of its special feature to encompass various wage-bargaining models, it has become especially popular as a description of wage setting in small open economies[7]. Its popularity has resulted in numerous modifications, for application to Norwegian manufacturing wages see Nymoen (1989), Johansen (1995), Bjørnstad and Nymoen (1999), and Bowitz and Cappelen (2001). In these studies productivity, producer prices and the average unemployment rate are the explanatory variables in the long run, while the dynamic effects of the long-run variables make up the short-run part of the model.

The aggregated wage equations that are referred to above, assume homogenous labour covered by one single union. Skill heterogeneity opens for a more decentralized wage setting, so we have included education-specific unemployment rates in our model. In other respects the wage-equations in the manufacturing sector are similar to those that are referred to above. Wages in private and public services are, in the long run, homogenous to what we call the alternative wage level, which is a weighted average of the wage level in the other two sectors. This implies that wages in both public and private services follow the wage level in manufacturing. For each sector separately the wage equations were estimated as a panel with the five educational groups as the observational units using a general to specific procedure, i.e. starting out with all variables and with complete heterogeneity and imposing zero and homogeneity restrictions were statistically acceptable.

[6] The error-correction representation of wage level equations stems from the seminal papers by Sargan (1964, 1980).

[7] See Nickell and Andrews (1983), Hoel and Nymoen (1988), and Nymoen (1989).

The estimated long-run wage elasticities with respect to education-specific unemployment rates are given in Table 1, the complete estimation results are reported in Appendix D. The estimated effects are gross effects. In addition, wages in public and private services are affected through the alternative wage. Furthermore, there are short run effects of education-specific unemployment rates as well. Because of the dynamic specification these may have long-lasting effects, at least in the time horizon that we look at in the simulations in the next section. Nevertheless, as we can see from the table, the long-run effects of changes in these variables are small. For primary, secondary and higher university educated workers the estimated elasticities are -0.016, -0.032 and -0.028 respectively[8]. This means that a hypothetical doubling of unemployment would be associated with a fall in their relative remuneration of approximately 2-3%. For workers with lower university education there would be no such effect on wages, according to these estimates.

We have not been able to identify any long-run wage response of education-specific unemployment for the vocational educated workers in manufacturing. Wages to vocational educated workers in public and private services, however, depend moderately on education-specific unemployment. While the estimated effect is positive in public services it is negative in private services. These two estimates must be seen in connection with each other since both wages depend on the other through the alternative wage. Hence, the net effect is lower than indicated by these estimates. Nevertheless, the effects are statistically significant. These results may indicate that the large effect of average unemployment on all wages (see below) is dampened for the vocational educated workers in public services, in private services, however, there is an additional effect. Wages to workers with vocational education is not much affected by education-specific unemployment on average, since the numerical quantities of the two elasticities are similar and since their weight in the alternative wages are about the same.

Table 1: Estimated skill-specific unemployment effects on wages in the long run

Sector	Primary education	Secondary education	Vocational education	Lower university education	Higher university education
Manufacturing	-0.016	-0.032	0	0	-0.028
Public services	0	0	0.142	0	0
Private services	0	0	-0.122	0	0

The estimation results show that the wage elasticity with respect to average unemployment is high for all groups of workers in all sectors. Furthermore, the effect is equal for all groups within each sector. The elasticity of pay in manufacturing with respect to average unemployment is approximately -0.19 for all groups. This estimate is high, but does not contradict other findings. For example, using quarterly data Nymoen (1989) reports a long-run

[8] These estimates show up in the wage-equations in manufacturing only, but note that they also apply to the wage-equations in the other two sectors through the alternative wage.

unemployment elasticity of -0.21, while estimated on annual data, Johansen (1995) finds it to be -0.07. The corresponding estimate in Calmfors and Nymoen (1990), using annual time series, is -0.17, while Blanchflower and Oswald (1994) report an elasticity of -0.10 using microeconomic data. The elasticity estimates in Bean et al. (1986), Alogoskoufis and Manning (1988) and Layard et al. (1991) are -0.14, -0.17 and -0.24, respectively[9].

The high and similar estimates of wage elasticity with respect to average unemployment across educational groups and the corresponding low estimates with respect to education-specific unemployment indicates that there is a high degree of centralization and coordination in collective bargaining in Norway. This implies that because of the high focus on leveling out any potential mismatch between the domestic economy and our trading partners' economy, education specific imbalances are ignored in the Norwegian wage settlements. See Bjørnstad (2000) for a more thorough analysis of these and other issues related to the education specific wage equations.

5. The future structure of relative wages and unemployment in Norway

5.1. Baseline simulation

Our estimated labour demand equations for various skill-groups imply that the demand for unskilled labour will continue to decline in the future. At the same time the high entry rates into higher education will lead to a gradual change in the educational composition of the Norwegian labour force. As explained earlier labour supply by skill category is exogenous in the model and the forecasted composition of the labour force is taken from simulations from a microsimulation model in Statistics Norway[10]. This simulation is based on assumptions with respect to labour force participation that is very similar to the outcome of the macromodel and is shown in the top diagram in Figure 3 and in Table 2.

Table 2: Labour supply by education, 2001-2011, (1000 persons)

	Year		
Education	2001	2005	2011
Primary education	884	789	643
Secondary education	312	330	371
Vocational education	515	567	676
Lower university education	517	569	678
Higher university education	124	136	162
Total supply	2353	2391	2530

The recent historical trend in the composition of labour supply is assumed to continue during the present decade. The share of skilled personnel defined as the sum of the two groups with the longest education is thus assumed to increase from 27 per cent of the labour force in 2001 to 33 per cent in 2011.

[9] In these studies unemployment is not on logarithmic scale. Average unemployment between 1955 and 1990 is used in calculating the elasticities.

[10] See Andreassen and Texmon (2000).

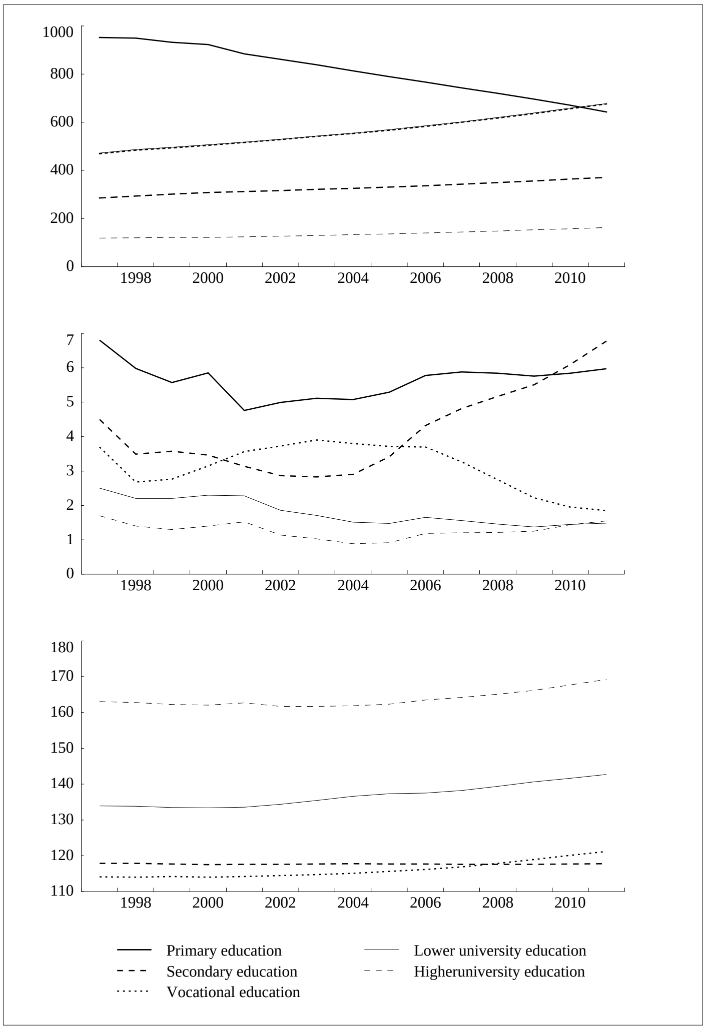

Figure 3: Baseline simulation. Top: Labour supply in 1000 persons. Middle: Unemployment rates in per cent. Bottom: Educational premiums per hour (primary education = 100)

The general macroeconomic development in our baseline simulation is characterised by an annual growth of mainland GDP between 1.5 and 3.0 %, and with a growth rate of consumption that varies around 3 % annually. While growth in average labour productivity is of approximately one and two per cent annually, growth in average real wages is about one per cent higher. This is partly due to a somewhat tighter labour market as measured by the unemployment rate, but it is also an effect of the shift in the structure of the labour force as employees with university education increase their share of the labour force.

The first column of Table 3 and the middle and bottom diagrams in Figure 3 show the education specific unemployment rates and the educational premiums in the baseline simulation. The educational premiums are first of all quite stable. There is a slight tendency for the premiums to increase over time in particular for people with lower university education. The reason for that is partly to find in unemployment for this group which can be expected to decline. The labour markets prospects for people with only secondary education is not that positive, in fact, they will experience similar difficulties as those which have been facing workers with primary education for a long time.

The baseline simulation shows that in spite of the substantial increase in the supply of labour with higher education, there is a similar increase in demand which mainly comes from the change in skill composition of labour within each sector of the economy. If anything, the simulation shows a slight increase in educational premiums from about 2003 due to a small increase in mismatch in that unemployment among unskilled workers rise while the skilled workers experience a somewhat tighter labour market. However, these changes are small. The baseline simulation is designed mainly by extending previous trends in the Norwegian economy. The results therefore tend to show that with the change in supply of labour by educational status, earlier educational premiums and unemployment rates by various groups will persist for another decade.

5.2. Shift in the supply of skilled labour

In this first alternative simulation we have changed the workers' educational attainment. This shift is mainly created in order to show the sensitivity of the baseline educational premiums and unemployment with respect to changes in supply. We have increased entry into lower and higher university education so that by 2011 the supply is 1.1 % higher than in the baseline simulation for both university groups, while the supply of workers with secondary and vocational education is 1.1 and 0.8 % lower, respectively. We have not changed the supply of workers with only primary education because there is almost no entry into this group anyway.

The results show a clear change in unemployment between groups as can be seen from the top diagram in Figure 4 and from the second column in Table 3. By 2011 in this alternative simulation the unemployment rates for workers with both lower and higher university education are one percentage point higher than in the baseline simulation. While the unemployment rate for secondary educated workers decreases with one percentage point, the unemployment rate for persons with vocational education is 0.7 percentage points lower. Looking at the top diagram in Figure 4 and comparing with the middle diagram in Figure 3 in the baseline simulation, we see that this shift dampens the increase in unemployment among workers with secondary education, but at the same time it increase the deficiency of workers with vocational education. On the other hand this shift reduces the shortage of workers with both lower and higher university education. Hence, with the exception of the lower unemployment of workers with vocational education, this shift might be described as a shift that reduces the slight increase in skill mismatch that we observed in the baseline simulation.

