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# The Effect of Skill Mismatch on Wages in a small open Economy with Centralized Wage Setting: The Norwegian Case

**Abstract:**
Pervasive skill-biased technological changes, probably from trade in computer technology, have visualized the pros and cons of wage setting centralization in small open economies. Skill mismatch has increased in countries with wage rigidity. As a small open economy with centralized wage setting, Norway is a particularly interesting case. Indeed, this analysis shows that skill\mismatch has increased and is long-lived because of low focus on skill-specific imbalances in wage settlements. The conclusions are drawn on the basis of an econometric analysis of the determinants of wages to workers in five educational categories in Norwegian manufacturing. Furthermore, I estimate a 15 per cent drop in equilibrium wages to workers with higher university education after 1987, a period of recentralization of collective bargaining.

**Keywords:** Skill mismatch, wage flexibility, centralized wage setting, wage curve.

**JEL classification:** E24, E64, J31.

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# 1 Introduction[1]

Trade in computer technology seems to be the link between common patterns of skill-upgrading across countries as new technologies and skilled workers are found to be complementary factors[2]. With that the centralized wage setting system in small open economies is challenged. As Krugman (1994) points out, *wage flexibility* is essential to prevent *skill mismatch*[3]. Indeed, one leading theory for the decentralization in collective bargaining since of the early 1980s in a number of countries is the widespread adoption of new production technologies[4]. The correlation matrix in table 1 shows the correlations between population size, wage setting centralization, openness in trade, high-technology export and import ratios, and earnings dispersion across 16 OECD countries. The main picture is quite clear, the larger the country, the more decentralized wage setting, the smaller dependence on foreign product markets, and the smaller high-technology export and import ratios. Furthermore, we see that centralization in wage setting is negatively correlated with wage inequality, especially in the bottom[5]. Hence, small open economies seem to be more exposed to skill-biased technological changes from the revolution in high-technology and may experience skill mismatch due to rigidity in relative wages.

To pursue this hypothesis further I have turned to the Norwegian case. Norway is a small open economy with centralized wage setting and score high on technology indicators. From table 1 we see that Norway has an average import and export ratio of 37.5% compared to 12.2% for the US. Furthermore, both the high-technology export and import ratios are very high in Norway, 50% and 76% respectively, these are considerably lower in the US, 29% and 33% respectively[6]. 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. At the same time, earnings dispersion has shown great stability and even declined in the bottom (OECD (1996, Table 3.1.)). Freeman (1996) and Kahn (1998) focus on the high degree of wage setting centralization to explain the stabil-

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[2]It is well documented that unskilled workers have worsened their labour market position during the last decades in the developed world (see e.g. Freeman and Katz (1994), Katz and Revenga (1989), Katz et al. (1995), Davis (1992), Machin (1996a), Nickell and Bell (1995) and Manacorda and Petrongolo (1999)). Cross-country evidence of within-industry demand shifts that are associated with effectively utilizing computer technology are interpreted as pervasive skill-biased technological changes (see Berman et al. (1998) and Freeman and Katz (1994). See also Salvanes and Førre (1999) for Norway, Machin (1996b) for the UK, and Autor et al. (1998), Bartel and Lichtenberg (1987), Dunne et al. (1996), Doms et al. (1997), Levy and Munane (1996) and Berman et al. (1994) for the US).

[3]In the literature, any imbalances between demand and supply of skills are referred to as *skill mismatch.*

[4]See Katz (1993) and Golden and Wallerstein (1995).

[5]Similar results are also documented in Blau and Kahn (1996).

[6]In addition, Norway has one of the highest mobile cellular and personal computer penetrations in the world (OECD (1999, Table 2.4.1. and 2.5.1.)).

Table 1: Coherences acorss OECD countries.

| | Correlations for 16 OECD countries[1] | | | | | | | Norway | US |
|---|---|---|---|---|---|---|---|---|---|
| Size[2] | 1.00 | | | | | | | 4.4 mill. | 268 mill. |
| Centralization[3] | -0.59 | 1.00 | | | | | | 9 | 3 |
| Openness[4] | -0.67 | 0.47 | 1.00 | | | | | 37.5% | 12.2% |
| Technology export[5] | -0.41 | 0.43 | 0.75 | 1.00 | | | | 50% | 29% |
| Technology import[6] | -0.60 | 0.31 | 0.78 | 0.85 | 1.00 | | | 76% | 33% |
| Top earnings dispersion[7] | -0.25 | -0.21 | -0.06 | -0.43 | -0.32 | 1.00 | | 1.50 | 2.03 |
| Bottom earnings dispersion[8] | 0.33 | -0.86 | -0.10 | -0.53 | -0.52 | 0.45 | 1.00 | 1.32 | 2.05 |

1. Denmark, France, Germany, Italy, Netherlands, Portugal, Spain, UK, Australia, New Zealand, Canada, US, Japan, Finland, Norway, Sweden. Not Spain in correlations concerning earnings dispersion.