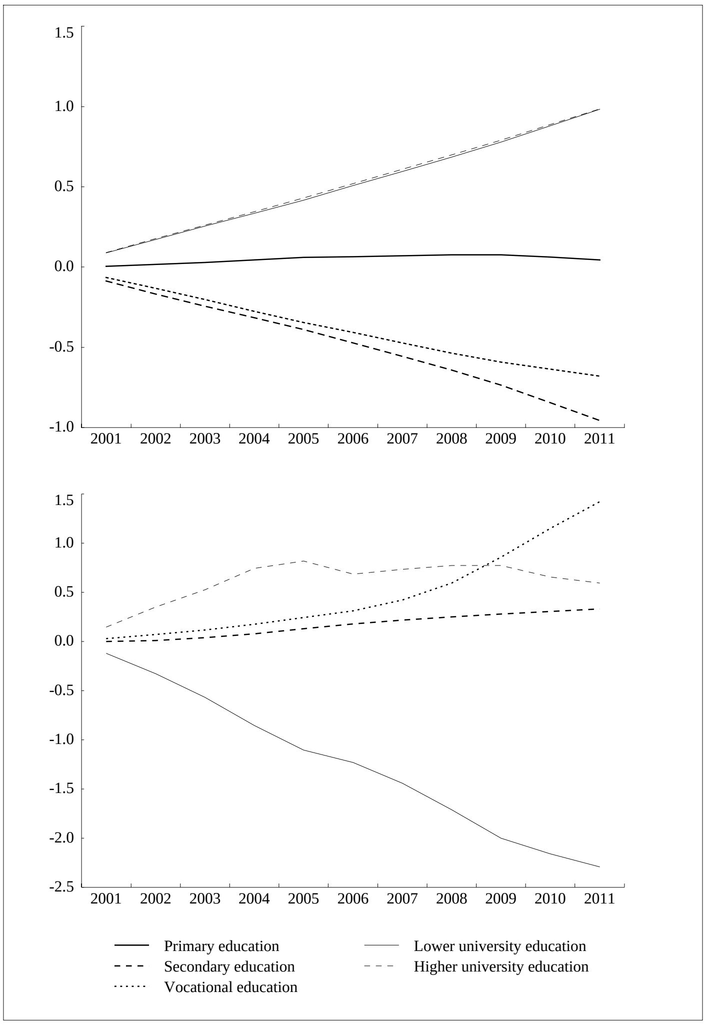

Figure 4: Increased educational attainment, absolute deviations from baseline simulation. Top: Unemployment rates in per cent. Bottom: Educational premiums per hour (primary education = 100)

The reduction in skill mismatch also reduces the increase in educational premiums to workers with lower university education as can be seen in the second column in Table 3 and in Figure 4.

Table 3: Education-specific unemployment rates and educational premiums in the baseline simulation and absolute changes in the three alternative simulations

	Baseline			Increased educational attainment		Increased public spending		Reduced VAT	
	2000	2005	2011	2005	2011	2005	2011	2005	2011
Education-specific unemployment rates:									
Primary education	5.9	5.3	6.0	0.1	0.0	-0.2	-0.0	-0.1	-0.1
Secondary education	3.5	3.4	6.8	-0.4	-1.0	-0.4	-0.4	-0.1	-0.2
Vocational education	3.1	3.7	1.8	-0.3	-0.7	-0.2	-0.1	-0.0	-0.5
Lower university edu.	2.3	1.5	1.5	0.4	1.0	-0.4	-0.4	-0.0	0.1
Higher university edu.	1.4	0.9	1.5	0.4	1.0	-0.4	-0.4	0.0	0.3
Educational premiums[a]:									
Primary education	100.0	100.0	100.0	-	-	-	-	-	-
Secondary education	117.5	117.7	117.8	0.2	0.3	-0.0	0.0	-0.2	-0.4
Vocational education	114.0	115.6	121.2	0.2	1.4	0.3	0.5	0.0	0.8
Lower university edu.	133.3	137.3	142.7	-1.1	-2.3	1.1	0.8	-0.6	-1.7
Higher university edu.	162.1	162.3	169.3	0.9	0.6	-1.1	-0.2	-0.6	-1.6

[a]Primary education = 100

5.3. Two ways to incorporate the real returns of the Petroleum Fund

For some years now the government's net cash flows from the Norwegian petroleum sector have been substantial. The budget surpluses are invested in the *Norwegian Petroleum Fund* and invested in bonds and shares abroad. Since Norway has experienced close to full employment since 1997 the government has been careful not to increase domestic demand by fiscal policy. However, the cash flow from the petroleum sector is expected to increase in the future and the government has come to the conclusion that some of it must be incorporated into the Norwegian economy. Therefore, in March 2001, the government adopted a rule on how much to spend. This rule implies, somewhat simplified, that the government can decrease its surplus each year by about the same amount as the expected increase in the real returns from the fund. Presently this fiscal stimulus amounts to approximately 0.5% of GDP each year. We have conducted simulations of two alternative ways to do this; increased public spending and a decrease in VAT. The shifts are designed so that the public surplus is reduced by approximately 22 billion 1997-kroner in 2011, which is about 1.5% of GDP.

5.3.1. Increased public spending

In this shift we have increased public spending by approximately 6 % or 15 billion 1997-kroner in 2002, which represents about 1.3 % of GDP. Of this 10 billion kroner are spent on materials and 5 billion kroner are used to increase public employment. This implies that public spending (in a relative sense) is turned towards goods and services compared to the present situation where about two thirds of public spending are geared towards employment. Because of the second-round effects, the decrease in public surplus is 21 billion 1997-kroner in 2011 as compared to 8 billion kroner in 2002. This represents 1.4 % and 0.6 % of GDP respectively. GDP in real terms increases by 1.3 % in 2002 and 1.1 % in 2011 as compared to the baseline simulation. The corresponding increase in aggregate labour demand is almost fully compensated by an increase in labour supply so that the decrease in the average unemployment rate is only 0.2-0.3 percentage points throughout the simulation period. In 2011 average wage per hour in manufacturing industry, which may be seen as a measure of international competitiveness, is 3.0 % higher than in the baseline simulation. Hence, international competitiveness decreases slightly. After an increase in the beginning of the period, gross product in manufacturing industry as a whole is about 0.8 % lower in 2011 as compared to the baseline simulation. To sum up the macroeconomic consequences of this policy experiment are fairly moderate.

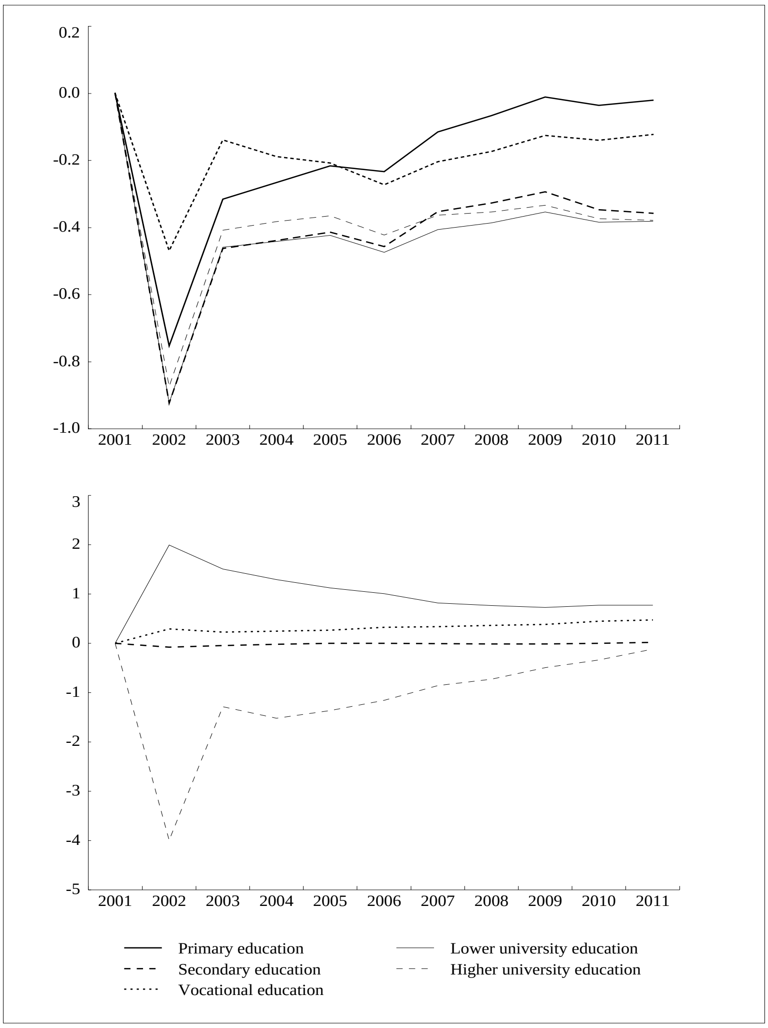

Figure 5: Increased public spending, absolute deviations from baseline simulation. Top: Unemployment rates in per cent. Bottom: Educational premiums per hour (primary education = 100)

Column two in Table 3 and top diagram in Figure 5 show the education-specific unemployment rates as deviations from the baseline simulation. We see that the increase in labour demand has a relatively strong and immediate effect on unemployment for all groups. However, while the unemployment rate for vocational educated workers is "only" 0.4 percentage points lower than in the baseline simulation in 2002, the other education-specific unemployment rates are reduced by at least another 0.4 percentage points. Increased labour supply dampens the fall in unemployment from 2003 and onwards. By 2011 the unemployment rates for primary and vocational educated workers are about the same as in the baseline simulation. Both labour demand and supply are approximately 0.9 % higher for these two groups. Labour demand for workers in the other educational groups are somewhat higher in 2011, which imply that their unemployment rates are about 0.4 percentage points below the baseline simulation.

Since an increase in public spending affects demand for all groups in the same direction there are no tendencies for increased mismatch, at least not in the ten-year period we look at here. Consequently, as we see from column 5 in Table 3 and from bottom diagram in Figure 5, the model does not predict any changes in the education-premiums worth mentioning. On the other hand, increased spending domestically, when there is close to full employment, causes sector-specific imbalances in that competitiveness descreases. However, the centralized wage bargaining set-up in Norway is in many ways "designed" to deal with shocks of this nature, i.e. shocks in terms of trade that have only minor group-specific consequences. Thus, although the modelled wages react relatively strongly to changes in average unemployment they are all equally affected by changes in terms of trade and wages per hour are "only" 2-3 % higher in all sectors as compared to the baseline simulation.

5.3.2. Decreased VAT

In this simulation we have reduced the value-added tax (VAT) by four percentage points in 2002, i.e. from 24 % in 2001 to 20 % in 2002 and onwards. This reduces the public surpluses by approximately 21 billion kroner each year as compared to the baseline alternative (which represents about 1.5 % of GDP). The consequence for the public surplus in 2011 is about the same as in the previous shift. Compared to that shift, however, this shift has less effect on total demand in the beginning of the simulation period and a stronger effect at the end. GDP, for example, increases by 0.2 % in 2004 and 1.6 % in 2011 as compared to the baseline simulation. In the previous shift these figures were 1.5 % and 1.3 %, respectively. A reduction in VAT increases real wages, which contributes to more private spending. However, it also increases real interest rates which crowds out much of this effect at the beginning of the simulation period. In 2003 private consumption actually falls as compared to the baseline simulation. At the end of the simulation period the effects from higher real wages dominate. In 2011 private consumption is 3.4 % higher than in the baseline simulation. Since much of the goods produced in the manufacturing industry are exported the increased demand is primarily directed towards private services and imported goods. However, manufacturing benefits from moderating effects on wages of lower consumption prices. In 2011, as compared to the baseline simulation, gross output in private services is on average 2.4 % higher, gross output in manufacturing is 1.2 % higher, and total import is 2.1 % higher, while total export is roughly constant.

The average unemployment rate is almost unchanged as compared to the baseline simulation, however, there are clear differences across educational groups. Since higher real wages increase private spending, demand towards the private services sector increases relatively to the other sectors. The increase in gross product in the large wholesale and retail trade sector is particularly high. Since almost 70 % of the employed in this sector have either primary or secondary education, both absolute and relative demand for these workers increases. In addition, many of the vocational educated workers are employed within the construction sector which also experiences a higher demand. As a consequence, relative demand towards workers with vocational education increases as well.

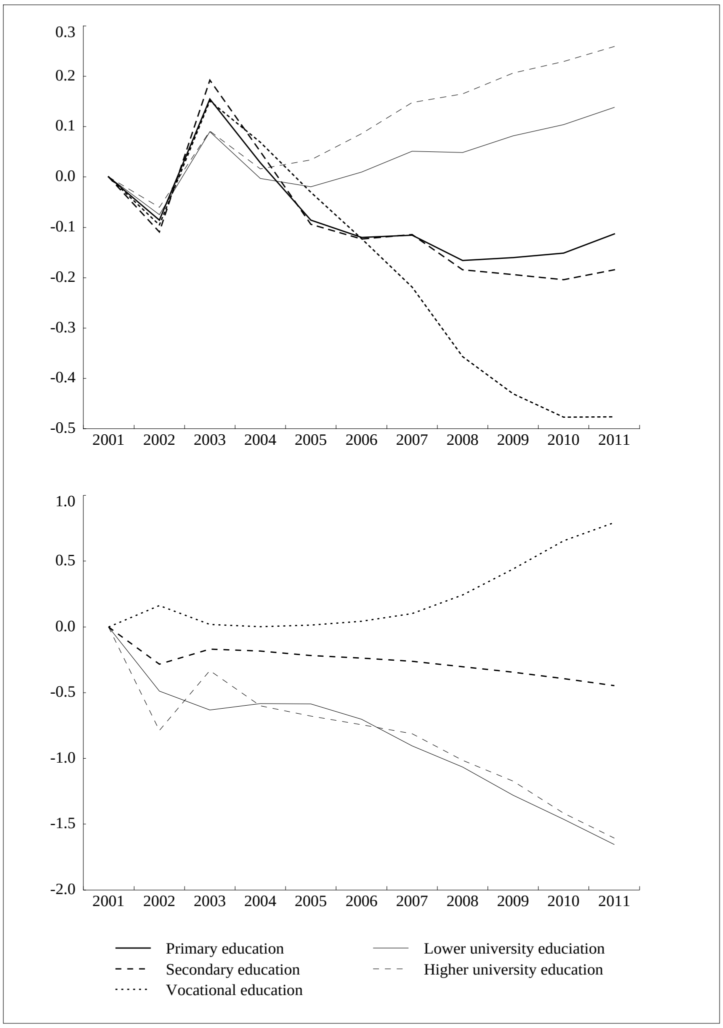

Figure 6: Reduced VAT, absolute deviations from baseline simulation. Top: Unemployment rates in per cent. Bottom: Educational premiums per hour (primary education = 100)

The education-specific unemployment rates are shown in column 3 in Table 3 and in the top diagram in Figure 6 as deviation from the respective rates in the baseline simulation. We see that the increase in demand for primary and secondary educated workers in the wholesale and retail trade, and for vocational educated workers in construction, bring unemployment among these workers down. Although demand for all groups of workers increases, supply increases more for the two groups with the highest education resulting in increased unemployment among these workers. Hence, what appeared to be an increase in mismatch in the baseline simulation seems to be dampened with a reduction in VAT.

The reduction in mismatch between low and high-educated workers contributes to lower wage differentials as compared to the baseline simulation, as is seen in column 6 in Table 3 and in the bottom diagram in Figure 6. In 2011, as compared to the baseline simulation, the educational premium for workers with both lower and higher university education are 1.7 and 1.6 % lower, respectively. Also workers with secondary education experience a somewhat lower educational premium with a reduction of 0.4 % in 2011. The highest wage increase is received by those who have a vocational education. Their educational premium increases with 0.8 % in 2011 as compared to the baseline simulation.

To conclude, these simulations show that a reduction in the level of VAT when the labour market is tight, as compared to increased public spending, is likely to have less effects on total demand at least in the short and medium term. In addition, the baseline simulation shows a slight increase in mismatch during the simulation period (1998-2011) and, as a consequence, somewhat higher educational premiums. While a reduction in VAT tightens the labour market among the less educated workers, unemployment rates for higher educated workers are likely to increase. This reduces the mismatch problem and wage differences decline. In the shift where we increase public spending wage differences increase even more than in the baseline simulation.

6. Concluding comments

It is well documented that skill premiums have been quite stable in Norway during the previous two decades. Both microeconometric studies as well as our extended national accounts based data on hourly wages and employment show the same pattern. Although unemployment rates for people with different education have varied considerably over time, there has been no strong trend in relative unemployment rates between different groups. If anything unemployment for people with higher education has increased relative to unemployment for people with only primary education in Norway during the 1990s. Thus no clear signs of increasing mismatch in the labour market is evident. Will these favourable tendencies continue?

Our study employs a large scale macroeconometric model that includes factor demand equations which contain elements of skill biased technical change so that over time there is a change in the composition of labour toward skilled labour. Without a similar change in the composition of the labour force, relative wages and unemployment will have to change too. We show that during the coming decade there are reasons to believe (according to our baseline simulation) that unemployment rates for skilled labour will decline somewhat, while they will remain stable or even increase somewhat for the unskilled categories. As a consequence, there are indications of some increase in the educational wage premiums.

In a number of alternative simulations, we show how the baseline results depend on the assumed composition of labour supply and some fiscal policy shocks. A further increase in educational attainment - already being high in Norway by OECD standards - will reduce the imbalances in the baseline somewhat. The decline in unemployment for people with higher education will be moderated and educational premiums will not increase as much as in baseline. The latter result applies in particular to those with lower university education. Fiscal policies may affect our results but these are quite sensitive to what kind of fiscal policy changes that are implemented. A cut in the VAT-rate or in indirect taxes on consumption in general will tend to lower unemployment for unskilled labour and thus result in lower educational premiums. A main factor behind this result is that the production of private consumption goods is relatively unskilled intensive. On the other hand an increase in public spending will lead to more demand for skilled labour and tend to have the opposite effect on relative unemployment rates and educational skill premiums compared to a tax cut.

Thus educational premiums may depend on a number of factors other than those that have been mainly focused on in the literature and which we referred to earlier. Although skill biased technical change is a main factor in shaping educational premiums and unemployment rates, it can be moderated through changes in the structure of labour supply as well as policy changes that affect the industry structure of the economy. Our results show that these effects are present in the Norwegian economy and have probably been important for the explanation of skill premiums and labour market balances.

Literature

Acemoglu, D. (1998), Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality, *Quarterly Journal of Economics,* **CXIII**, 1055-1090.

Alogoskoufis, G.S. and A. Manning (1988), Unemployment Persistence, *Economic Policy*, **3**, 427-469.

Andreassen, L. and I. Texmon (2000), Using Dynamic Microsimulation Models for Policy Analysis and Research. In Gupta, A. and V. Kapur (eds.), *Microsimulation in Government Policy and Forcasting,* Amsterdam: North Holland, 265-294.

Autor, D.H., L.F. Katz and A.B. Kreuger (1998), Computing Inequality: Have Computers Changed the Labour Market? *Quarterly Journal of Economics,* **CXIII**, 1169-1214.

Barkbu, B. B., R. Nymoen and K. Røed (2001), Wage Coordination and Unemployment Dynamics in Norway and Sweden. Memorandum 11, Department of Economics, University of Oslo.

Bean, C.R., P.R.G. Layard and S.J. Nickell (1986), The Rise in Unemployment: A Multi-Country Study, *Economica*, **53**, S1-S22.

Berman, E., J. Bound and Z. Griliches (1994), Changes in the demand for skilled labour within U.S. manufacturing: Evidence from the annual survey of manufactures, *Quarterly Journal of Economics,* **CIX**, 367-397.

Berman, E., J. Bound and S. Machin (1998), Implications of Skill-Biased Technological Change: International Evidence, *Quarterly Journal of Economics,* **CXIII,** 1245-1280.

Bjørnstad, R. and R. Nymoen, (1999), Wage and Profitability, Norwegian Manufacturing 1967-1998, Disc. Paper no. 259, Statistics Norway.

Bjørnstad, R. (2000), The Effect of Skill Mismatch on Wages in a Small Open Economy with Centralized Wage Setting: The Norwegian Case, Discussion Paper no. 270, Statistics Norway.

Blanchflower, D.G. and A.J. Oswald (1994), *The Wage Curve*, MIT Press, Cambridge, Mass.

Bowitz. E. and Å. Cappelen (2001), Modeling income policies: some Norwegian experiences 1973-1993, *Economic Modelling,* **18**, 349-379.

Calmfors, L. and R. Nymoen (1990), Nordic Employment, *Economic Policy,* **5**, 397-448.

Cappelen, Å. (1992), MODAG A macroeconometric model of the Norwegian Economy, in L. Bergman and Ø. Olsen, *Economic Modeling in the Nordic Countries,* Amsterdam: North-Holland Publ. Comp.

Card, D., F. Kramarz and T. Lemieux (1998), Changes in the relative structure of wages and employment: A comparison of Canada, France and the United States, CEPR Disc. Paper No. 2008.

Davis, S. (1992), Cross-Country Patterns of Change in Relative Wages. In Blanchard, O. J. and S. Fischer (eds.), *National Bureau of Economic Research Macroeconomics Annual,* 239-292. MIT Press, Cambridge, MA.

Edin, P-A. and B. Holmlund (1995), The Swedish wage structure: the rise and fall of solidarity wage policy, in Freeman and Katz (1995).

Freeman, R.B. and L.F. Katz (1995), Differences and Changes in Wage Structure, Chicago: University of Chicago Press and NBER.

Gottschalk, P. and T. M. Smeeding (1997), Cross-National Comparisons of Earnings and Income Inequality, *Journal of Economic Literature,* **XXXV**, 633-687.

Hamermesh, D.S. (1993), *Labour Demand,* Princeton University Press, Princeton, New Jersey, US.

Haskel, J.E. and M.J. Slaughter (1998), Does the sector bias of skill-biased technical change explain changing wage inequality?, CEPR, Disc. Paper No. 1940.

Hoel, M. and R. Nymoen (1988), Wage Formation in Norwegain Manufacturing. An Empirical Application of a Theoretical Bargaining Model, *European Economic Review,* **32**, 977-997.

Hægeland, T., T.J. Klette and K.G. Salvanes (1999), Declining Returns to Education in Norway? Comparing Estimates across Cohorts, Sectors and over Time, *Scandinavian Journal of Economics,* **101,** 555-576.

Iversen, T. (1999), *Contested Economic Institutions. The Politics of Macroeconomics and Wage Bargaining in Advanced Democracies.* Cambridge University Press, Cambridge.

Johansen, K. (1995), Norwegian Wage Curves, *Oxford Bulletin of Economics and Statistics,* **51**, 229-247.

Kahn, L.M. (1998), Against the wind: Bargaining Recentralisation and Wage inequality in Norway 1987-91, *Economic Journal,* **108**, 603-645.