2. Population size. Source: UN, Population Information Network.

3. Wage bargaining centralization and coordination: Worker coverage + union coordination + employer coordination (for each: 1 = low, 2 = middle, 3 = high). Source: Layard et al. (1991, Table 6).

4. Average of imports and exports as a percentage of nominal GDP in 1997. Source: OECD (1999, Table 7.1.1.).

5. High-technology export as a percentage of production in 1996. Source: OECD (1999, Table 7.3.1.).

6. High-technology import as a percentage of domestic demand (estimated as production plus imports minus exports) in 1996. Source OECD (1999, Table 7.3.2.).

7. 9th decile relative to 5th decile in 1991 (1990 for Denmark and New Zealand, and 1993 for the US). Source OECD (1996, Table 3.1.).

8. 5th decile relative to 1th decile in 1991 (1990 for Denmark and New Zealand, and 1993 for the US). Source OECD (1996, Table 3.1.).

ity in wage inequality in Norway. This suggests that the Norwegian labour market has experienced mismatch problems. On the other hand, Hægeland et al. (1999) estimate a clear rise in education premiums when controlling for self-selection into higher education. Thus, the imbalance between demand and supply of skills may have been kept at a relatively steady level. However, Nickell and Bell (1995) show that there has been a clear rise in the unemployment rate among workers with low education relative to workers with high education, skill mismatch has increased.

In this article I look at the Norwegian unemployment rates in even more detail and find that workers with primary education and workers with secondary education lost ground relatively and absolutely to vocational and university educated workers, respectively. Furthermore, I argue that skill mismatch has endured as a consequence of low focus on skill-specific imbalances in wage settlements. This conclusion is drawn on the basis of an econometric analysis of the determinants of wages to workers in five educational categories in Norwegian manufacturing. However, centralized wage bargaining plays a role for macroeconomic performance as I estimate a real wage elasticity with respect to average unemployment of -0.19. Finally, after 1987, a period Kahn (1998) refers to as a period of recentralization of collective bargaining, I estimate a 15% drop in the equilibrium wage level to workers with higher university education relative to other groups.

Next, in section 2.1, a simple Cobb-Douglas economy is set up to see that the effect on skill mismatch of a skill-biased demand shock depends on wage flexibility. Section 2.2 presents the data on skill mismatch and wages that are used in section 3 to estimate wage flexibility in Norwegian manufacturing. Conclusions and final remarks are given in section 4.

## 2 Skill mismatch and wages

In this section I first present a model for studying the implications of a skill biased demand shock for skill mismatch and wage inequality. We will see that the effect on absolute unemployment differences are larger the less flexibility there is in wage setting. Then, in section 2.2, I look at the evolution of skill mismatch and relative wages in Norway. We will see that there have been skill-biased structural changes in employment and increased skill mismatch. However, there have been relatively small changes in wage inequality.

### 2.1 Theory

Consider an economy that produces one single good, $Y$, using labour, $N$. A Cobb-Douglas production function defines the production technology[7];

$$Y = \varphi \prod_{i=1}^{n} N_i^{\alpha_i}, \quad i = \{1, ..., n\}, \tag{1}$$

where $\varphi$ is the aggregate state of technology. The subscript $i$ indexes skill and there are $n$ skill groups. $\alpha_i$ are the technology known by labour in skill group $i$. The $\alpha$'s add up to unity, hence, there are constant returns to scale. Under perfect competition in the goods market profit maximization implies that the labour demand equations are (product prices are set to unity):

$$(1 - \alpha_i) \ln (N_i) = \sum_{j \neq i} \alpha_j \ln (N_j) - \ln (WC_i) + \ln(\ \alpha_i) + \ln(\varphi), \tag{2}$$

where $WC_i$ are skill-specific wage costs per unit labour. The $\alpha$'s are the respective product shares and can be thought of as relative demand indicators. Hence, skill-biased technological changes shift the $\alpha$'s. By subtracting (2) for type $u$ labour (unskilled) from (2) for type $s$ labour (skilled), we get the relative labour demand between type $s$ labour and type $u$ labour:

$$\ln \left( \frac{N_s}{N_u} \right) = \ln \left( \frac{WC_u}{WC_s} \right) + \ln(\ \frac{\alpha_s}{\alpha_u}). \tag{3}$$