Katz, L. F., G. W. Loveman and D. G. Blanchflower (1995), A Comparison of Changes in the Structure of Wages in Four OECD Countries. In Katz, L. F. and R. Freeman (eds.), *Differences and Changes in Wage Structures.* University of Chicago Press, Chicago, IL.

Krugman, P. R. (1994), Past and Prospective Causes of High Unemployment. In *Reducing Unemployment: Current Issues and Policy Options. The Federal Reserve Bank of Kansas Symposium 1994*, 49-80. The Federal Reserve Bank of Kansas, Kansas City.

Layard, R. S. Nickell and R. Jackman (1991), *Unemployment*, Oxford: Oxford University Press.

Lindquist, K.-G. and T. Skjerpen (2000), Explaining the Change in Skill Structure of Labour Demand in Norwegian Manufacturing, Disc. Paper no. 293, Statistics Norway.

Nickell, S.J. and M. Andrews (1983), Unions, Real-Wages and Employment in Britain 1951-79, *Oxford Economic Papers (Supplement),* **35**, 183-206.

Nymoen, R. (1989), Modelling Wages in the Small Open Economy: An Error Correction Model of Norwegian Manufacturing Wages, *Oxford Bulletin of Economics and Statistics,* **51**, 239-258.

OECD (1993), *Employment Outlook.* Paris: OECD.

OECD (1996), *Employment Outlook.* Paris: OECD.

Salvanes, K. G. and S. E. Førre (1999), Job Destruction, Heterogeneous Workers, Trade and Technical Change: Matched Plant/Worker Data Evidence from Norway. Discussion Paper no. 15/99, Norwegian School of Economics and Business Administration, Bergen.

Sargan, J. D. (1964), Wages and Prices in the United Kingdom: A Study of Econometric Methodology. In Hart, P. E., G. Mills and J. K. Whitaker (eds.), *Econometric Analysis for National Economic Planning*, 25-63. Butterworth Co., London.

Sargan, J. D. (1980), A Model of Wage-Price Inflation. *Review of Economic Studies,* **47***,* 113-135.

Wood, A. (1994), *North-South Trade, Employment and Inequality: Changing Fortunes in a Skill-Driven World,* Oxford: Clarendon Press.

Appendix A: The dynamic factor demand system with heterogeneous labour. Detailed results.

Table A1 below gives an overview of the different variables involved in the dynamic factor demand system. The industry and time indices are supressed.

Table A1: An overview of observable variables in the dynamic factor demand system with heterogeneous labour

			Presence of variables	
Variable	Interpretation of variable	Unit of measurement	Upper Level	Lower level
L	CES-aggregate of labour		Yes	Yes
X	Real gross output	Million 1997-kroner	Yes	Yes
K	Capital stock (all categories) at the beginning of the period	Million 1997-kroner	Yes	No
M	Materials input	Million 1997-kroner	Yes	No
E	CES-aggregate of energy		Yes	No
P_L	Price-index of CES-aggregate of labour	1997=1	Yes	Yes
P_M	Price-index of materials input	1997=1	Yes	No
P_E	Price-index of CES-aggregate of energy	1997=1	Yes	Yes
τ	Linear trend	1972=1	Yes	Yes
EL	Input of electricity	Million 1997-kroner	No	Yes
FU	Input of fuel	Million 1997-kroner	No	Yes
P_{EL}	Price-index of electricity	1997=1	No	Yes
P_{FU}	Price-index of fuel	1997=1	No	Yes
K_M	Capital stock of machinery at the beginning of the period	Million 1997-kroner	No	Yes
LSK	Input of skilled labour	1000 man-hours	No	Yes
LUS	Input of unskilled labour	1000 man-hours	No	Yes
P_{LSK}	Wage for skilled	Wage per man-hour	No	Yes
P_{LUS}	Wage for unskilled	Wage per man-hour	No	Yes

[1] For the production sectors 63 we do not use a CES-aggregate of energy but simply define E=EL+FU and $P_E = (P_{EL}EL+P_{FU}FU)/E$. The reason for this is that the use of fuel in some years is negligible.

A. 1. The dynamic factor demand system at the upper level

The dynamic factor demand system at the upper level consists of three econometric equations (lower case letters denote variables after log-transformation):

$$\text{(A1)}\quad \begin{aligned} &\Delta l_{i,t} = \gamma_{iLX}\Delta x_{i,t} + \gamma_{iLK}\Delta k_{i,t} + \gamma_{iLM}\left(\Delta p_{iL,t} - \Delta p_{iM,t}\right) + \gamma_{iLE}\left(\Delta p_{iL,t} - \Delta p_{iE,t}\right) + \\ &\alpha_{iL}\left[l_{i,t-1} - \rho_{iL} - \beta_{i0}x_{t-1} - \beta_{i1}k_{t-1} - \beta_{i2}\left(p_{iL,t-1} - p_{iM,t-1}\right) - \beta_{i3}\left(p_{iL,t-1} - p_{iE,t-1}\right) - \beta_{i5}\tau_{t-1}\right] + u_{iL,t}, \end{aligned}$$

$$\text{(A2)}\quad \begin{aligned}&\Delta m_{i,t} = \gamma_{iMX}\Delta x_{i,t} + \gamma_{iMK}\Delta k_{i,t} + \gamma_{iML}(\Delta p_{iM,t} - \Delta p_{iL,t}) + \gamma_{iME}(\Delta p_{iM,t} - \Delta p_{iE,t}) + \\ &\alpha_{iM}\left[m_{i,t-1} - \rho_{iM} - \beta_{i0}x_{t-1} - \beta_{i1}k_{t-1} - \beta_{i4}(p_{iM,t-1} - p_{iL,t-1}) - \beta_{i3}(p_{iM,t-1} - p_{iE,t-1}) - \beta_{i5}\tau_{t-1}\right] + u_{iM,t}\end{aligned}$$

and

$$\text{(A3)}\quad \begin{aligned}&\Delta e_{i,t} = \gamma_{iEX}\Delta x_{i,t} + \gamma_{iEK}\Delta k_{i,t} + \gamma_{iEL}(\Delta p_{iE,t} - \Delta p_{iL,t}) + \gamma_{iEM}(\Delta p_{iE,t} - \Delta p_{iM,t}) + \\ &\alpha_{iE}\left[e_{i,t-1} - \rho_{iE} - \beta_{i0}x_{t-1} - \beta_{i1}k_{t-1} - \beta_{i4}(p_{iE,t-1} - p_{iL,t-1}) - \beta_{i2}(p_{iE,t-1} - p_{iM,t-1}) - \beta_{i5}\tau_{t-1}\right] + u_{iE,t}.\end{aligned}$$

In equations (A1)-(A3) $u_{iL,t}$, $u_{iM,t}$ and $u_{iE,t}$ are error terms and $u_{i,t}=[u_{iL,t}, u_{iM,t}, u_{iE,t}]^{/}$ is assumed to be a white noise vector error process with expectation zero and with an unrestricted contemporaneous covariance matrix denoted by Σ^{i}. The index i runs over production sector. According to (A1)-(A3) and the assumption about the second order moments of the error vectors, all unknown parameter are sector specific. Thus (A1) and (A3) are estimated separately for each sector. In most industries energy and labour are both represented by a CES-aggregate at the upper level.

Note that in equations (A1)-(A3) there are parameter restrictions across equations. To estimate the parameters we use a two-stage procedure. Consistent estimates of β_{i2}, β_{i3} and β_{i4} can be obtained by utilising sample averages of cost-shares. If we let $s_{Li\,t}$, $s_{Mi\,t}$ and $s_{Ei\,t}$ denote the cost shares of labour, materials and energy in industry i in year t, we have

$$\hat{\beta}_{i2} = -\frac{1}{26}\sum_{t=1972}^{1997} s_{Mit},\ \hat{\beta}_{i3} = -\frac{1}{26}\sum_{t=1972}^{1997} s_{Eit} \text{ and } \hat{\beta}_{i4} = -\frac{1}{26}\sum_{t=1972}^{1997} s_{Lit}.$$

The advantage of these estimators is that they impose theory-consistent signs of price effects. At the second stage the above estimates replace their unobserved counterparts and the remaining parameters are estimated with maximum likelihood. The above discussion implicitly assumes that the parameters in the CES-aggregates and their prices are known. However these parameters are unknown and must be estimated.

A. 2. The factor demand system at the lower level

The CES-aggregate of energy and the price of the CES-aggregate of energy are given in equations (A.4) and (A.5) below

$$\text{(A4)}\quad E_{i,t} = \left[de_{i,t}\left(\frac{EL_{i,t}}{de_{i,t}}\right)^{(-\xi_i)} + (1 - de_{i,t})\left(\frac{FU_{i,t}}{(1 - de_{i,t})}\right)^{(-\xi_i)} \right]^{\left(\frac{-1}{\xi_i}\right)}$$

and

$$\text{(A5)}\quad P_{iE,t} = \left[de_{i,t} P_{iEL,t}^{\frac{\xi_i}{1+\xi_i}} + (1 - de_{i,t}) P_{iFU,t}^{\frac{\xi_i}{1+\xi_i}} \right]^{\frac{1+\xi_i}{\xi_i}}.$$

In (A4) EL and FU denote use of electricity and fuel, respectively. Their prices which occur in (A5) are denoted by P_{EL} and P_{FU}. ξ denotes a deduced substitution parameter. A time-varying distribution parameter is a function of data and estimated parameters. The following econometric equation follows from cost minimisation given a fixed value of the CES-aggregate of energy

$$(A6)\quad el_{i,t} - fu_{i,t} = \rho_{i0} + \rho_{iKM} km_{i,t} + \rho_{i\tau}\tau_t + \rho_{iP}(pel_{i,t} - pfu_{i,t}) + \eta_{i,t}.$$

Equation (A6) is estimated by OLS. If we let ^ denote an estimated value we can derive $de_{i,t}$ and $\hat{\xi}_i$ by.

$$(A7)\quad de_{i,t} = \frac{\exp[\hat{\rho}_{i0} + \hat{\rho}_{iKM} km_{i,t} + \hat{\rho}_{i\tau}\tau_t]}{1 + \exp[\hat{\rho}_{i0} + \hat{\rho}_{iKM} km_{i,t} + \hat{\rho}_{i\tau}\tau_t]}$$

and

$$(A8)\quad \hat{\xi}_i = -1 - \frac{1}{\hat{\rho}_{iP}}.$$

We distinguish between two types of labour, which we refer to as skilled (SK) and unskilled (US), respectively. The precise definition of these categories varies somewhat between industries.

$$(A9)\quad L_{i,t} = \left[dl_{i,t}\left(\frac{LSK_{i,t}}{dl_{i,t}}\right)^{(-\varsigma_i)} + (1 - dl_{i,t})\left(\frac{LUS_{i,t}}{(1 - dl_{i,t})}\right)^{(-\varsigma_i)} \right]^{\left(\frac{-1}{\varsigma_i}\right)}$$

and

$$(A10)\quad P_{iL,t} = \left[dl_{i,t} P_{iLSK,t}^{\frac{\varsigma_i}{1+\varsigma_i}} + (1 - dl_{i,t}) P_{iLUS,t}^{\frac{\varsigma_i}{1+\varsigma_i}} \right]^{\frac{1+\varsigma_i}{\varsigma_i}}.$$

In equation (A9) dl is a time-varying distribution parameter and ς is a substitution parameter. These two terms can be derived from the following econometric equation based on minimising the labour cost given a fixed level of the CES-aggregate defines in (A9)

$$(A11)\quad lsk_{i,t} - lus_{i,t} = \lambda_{i0} + \lambda_{iKM} km_{i,t} + \lambda_{iX} x_{i,t} + \lambda_{i\tau}\tau_t + \lambda_{iP}(plsk_{i,t} - plus_{i,t}) + \varphi_{i,t}.$$

Equation (A11) is estimated by OLS. We can now derive $dl_{i,t}$ and $\hat{\varsigma}_i$ by

$$(A12)\quad dl_{i,t} = \frac{\exp[\hat{\lambda}_{i0} + \hat{\lambda}_{iKM} km_{i,t} + \hat{\lambda}_{iX} x_{i,t} + \hat{\rho}_{i\tau}\tau_t]}{1 + \exp[\hat{\lambda}_{i0} + \hat{\lambda}_{iKM} km_{i,t} + \hat{\lambda}_{iX} x_{i,t} + \hat{\rho}_{i\tau}\tau_t]}$$

and

$$(A13)\quad \hat{\varsigma}_i = -1 - \frac{1}{\hat{\lambda}_{iP}}.$$

Table A2: Long-run parameters in the dynamic factor demand system. Standard errors in parentheses

Industry	Parameter								
	β_0	β_1	β_2	β_3	β_4	β_5	δ_L	δ_M	δ_E
11	1[a]	-0.3[a]	-0.778	-0.061	-0.160	0[a]	0[a]	1.544 (0.455)	-0.612 (0.155)
15	1.386 (0.005)	-0.5[a]	-0.816	-0.016	-0.168	0[a]	-1.958 (0.061)	0[a]	-4.121 (0.081)
25	1[a]	-0.280 (0.003)	-0.669	-0.023	-0.308	0[a]	0[a]	0.947 (0.049)	-2.304 (0.157)
34	1[a]	-0.3	-0.752	-0.058	-0.190	0[a]	0[a]	1.556 (0.067)	-0.822 (0.044)
37	1[a]	-0.3	-0.740	-0.067	-0.192	-0.025 (0.002)	0.418 (0.069)	1.973 (0.129)	-0.598 (0.041)
43	1[a]	-0.272 (0.012)	-0.718	-0.091	-0.191	-0.016 (0.007)	0[a]	1.740 (0.109)	-0.447 (0.232)
45	1[a]	-0.3	-0.633	-0.014	-0.352	-0.008 (0.002)	0.112 (0.048)	0.970 (0.081)	-3.562 (0.393)
50	1.241 (0.093)	-0.566 (0.103)	-0.695	-0.007	-0.298	-0.002 (0.002)	0[a]	0.928 (0.054)	-3.634 (0.145)
63	1[a]	0[a]	-0.461	-0.008	-0.532	0[a]	-4.138 (0.019)	-3.964 (0.134)	-7.537 (0.309)
81	1[a]	-0.273 (0.002)	-0.477	-0.020	-0.503	-0.013 (0.010)	0[a]	0[a]	-3.233 (0.146)
85	1[a]	0[a]	-0.496	-0.015	-0.489	0[a]	-3.364 (0.160)	-3.488 (0.040)	-6.761 (0.115)

[a] Fixed value

Table A3: Deduced Cobb-Douglas (production function) parameters

		Marginal elasticity of output with respect to				
Industry	Scale elasticity	CES-aggregate of labour	Materials	CES-aggregate of energy	Real capital	Neutral technical progress
11	1.30	0.16	0.78	0.06	0.30	0.000
15	1.41	0.12	0.59	0.01	0.39	0.000
25	1.28	0.31	0.67	0.02	0.28	0.000
34	1.30	0.19	0.75	0.06	0.30	0.000
37	1.30	0.19	0.74	0.07	0.30	0.025
43	1.27	0.19	0.72	0.09	0.27	0.016
45	1.30	0.35	0.63	0.01	0.30	0.008
50	1.51	0.24	0.56	0.01	0.70	0.002
63	1.00	0.53	0.46	0.01	0.00	0.000
81	1.27	0.50	0.48	0.02	0.27	0.013
85	1.00	0.49	0.50	0.01	0.00	0.000

Table A4: Short-run parameters in the dynamic factor demand system. Standard errors in parentheses

Industry	Parameter											
	γ_{LX}	γ_{LK}	γ_{LM}	γ_{LE}	γ_{MX}	γ_{MK}	γ_{ML}	γ_{ME}	γ_{EX}	γ_{EK}	γ_{EL}	γ_{EM}
11	0[a]	0[a]	-0.208	0[a]	0[a]	0.994	-0.642	0[a]	1.163	0[a]	-0.700	0[a]
			(0.169)			(0.311)	(0.115)		(0.375)		(0.125)	
15	0.840	0[a]	-0.349	0[a]	0.863	-0.292	0[a]	-0.047	0[a]	0[a]	0[a]	-0.504
	(0.124)		(0.105)		(0.066)	(0.107)		(0.020)				(0.170)
25	0.739	0[a]	0[a]	0[a]	1.181	0[a]	0[a]	0[a]	0[a]	0[a]	0.969	-1.858
	(0.089)				(0.052)						(0.560)	(0.624)
34	0.232	-0.160	-0.169	0[a]	1.068	0[a]	0[a]	0.107	1.246	0[a]	0[a]	0[a]
	(0.054)	(0.082)	(0.058)		(0.050)			(0.041)	(0.197)			
37	0[a]	0[a]	0[a]	0.291	0.865	0[a]	0[a]	0[a]	0.798	0.437	0[a]	-0.418
				(0.145)	(0.072)				(0.142)	(0.161)		(0.163)
43	0.398	0[a]	0[a]	0[a]	1.011	-0.441	0[a]	0[a]	0.620	0.488	0[a]	-0.203
	(0.113)				(0.078)	(0.157)			(0.141)	(0.290)		(0.094)
45	0.611	0[a]	0[a]	0[a]	1.080	-0.415	0[a]	0[a]	0.703	0[a]	-0.843	0[a]
	(0.060)				(0.048)	(0.155)			(0.279)		(0.192)	
50	0.353	0[a]	0[a]	0[a]	1.094	-0.632	0[a]	0[a]	0[a]	0[a]	-0.923	0[a]
	(0.056)				(0.038)	(0.252)					(0.208)	
63	0.885	0[a]	-0.154	0^0	0.705	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	-1.023
	(0.045)		(0.067)		(0.272)							(0.287)
81	0.406	0[a]	0[a]	0[a]	0.752	-0.557	-0.420	0[a]	0.655	0[a]	-0.950	0[a]
	(0.074)				(0.117)	(0.163)	(0.162)		(0.429)		(0.151)	
85	0.681	0[a]	-0.322	0.072	0.755	0[a]	-0.514	0[a]	0[a]	0[a]	0[a]	-1.046
	(0.103)		(0.140)	(0.030)	(0.190)		(0.185)					(0.117)

[a] Fixed value

Table A5: Adjustment coefficients in the dynamic factor demand system. Standard errors in parentheses

Industry	α_L	α_M	α_E
11	-0.025	-0.025[a]	-0.096
	(0.024)		(0.052)
15	-0.285	-0.05[a]	-0.241
	(0.053)		(0.080)
25	-0.269	-0.101	-0.211
	(0.102)	(0.042)	(0.101)
34	-0.075	-0.05[a]	-0.309
	(0.012)		(0.079)
37	-0188	-0.061	-0.509
	(0.081)	(0.036)	(0.142)
43	-0.1[a]	-0.05[a]	-0.05[a]
45	-0.231	-0.091	-0.05[a]
	(0.065)	(0.045)	
50	-0.210	-0.365	-0.144
	(0.065)	(0.146)	(0.055)
63	-0.160	-0.153	-0.130
	(0.043)	(0.056)	(0.033)
81	-0.157	-0.6[a]	-0.153
	(0.086)		(0.086)
85	-0.044	-0.256	-0.223
	(0.044)	(0.148)	(0.092)

[a] Assumed value

Table A6: Parameters in the CES-aggregate of energy[a]

Industry	ρ_0	ρ_{KM}	ρ_τ	ρ_P
11	-0.842	0[b]	0.033	-0.269
15	-23.993	2.737	-0.040	-0.824
25	0.862	0[b]	0.012	-0.740
34	-4.799	0.760	-0.019	-0.576
37	2.276	0[b]	-0.008	-0.653
43	7.801	-0.556	0.019	-0.858
45	-14.175	1.711	0[b]	-0.857
50	-1.316	0.405	0[b]	-0.949
81	-28.857	2.941	-0.033	-0.342
85	-14.841	1.626	0[b]	-0.653

[a] Since the estimates are based on estimating a static relation no standard errors are reported.
[b] Fixed value.

Table A7: Parameters in the CES-aggregate of labour [a]

Industry	λ_0	λ_{KM}	λ_X	λ_τ	λ_P
11	0^b	-0.364	0^b	0.048	-0.454
15	-13.857	0.703	0.371	0.029	-0.695
25	0^b	0^b	-0.232	0.045	-0.859
34	-7.221	0.289	0.206	0.030	-0.718
37	-4.626	0^b	0.343	0.011	-0.5^c
43	5.374	-0.329	-0.451	0.105	-0.75^c
45	-7.117	0.618	0^b	0.063	-0.75^c
50	0^b	0^b	-0.264	0.037	-0.5^c
63	5.278	0^b	-0.649	0.049	-0.5^c
81	-2.978	0.116	0^b	0.047	-0.961
85	5.151	-0.686	0^b	0.087	-0.709

[a] Since the estimates are based on estimating a static relation no standard errors are reported.
[b] Fixed value.
[c] Assumed value.

Table A8: The production sectors/industries in MODAG and definition of skilled/unskilled in industries in which demand of heterogenous labour is modelled econometrically

MODAG code	Full name	Def. of skilled/unskilled[a]
11	Agriculture	Definition I
12	Forestry	
13	Fishing etc.	
14	Fish Farming	
15	Manufacture of Consumption Goods	Definition I
25	Manufacture of Materials and Investment Goods	Definition I
34	Manufacture of Pulp and Paper	Definition I
37	Manufacture of Industrial Chemicals	Definition I
40	Petroleum Refining	
43	Manufacture of Metals	Definition II
45	Manufacture of Machinery etc.	Definition II
50	Manufacture of Ships and Transport equipment	Definition I
55	Construction	
63	Finance and Insurance	Definition I
64	Production and Pipeline Transport of Oil and Gas etc.	
65	Ocean Transport	
71	Production of Electricity	
74	Domestic Transport	
81	Wholesale and Retail Trade	Definition II
83	Housing Services	
85	Other Private Services	Definition II
92S	Defence	
93S	Education: Central Government	
94S	Health-Care: Central Government	
95S	Other Services: Central Government	
93K	Education: Local Government	
94K	Health-Care: Local Government	
95K	Other Services: Local Government	

[a] Altogether there are 5 educational group: i) GRK: Employees with primary education (including employees with unknown education); ii) VA: Employees with secondary education; iii) VF: Employees with vocational education; iv) HO: Employees with lower university education; v) UN: Employees with higher university education. Using Definition I we have Unskilled=GRK+VA+VF, Skilled=HO+UN. Using Definition II we have Unskilled=GRK+VA, Skilled=VF+HO+UN.

Appendix B: Employment (man-hours) by skill category and industry, 1972-1997.