For given skill-specific labour supply, $L_i$, labour demand determine the skill-specific unemployment rates, $U_i = (L_i - N_i)/L_i$. Hence, (3) can be rearranged:

$$U_u - U_s = \ln \left( \frac{WC_u}{WC_s} \right) + \ln(\ \frac{\alpha_s}{\alpha_u}) - \ln(\frac{l_s}{l_u}), \tag{4}$$

where $l_i = L_i/L$ are skill-specific labour force shares ($L$ is total labour supply), and where I have used the property $\ln(1 - U_i) \approx -U_i$ when $U_i$ are small. Since $\alpha_i/l_i$ are

[7] A Cobb-Douglas production function assumes that the elasticity of substitution between skill-groups is unity. Usually this elasticity is found to exceed unity (see e.g. Hamermesh (1986)), while Manacorda and Petrongolo (1999), for example, find that the substitution elasticity between skilled and unskilled labour is insignificantly different from unity for 6 OECD countries. Furthermore, Manacorda and Petrongolo (1999) show that the Cobb-Douglas assumptions does not change the results qualitatively.

net relative demand indicators, unemployment differences depend on net relative demand and relative wages.

Next, I turn to wage setting. I follow a well established literature where the wage function is represented by a *wage curve* (see e.g. Layard et al. (1991, Chapter 6) and Blancflower and Oswald (1994, Chapter 3)):

$$WC_i = \beta_i U_i^{-\gamma_i} U^{-\gamma}, \qquad \gamma_1 \geq 0,\ \gamma \geq 0, \tag{5}$$

where, as before $U_i$, are the skill-specific unemployment rates, while $U$ is the average unemployment rate. $\beta_i$ represent (constant) group-specific wage pressure factors. While the wage curve representation encompasses several theories on wage setting[8], 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. $\gamma_i$ represents wage flexibility, and $\gamma$ is the degree of centralization and coordination in wage setting. Formally, $\gamma_i$ and $\gamma$ represent real wage elasticities with respect to own-group and average unemployment respectively.

Substituting (5) into (4) and differentiating give:

$$d\left(U_u - U_s\right) + \gamma_u\ d\ln(U_u) - \gamma_s\ d\ln(U_s) = d\ln\left(\frac{\alpha_s}{\alpha_u}\right) - d\ln\left(\frac{l_s}{l_u}\right). \tag{6}$$

Demand shifts, when the skill structure of the labour force, $l_s/l_u$, is fixed, increase skill mismatch. The effect on absolute unemployment differences are larger the less flexible wages are, i.e. the smaller $\gamma_u$ and $\gamma_s$. In the long run the labour force structure is endogenous, and skill upgrading will eventually balance the labour market.

## 2.2 Skill mismatch and wages in Norway

As most industrialized countries Norway has experienced both changes in labour demand towards more skilled workers and skill upgrading. However, in this section we will see that net demand has been skill-biased. Unemployment among workers with primary education and secondary education have risen relatively and absolutely to unemployment among vocational and lower university educated workers, respectively. At the same time relative wages in Norwegian manufacturing have been stable.

Skill is unobservable, therefore the educational attainment is used as an indicator of skill. Other indicators are even more inaccurate, for example is occupation often unclassifiable. I have data on hourly wages in Norwegian manufacturing, and national employment and unemployment rates for five educational categories:

1. Primary education, which is less than 11 years of education.
2. Secondary education, which is 11–12 years of education.
3. Vocational education, which is education from a vocational school (also 11–12 years of education).