Table B1: Man-hours in educational group GRK by industry relative to the total number of man-hours by this educational group. Selected years (per thousands)

Industry	1972	1977	1982	1987	1992	1997
11	128.3	118.4	107.3	89.8	80.0	71.1
12	7.8	7.4	5.7	5.7	4.8	3.9
13	17.4	15.7	17.2	16.7	15.7	15.4
14	0.1	0.3	1.0	2.4	2.3	2.2
15	62.8	53.7	50.8	44.9	43.5	44.6
25	78.0	73.5	64.1	61.6	52.3	57.2
34	13.9	11.3	9.1	7.8	7.2	6.8
37	5.3	5.2	4.7	4.3	3.9	3.2
40	0.3	0.8	0.8	0.8	0.8	0.5
43	15.8	14.5	13.7	11.7	9.1	8.5
45	57.9	57.1	50.2	47.5	40.6	41.8
50	23.0	26.5	22.5	14.8	16.1	19.2
55	81.6	78.1	76.3	84.1	61.7	62.3
63	13.7	14.5	15.2	17.0	16.3	13.0
64	0.1	1.4	4.2	5.1	6.7	7.0
65	39.0	27.6	24.7	25.5	47.8	45.6
71	7.7	7.4	7.4	7.0	6.6	5.5
74	78.5	81.3	85.9	89.3	90.0	91.8
81	146.9	158.2	162.2	164.6	161.6	163.4
83	0.2	0.2	0.2	0.2	0.3	0.3
85	88.2	91.7	101.5	116.4	119.3	129.8
92S	36.1	34.6	37.4	36.5	42.2	35.3
93S	3.2	3.3	3.1	3.2	4.1	4.7
94S	2.9	3.2	3.6	2.7	2.6	2.8
95S	18.6	20.5	21.4	20.5	22.7	19.2
93K	16.9	16.8	17.2	17.8	18.9	19.3
94K	33.3	50.7	64.7	72.8	88.2	93.4
95K	22.6	26.4	28.1	29.1	34.8	31.9
Σ	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

Table B2: Man-hours in educational group VA by industry relative to the total number of man-hours by this educational group. Selected years (per thousands)

Industry	1972	1977	1982	1987	1992	1997
11	38.0	34.9	33.6	29.4	30.8	28.1
12	4.9	4.4	3.2	2.7	2.5	1.9
13	2.7	2.3	2.3	2.0	1.9	2.4
14	0.0	0.1	0.2	0.8	0.6	0.8
15	38.8	32.0	29.5	25.2	28.1	30.7
25	64.9	59.6	51.3	47.8	42.1	46.6
34	7.7	6.1	4.8	4.0	3.7	3.3
37	4.5	4.4	4.0	3.4	3.0	2.5
40	0.3	0.7	0.7	0.6	0.6	0.4
43	9.1	8.1	7.7	6.4	4.7	4.3
45	33.7	32.8	28.9	26.6	21.7	24.1
50	9.3	10.9	9.5	6.6	8.3	7.8
55	42.7	39.8	38.2	41.9	34.9	34.4
63	124.4	126.3	126.0	136.8	105.1	80.2
64	0.2	3.5	8.9	9.8	10.3	8.3
65	32.8	22.9	17.0	6.9	5.7	5.6
71	4.5	4.4	4.7	4.5	4.7	3.9
74	79.5	81.9	87.1	89.7	83.8	88.2
81	196.7	206.5	205.2	199.9	221.7	231.2
83	0.9	0.8	0.7	0.7	0.8	0.8
85	123.3	129.0	143.6	168.6	179.2	192.9
92S	43.5	32.7	25.9	23.0	19.2	17.1
93S	4.9	4.9	4.5	4.3	5.4	6.0
94S	2.6	2.9	3.1	2.0	2.2	2.5
95S	58.6	60.7	60.4	53.9	52.7	42.3
93K	25.1	24.6	24.3	23.6	24.9	24.2
94K	24.8	37.9	48.1	52.1	68.9	80.4
95K	21.5	25.2	26.6	26.5	32.5	29.1
Σ	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

Table B3: Man-hours in educational group VF by industry relative to the total number of man-hours by this educational group. Selected years (per thousands)

Industry	1972	1977	1982	1987	1992	1997
11	117.5	117.9	126.7	106.6	90.0	72.5
12	8.4	8.9	7.6	7.6	6.4	4.8
13	7.6	7.6	9.2	8.5	7.1	7.4
14	0.0	0.1	0.6	2.0	1.7	1.9
15	41.1	33.3	31.3	29.2	30.5	33.3
25	66.1	65.9	61.0	58.8	51.2	58.7
34	9.3	8.3	7.3	6.9	7.6	7.5
37	8.6	9.4	9.3	9.0	9.0	7.2
40	0.5	1.4	1.6	1.6	1.8	1.2
43	13.6	14.0	14.6	13.0	13.1	15.6
45	68.8	74.1	69.3	66.3	58.2	69.1
50	28.9	37.6	35.3	25.5	34.8	37.2
55	98.9	106.8	111.6	134.4	116.0	120.1
63	8.2	7.5	7.2	8.3	8.4	5.1
64	0.2	3.3	10.0	11.0	14.9	15.2
65	49.1	40.1	32.3	13.4	12.0	11.3
71	20.6	21.8	23.5	23.5	24.9	19.3
74	64.9	70.1	75.5	77.6	69.7	68.2
81	100.9	105.1	106.8	112.9	110.3	117.0
83	0.3	0.3	0.4	0.4	0.5	0.4
85	132.6	116.0	114.6	135.4	150.6	153.1
92S	49.7	43.8	38.1	32.5	25.4	17.8
93S	4.2	3.8	3.4	3.0	3.8	3.7
94S	2.9	2.5	2.3	1.7	2.4	2.7
95S	16.9	18.0	18.7	17.6	18.8	13.1
93K	21.2	18.8	17.9	16.4	16.5	14.1
94K	33.4	32.9	31.8	41.8	73.5	85.1
95K	25.4	30.6	32.3	34.9	41.0	37.3
Σ	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

Table B4: Man-hours in educational group HO by industry relative to the total number of man-hours by this educational group. Selected years (per thousands)

Industry	1972	1977	1982	1987	1992	1997
11	16.5	13.3	13.5	10.4	10.4	11.0
12	0.8	0.8	0.6	0.6	0.6	0.7
13	1.9	1.7	1.8	1.9	1.6	1.8
14	0.0	0.0	0.2	0.7	0.5	0.5
15	13.0	10.6	10.0	8.8	8.5	9.5
25	36.8	34.0	30.1	30.0	25.3	29.5
34	5.1	4.0	3.2	3.0	2.4	2.3
37	6.6	6.3	5.9	5.3	4.2	3.5
40	0.4	1.0	1.0	1.0	0.8	0.6
43	6.9	6.1	5.8	5.5	3.8	3.5
45	43.9	41.4	35.8	33.2	24.2	24.6
50	11.7	13.1	11.2	8.1	8.8	8.2
55	32.5	30.6	29.2	32.7	21.6	19.4
63	34.8	35.0	34.5	41.0	35.7	34.4
64	0.3	5.4	14.7	16.8	17.3	15.0
65	67.5	47.8	35.1	15.4	15.2	15.5
71	9.6	8.6	8.4	8.5	7.8	7.5
74	41.5	42.3	42.5	41.7	39.2	44.0
81	75.5	79.0	79.5	81.5	81.5	86.4
83	1.1	1.1	1.0	1.1	1.1	1.0
85	202.2	195.7	192.6	208.3	212.2	216.6
92S	27.2	20.5	16.4	14.9	18.6	16.7
93S	36.7	36.5	33.5	31.8	34.8	35.3
94S	5.9	6.6	7.2	5.0	5.0	5.3
95S	41.3	42.6	42.8	40.5	55.2	56.1
93K	185.6	181.9	180.6	173.4	157.8	140.1
94K	58.2	91.4	117.4	130.1	162.7	169.8
95K	36.3	43.0	45.5	48.8	43.0	41.2
Σ	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

Table B5: Man-hours in educational group UN by industry relative to the total number of man-hours by this educational group. Selected years (per thousands).

Industry	1972	1977	1982	1987	1992	1997
11	14.0	12.9	12.1	12.9	10.7	9.6
12	2.8	2.5	1.8	1.8	1.0	0.9
13	1.6	1.4	1.4	1.5	0.9	0.8
14	0.0	0.0	0.2	0.6	0.4	0.3
15	8.6	7.4	7.1	6.5	6.2	6.9
25	21.9	20.5	18.5	18.0	16.3	20.3
34	4.9	3.9	3.2	3.0	2.4	2.4
37	9.9	9.5	8.8	7.7	6.2	5.8
40	0.6	1.4	1.5	1.4	1.2	1.0
43	7.7	6.9	6.6	6.3	4.6	4.9
45	33.9	32.4	28.2	25.0	20.9	24.4
50	4.5	5.1	4.4	3.8	5.4	4.1
55	22.3	21.4	20.3	22.2	15.8	15.2
63	21.0	21.1	20.3	23.1	19.7	20.8
64	0.5	9.5	27.4	30.9	35.2	36.2
65	16.8	12.3	9.2	3.6	2.5	6.2
71	9.9	9.1	9.1	10.4	9.0	8.6
74	17.8	18.1	18.3	16.4	14.7	21.3
81	35.1	36.2	37.0	39.4	38.6	38.0
83	1.8	1.8	1.7	1.7	1.8	1.6
85	305.4	295.4	295.1	316.2	326.2	320.2
92S	44.1	33.9	27.1	24.3	33.3	36.5
93S	40.6	38.9	35.5	31.1	37.0	38.6
94S	9.2	10.1	10.0	5.6	4.4	4.1
95S	90.1	92.5	92.2	86.6	90.6	94.2
93K	193.5	188.1	185.2	167.1	162.1	143.3
94K	42.6	62.1	71.7	85.0	90.9	88.7
95K	38.8	45.7	46.0	48.0	42.3	44.9
Σ	1000.0	1000.0	1000.0	1000.0	1000.0	1000.0

Table B6: Man-hours in educational group GRK relative to total man-hours by industry. Selected years (per cent)

Industry	1972	1977	1982	1987	1992	1997
11	92.2	86.6	75.8	69.8	63.0	56.4
12	89.2	82.5	71.7	65.9	58.7	51.1
13	95.5	92.2	86.4	83.3	80.1	72.7
14	94.7	91.2	82.6	72.3	68.7	58.0
15	91.0	86.8	79.8	74.2	66.3	57.4
25	86.7	80.4	70.5	64.1	56.2	47.3
34	89.4	84.0	75.1	67.9	59.2	51.0
37	74.8	65.2	52.3	45.3	37.9	30.6
40	74.6	65.3	52.3	45.3	37.9	30.6
43	87.4	81.0	70.6	63.5	52.9	40.9
45	83.5	75.8	64.5	58.2	51.1	40.6
50	86.9	78.8	66.7	58.0	45.6	41.2
55	87.2	79.4	68.1	60.2	49.6	41.5
63	53.1	45.8	36.6	29.6	27.6	21.8
64	52.0	42.5	33.7	30.0	26.6	22.9
65	76.5	67.0	59.3	73.2	80.0	73.3
71	73.8	62.7	48.5	40.2	31.2	24.7
74	85.7	79.3	69.9	63.9	59.0	50.9
81	84.9	79.3	70.5	63.9	55.7	47.4
83	44.2	36.7	28.7	24.7	21.3	19.5
85	65.5	58.4	49.6	43.7	35.7	30.4
92S	78.8	74.2	69.4	65.5	63.0	55.3
93S	35.6	29.5	22.4	20.4	17.1	14.6
94S	69.8	62.6	54.0	50.3	41.1	33.9
95S	60.7	53.9	44.3	38.5	31.2	23.8
93K	37.1	30.2	23.0	20.7	17.5	15.3
94K	75.7	69.2	60.4	53.8	43.4	35.6
95K	74.4	65.8	55.1	48.0	44.1	36.1

Table B7: Man-hours in educational group VA relative to total man-hours by industry. Selected years (per cent)

Industry	1972	1977	1982	1987	1992	1997
11	1.6	2.1	3.0	4.2	5.6	6.5
12	3.4	4.0	5.2	5.9	7.0	7.3
13	0.9	1.1	1.5	1.9	2.3	3.3
14	1.3	1.7	2.7	4.2	4.5	6.4
15	3.3	4.3	5.9	7.7	9.9	11.6
25	4.3	5.4	7.2	9.2	10.4	11.2
34	2.9	3.7	5.0	6.4	7.0	7.3
37	3.8	4.5	5.7	6.7	6.6	7.0
40	3.9	4.8	5.8	6.8	6.3	6.8
43	3.0	3.7	5.1	6.4	6.3	6.1
45	2.9	3.6	4.7	6.0	6.3	6.8
50	2.1	2.7	3.6	4.8	5.4	4.9
55	2.7	3.3	4.4	5.6	6.5	6.7
63	28.7	32.8	38.8	44.1	40.8	39.2
64	8.7	8.9	9.2	10.7	9.4	7.9
65	3.8	4.6	5.2	3.7	2.2	2.6
71	2.5	3.1	3.9	4.8	5.0	5.1
74	5.2	6.6	9.0	11.9	12.6	14.3
81	6.8	8.5	11.4	14.4	17.6	19.6
83	11.7	12.5	13.6	14.8	14.5	15.0
85	5.4	6.8	9.0	11.7	12.3	13.2
92S	5.6	5.8	6.1	7.6	6.6	7.8
93S	3.3	3.6	4.1	5.0	5.2	5.4
94S	3.8	4.6	5.9	7.1	7.8	8.9
95S	11.4	13.2	15.9	18.7	16.6	15.3
93K	3.3	3.6	4.2	5.1	5.3	5.6
94K	3.3	4.3	5.7	7.1	7.8	8.9
95K	4.2	5.2	6.7	8.1	9.5	9.6

Table B8: Man-hours in educational group VF relative to total man-hours by industry. Selected years (per cent)

Industry	1972	1977	1982	1987	1992	1997
11	4.6	9.4	18.6	23.0	27.4	31.6
12	5.3	10.9	20.0	24.6	30.3	34.9
13	2.3	4.9	9.6	11.7	14.0	19.2
14	2.7	4.9	10.8	16.9	20.2	27.5
15	3.3	5.9	10.2	13.4	18.0	23.5
25	4.0	7.9	13.9	16.9	21.3	26.6
34	3.3	6.7	12.5	16.5	24.1	30.6
37	6.7	13.0	21.6	26.4	33.7	37.6
40	6.6	12.7	21.4	26.2	34.1	38.1
43	4.1	8.6	15.6	19.5	29.4	41.2
45	5.4	10.8	18.5	22.5	28.3	36.9
50	6.0	12.3	21.8	27.6	38.0	43.7
55	5.8	11.9	20.7	26.7	36.0	43.8
63	1.7	2.6	3.6	4.0	5.4	4.7
64	6.2	10.9	16.8	18.0	22.9	27.2
65	5.3	10.7	16.1	10.6	7.8	9.9
71	10.8	20.2	31.9	37.2	45.3	47.5
74	3.9	7.5	12.8	15.4	17.7	20.7
81	3.2	5.8	9.7	12.1	14.7	18.6
83	3.6	6.8	10.6	11.8	14.3	15.9
85	5.4	8.1	11.7	14.1	17.4	19.7
92S	5.9	10.3	14.7	16.2	14.6	15.3
93S	2.6	3.8	5.1	5.3	6.1	6.3
94S	3.8	5.3	7.3	9.0	14.2	17.7
95S	3.0	5.2	8.1	9.2	10.0	8.9
93K	2.6	3.7	5.0	5.3	5.9	6.1
94K	4.2	4.9	6.2	8.6	14.0	17.8
95K	4.6	8.4	13.2	16.0	20.1	23.2

Table B9: Man-hours in educational group HO relative to total man-hours by industry. Selected years (per cent)

Industry	1972	1977	1982	1987	1992	1997
11	1.2	1.4	2.0	2.1	3.1	4.4
12	0.9	1.2	1.6	1.9	2.8	4.9
13	1.0	1.4	1.9	2.5	3.1	4.3
14	0.7	1.7	3.0	5.2	5.5	6.9
15	1.9	2.4	3.3	3.8	4.8	6.2
25	4.0	5.2	7.0	8.2	10.2	12.4
34	3.2	4.1	5.6	7.0	7.5	8.5
37	9.2	11.2	13.8	14.9	15.3	16.8
40	9.4	11.4	13.9	15.0	15.1	16.6
43	3.8	4.8	6.4	7.8	8.4	8.5
45	6.2	7.7	9.8	10.7	11.4	12.2
50	4.3	5.5	7.1	8.3	9.3	9.0
55	3.4	4.3	5.5	6.2	6.5	6.6
63	13.2	15.4	17.6	18.8	22.6	29.3
64	20.3	23.2	25.3	26.2	25.8	24.9
65	13.0	16.2	17.9	11.7	9.6	12.7
71	9.0	10.2	11.7	12.9	13.8	17.1
74	4.4	5.8	7.3	7.9	9.6	12.4
81	4.3	5.5	7.3	8.4	10.5	12.7
83	24.8	27.8	30.8	32.4	33.9	33.9
85	14.7	17.4	20.0	20.7	23.8	25.8
92S	5.8	6.1	6.4	7.1	10.4	13.3
93S	40.5	45.7	51.1	53.0	54.6	56.1
94S	13.9	17.8	22.8	25.0	29.4	32.3
95S	13.2	15.7	18.8	20.1	28.5	35.2
93K	40.2	45.6	51.1	53.0	54.8	56.5
94K	13.0	17.4	23.2	25.4	30.0	32.8
95K	11.8	15.0	18.9	21.3	20.4	23.7

Table B10: Man-hours in educational group UN relative to total man-hours by industry. Selected years (per cent)

Industry	1972	1977	1982	1987	1992	1997
11	0.4	0.5	0.6	0.8	0.9	1.1
12	1.3	1.4	1.6	1.7	1.3	1.8
13	0.4	0.4	0.5	0.6	0.5	0.6
14	0.7	0.5	0.9	1.5	1.2	1.2
15	0.5	0.6	0.8	0.9	1.0	1.3
25	1.0	1.1	1.4	1.5	1.9	2.4
34	1.2	1.4	1.8	2.1	2.1	2.6
37	5.5	6.0	6.6	6.7	6.6	8.0
40	5.5	5.9	6.6	6.7	6.6	8.0
43	1.7	1.9	2.3	2.8	2.9	3.4
45	1.9	2.1	2.5	2.5	2.9	3.4
50	0.7	0.8	0.9	1.2	1.7	1.3
55	0.9	1.1	1.2	1.3	1.4	1.5
63	3.2	3.3	3.3	3.3	3.6	5.0
64	12.7	14.5	15.0	15.1	15.3	17.1
65	1.3	1.5	1.5	0.9	0.5	1.4
71	3.8	3.9	4.0	4.9	4.6	5.6
74	0.8	0.9	1.0	1.0	1.1	1.7
81	0.8	0.9	1.1	1.3	1.5	1.6
83	15.7	16.2	16.4	16.3	15.9	15.7
85	9.0	9.4	9.8	9.8	10.7	10.9
92S	3.8	3.6	3.4	3.6	5.4	8.3
93S	18.0	17.4	17.3	16.3	17.0	17.5
94S	8.7	9.8	10.1	8.6	7.5	7.2
95S	11.6	12.1	12.9	13.5	13.7	16.9
93K	16.8	16.9	16.7	16.0	16.5	16.5
94K	3.8	4.2	4.5	5.2	4.9	4.9
95K	5.1	5.7	6.1	6.6	5.9	7.4

Appendix C: Partial simulation using the factor demand system only

Table C1: Effects on unskilled and skilled labour when assuming no change in exogenous variables apart from changes in the wage rates (relative to a reference simulation). Deviations in per cent

	Industry							
	11		15		25		34	
Year	LUS[a]	LSK[b]	LUS	LSK	LUS	LSK	LUS	LSK
1997	0.3	-3.4	0.6	-6.0	0.4	-2.5	0.5	-3.8
1998	0.6	-6.9	1.1	-10.9	1.1	-6.0	0.9	-6.2
1999	1.0	-10.4	1.7	-14.9	1.9	-9.9	1.5	-10.0
2000	1.4	-14.0	2.2	-18.2	2.8	-13.4	2.0	-13.2
2001	1.8	-17.6	2.8	-21.9	3.7	-16.9	2.6	-15.9
2002	2.3	-20.9	3.2	-23.6	4.6	-19.6	3.1	-18.2
2003	2.8	-24.0	3.7	-25.9	5.5	-22.0	3.7	-20.7
2004	3.2	-26.8	4.2	-28.5	6.3	-24.1	4.3	-23.3
2005	3.7	-29.5	4.9	-31.1	7.2	-26.3	5.0	-25.7
2006	4.2	-32.0	5.6	-33.8	8.1	-28.3	5.7	-28.0
2007	4.8	-34.5	6.3	-36.4	9.0	-30.3	6.4	-30.2
2008	5.3	-36.9	7.1	-38.9	10.0	-32.1	7.2	-32.3
2009	6.0	-39.4	7.9	-41.4	10.9	-33.9	8.0	-34.3
2010	6.6	-41.8	8.8	-43.8	12.0	-35.6	8.8	-36.3
2011	7.4	-44.2	9.7	-45.8	13.1	-37.4	9.6	-38.1
2012	8.2	-46.5	10.6	-47.7	14.2	-39.1	10.4	-39.8
2013	9.1	-48.8	11.6	-49.6	15.4	-40.7	11.3	-41.4
2014	10.0	-51.0	12.6	-51.4	16.6	-42.3	12.2	-42.9
2015	11.0	-53.1	13.7	-53.2	17.9	-43.8	13.1	-44.4
2016	12.1	-55.1	14.8	-54.8	19.2	-45.2	14.1	-45.9
2017	13.2	-57.0	15.9	-56.4	20.6	-46.5	15.0	-47.2
2018	14.3	-58.7	17.1	-57.9	22.0	-47.9	16.0	-48.5
2019	15.5	-60.4	18.4	-59.3	23.5	-49.2	17.1	-49.7
2020	16.7	-61.9	19.7	-60.6	25.0	-50.4	18.1	-50.9

[a] Unskilled labour (man-hours).
[b] Skilled labour (man-hours).

Table C1 (cont.). Effects on unskilled and skilled labour when assuming no change in exogenous variables apart from changes in the wage rates (relative to a reference simulation). Deviations in per cent

	Industry							
	37		43		45		50	
Year	LUS[a]	LSK[b]	LUS	LSK	LUS	LSK	LUS	LSK
1997	0.9	-3.1	4.3	-3.7	4.4	-3.9	-0.5	4.0
1998	1.0	-3.1	10.3	-8.0	10.8	-8.4	-0.5	3.6
1999	1.1	-3.2	16.5	-11.5	20.1	-13.6	0.1	-0.9
2000	1.2	-3.3	24.8	-15.4	26.6	-16.3	0.8	-6.0
2001	2.4	-6.9	27.2	-16.2	33.0	-18.5	1.3	-8.7
2002	3.3	-8.9	33.1	-18.3	35.8	-19.3	1.6	-10.2
2003	3.9	-10.1	39.0	-20.1	37.5	-19.7	2.4	-14.5
2004	4.6	-11.4	45.5	-21.9	40.1	-20.4	3.4	-18.8
2005	5.5	-13.2	52.6	-23.5	43.9	-21.4	4.3	-22.1
2006	6.5	-15.1	60.7	-25.1	48.5	-22.5	5.1	-24.6
2007	7.6	-16.8	69.4	-26.6	53.6	-23.7	5.8	-26.7
2008	8.7	-18.5	79.1	-28.0	59.4	-24.9	6.5	-28.6
2009	9.9	-20.2	89.7	-29.4	65.8	-26.1	7.1	-30.2
2010	11.3	-21.9	101.5	-30.6	73.1	-27.3	8.0	-32.3
2011	12.5	-23.5	114.8	-31.8	80.9	-28.4	9.0	-34.9
2012	13.8	-24.8	129.4	-33.0	88.8	-29.4	9.6	-35.8
2013	15.1	-26.1	145.3	-34.0	97.0	-30.3	10.2	-37.0
2014	16.4	-27.4	162.8	-35.0	106.2	-31.3	11.1	-38.8
2015	17.8	-28.7	181.8	-35.8	116.1	-32.2	12.3	-40.9
2016	19.3	-30.0	202.2	-36.6	126.6	-33.0	12.6	-41.1
2017	20.8	-31.2	224.7	-37.3	138.5	-33.9	13.5	-42.7
2018	22.4	-32.4	249.5	-38.0	150.8	-34.6	15.4	-45.8
2019	24.0	-33.5	276.2	-38.6	162.6	-35.3	16.7	-47.4
2020	25.7	-34.7	305.2	-39.2	174.9	-35.9	17.7	-48.5

[a] Unskilled labour (man-hours).
[b] Skilled labour (man-hours).

Table C1 (cont.). Effects on unskilled and skilled labour when assuming no change in exogenous variables apart from changes in the wage rates (relative to a reference simulation). Deviations in per cent.						
	Industry					
	63		81		85	
Year	LUS[a]	LSK[b]	LUS	LSK	LUS	LSK
1997	1.7	-3.4	1.8	-3.6	1.9	-1.5
1998	2.5	-4.8	3.8	-7.1	3.0	-2.3
1999	3.0	-5.4	5.9	-10.3	1.0	-0.8
2000	2.9	-5.2	8.0	-13.2	1.1	-0.9
2001	3.0	-5.4	10.1	-15.9	2.4	-1.9
2002	3.4	-6.0	12.3	-18.3	5.6	-4.1
2003	4.5	-7.8	14.5	-20.5	8.9	-6.2
2004	6.3	-10.5	16.8	-22.6	12.9	-8.5
2005	8.3	-13.2	19.3	-24.7	17.6	-10.9
2006	10.3	-15.6	22.0	-26.7	22.8	-13.1
2007	12.1	-17.5	25.0	-28.8	28.4	-15.2
2008	13.6	-19.0	28.2	-30.7	34.0	-17.1
2009	15.1	-20.3	31.6	-32.6	39.9	-18.8
2010	16.6	-21.7	35.2	-34.3	46.0	-20.3
2011	18.4	-23.2	38.9	-35.9	52.6	-21.8
2012	20.3	-24.6	42.6	-37.4	60.0	-23.2
2013	22.2	-26.0	46.5	-38.8	67.8	-24.5
2014	24.4	-27.5	50.4	-40.0	76.1	-25.8
2015	26.6	-28.8	54.5	-41.3	85.3	-27.0
2016	28.8	-30.1	58.9	-42.4	95.1	-28.1
2017	31.2	-31.3	63.5	-43.5	105.3	-29.1
2018	33.7	-32.6	68.4	-44.6	116.6	-30.1
2019	36.2	-33.8	73.6	-45.7	129.2	-31.1
2020	38.8	-34.8	79.1	-46.7	142.3	-31.9

[a] Unskilled labour (man-hours).
[b] Skilled labour (man-hours).

Appendix D: The estimated wage equations

For the manufacturing sector we have estimated education-specific wage-equations in error-correction form similar to the following:

$$\text{(D1)} \quad \begin{aligned} \Delta wc_{mit} &= \gamma_{0i} - \gamma_{1i}(wc_{mi} - q_m - pr_m)_{t-1} - \gamma_{2i}u_{t-1} - \gamma_{3i}u_{it-1} + \gamma_{4i}\Delta q_{mt} \\ &+ \gamma_{5i}\Delta pr_{mt} + \gamma_{6i}\Delta pc_t - \gamma_{7i}\Delta u_t - \gamma_{8i}\Delta u_{it} + \gamma_{9i}z_{it} + \varepsilon_{it}, \end{aligned}$$

where wc_m is hourly wage cost, q_m is the producer price index, and pr_m is labour productivity in Norwegian manufacturing. u is the nationwide rate of unemployment and pc the consumer price index. All these variables are measured on logarithmic scale. Finally, z is a vector of other explanatory variables, e.g. dummies for incomes policies and education-specific supply-side dummies, ε_t is an error term, and the γ's are non-negative parameters. The subscripts i and t indexes educational group and time respectively. Note that u is the average unemployment rate and u_i are the education-specific unemployment rates.

If $\gamma_{1i} > 0$, steady state equations for the product shares are:

$$\text{(D2)} \quad wc_{mi} - q_m - pr_m = \mu_i - \gamma_{ui}u_i - \gamma_i u + \gamma_{zi}z_i$$

where $\mu_i = (\gamma_{0i} + (\gamma_{5i} - 1)\tau + (\gamma_{4i} + \gamma_{6i} - 1)\Delta pi)/\gamma_{1i}$, $\gamma_{ui} = \gamma_{3i}/\gamma_{1i}$, $\gamma_i = \gamma_{2i}/\gamma_{1i}$ and $\gamma_{zi} = \gamma_{9i}/\gamma_{1i}$. Steady state is defined as constant product shares for given unemployment rates and z_i's, constant productivity growth rate, τ, and growth rates in producer and consumer prices in accordance with the international rate of inflation Δpi.

Wages in public and private services are also modelled in equilibrium correction form. The long-run part of these wage-equations are given by

$$\text{(D3)} \quad w_{pi} = \beta_i + wa_{pi} + \beta_{ui}u_i + \beta_i u,$$

and

$$\text{(D4)} \quad w_{si} = \lambda_i + wa_{si} + \lambda_{ui}u_i + \lambda_i u,$$

respectively. w is the nominal wage level and wa is the alternative wage. The alternative wage is calculated as the wage level in the other sectors weighed by their representative employment shares. The subscripts p and s denotes public services and private services respectively.

By estimating the wage equations wage flexibility may be identified in the following way:

- If $\gamma_{ui}, \beta_{ui}, \lambda_{ui} = 0, \forall i,$ wages do not adjust to skill mismatch.
- If $\gamma_{ui}, \beta_{ui}, \lambda_{ui} > 0, \forall i,$ wages adjust to skill mismatch.
- If only some of $\gamma_{ui}, \beta_{ui}, \lambda_{ui} > 0,$ wages may adjust to skill mismatch, though slower than in the case above.

The detailed estimation results are given in Table D1.

Table D1: Wage equations by education groups, 1974-1997. Standard error in parentheses.

i =	Primary ed.	Secondary ed.	Vocational ed.	Lower un. ed.	Higher un. ed.
$\Delta wc_{mit} =$ [a]					
Constant	1.61 (0.12)	1.66 (0.12)	1.63 (0.12)	1.69 (0.13)	1.78 (0.13)
$(wc_{mi} - q_m - pr_m)_{t-1}$	−0.23 (0.018)	−0.23 (−)	−0.23 (−)	−0.23 (−)	−0.23 (−)
u_{t-1}	−0.042 (0.0027)	−0.042 (−)	−0.042 (−)	−0.042 (−)	−0.042 (−)
u_{it-1}	−0.0038 (0.0026)	−0.0074 (0.0026)	0	0	−0.0092 (0.0043)
Δq_{mt}	0	0	0	0	0
Δpr_{mt}	0	0	0	0	0
Δpc_{t-1}	0.34 (0.053)	0.34 (−)	0.34 (−)	0.34 (−)	0.34 (−)
Δu_t	−0.016 (0.0048)	−0.016 (−)	−0.016 (−)	−0.016 (−)	−0.016 (−)
Δu_{it}	0	0	0	0	−0.0083 (0.0039)
Δwc_{mit-1}	0.20 (0.027)	0.20 (−)	0.20 (−)	0.20 (−)	0.20 (−)
STEP88	-	-	-	-	−0.018 (0.0059)
$w_{mit-1} - w_{pit-2}$	-	-	-	-	−0.095 (0.025)
$\Delta w_{pit} =$ [b]					
Constant	0.017 (0.016)	0.019 (0.015)	0.012 (0.013)	0.004 (0.018)	0.009 (0.017)
$(w_{pi} - wa_{pi})_{t-1}$	−0.11 (0.030)	−0.11 (−)	−0.11 (−)	−0.11 (−)	−0.11 (−)
u_{t-1}	−0.018 (0.0058)	−0.018 (−)	−0.018 (−)	−0.018 (−)	−0.018 (−)
u_{it-1}	0	0	0.015 (0.0041)	0	0
Δu_{it}	0	0	0	0	0.027 (0.0048)
Δwa_{it}	0.51 (0.055)	0.51 (−)	0.51 (−)	0.51 (−)	0.51 (−)
Δpc_t	0.27 (0.10)	0.27 (−)	0.27 (−)	0.27 (−)	0.27 (−)
$\Delta w_{sit} =$ [c]					
Constant	−0.004 (0.008)	−0.006 (0.008)	0.005 (0.009)	0.015 (0.009)	0.012 (0.008)
$(w_{si} - wa_{si})_{t-1}$	−0.10 (0.030)	−0.10 (−)	−0.10 (−)	−0.10 (−)	−0.10 (−)
u_{t-1}	0.012 (0.0047)	0.012 (−)	0.012 (−)	0.012 (−)	0.012 (−)
u_{it-1}	0	0	−0.012 (0.0045)	0	0
Δu_{it}	0	0	−0.021 (0.0084)	−0.027 (0.0084)	−0.010 (0.0038)
Δwa_{it}	0.76 (0.059)	0.76 (−)	0.76 (−)	0.76 (−)	0.76 (−)
Δw_{sit-1}	0.27 (0.063)	0.27 (−)	0.27 (−)	0.27 (−)	0.27 (−)
$\Delta^2 pc_t$	0.27 (0.083)	0.27 (−)	0.27 (−)	0.27 (−)	0.27 (−)

[a] In addition there are dummies for income policies, changes in pay-roll taxes, changes in working hours and for extreme observations.
[b] In addition there are dummies for income policies and for extreme observations.
[c] In addition there is a dummy for income policies.

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