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

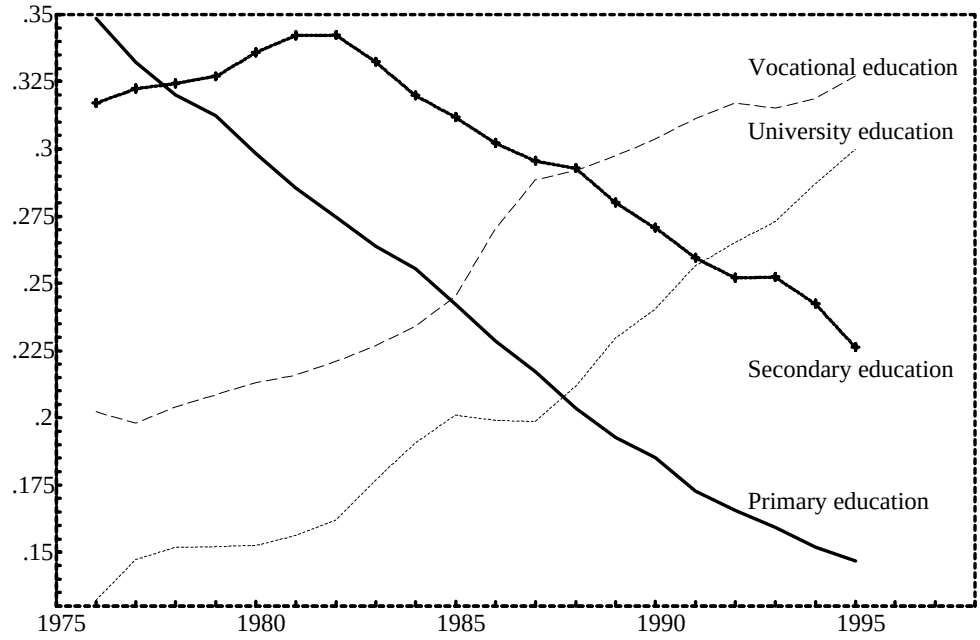


Figure 1: Number of employed persons by education as shares of total employment in Norway. *Source: Statistics Norway.*

4. Lower university education, engineering etc., which is 13–16 years of education.

5. Higher university education, which is more than 17 years of education.

Figure 1 shows employment shares by education at a national level for the period 1976–95[9]. While the share of workers with either primary or secondary education have fallen substantially over the period, the share of workers with either vocational or university education have a similar increase. Hence, there have been structural changes altering labour demand towards more skilled workers during the last decades. There is no clear-cut answer to which workers have replaced who. However, if labour supply follows labour demand the answer might lie within the change in education spells. A reasonable explanation for the observed increase in education spells is that formal education has replaced work experience. Consequently, demand has changed from workers with primary education to workers with vocational education, and from workers with secondary education to workers with university education.

Most researchers look for changes in either relative or absolute unemployment rates to identify mismatch problems, see e.g. Layard et al. (1991, Chapter 6), Manacorda and Petrongolo (1999) and Nickell and Bell (1995)[10]. For Norway, Nickell

[9] In figure 1, workers with university education includes both workers with lower and higher university education.

[10] Which mismatch-measure is better is not clear. While Manacorda and Petrongolo (1999) demonstrate how SBTC may cause changes in absolute differences, Layard et al. (1991, Chapter 6) show that mismatch measured as relative unemployment rates encompass mismatch measured as absolute differences.

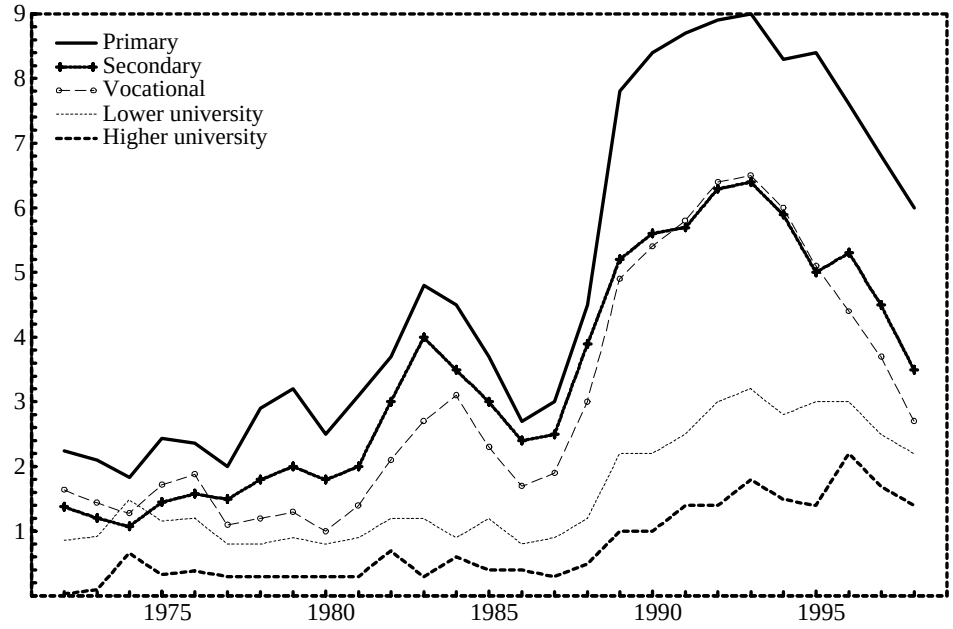


Figure 2: Education-specific unemployment percentages in Norway. *Source: Statistics Norway.*

and Bell (1995) reports a clear rise in the relative unemployment rate among low educated workers in the late 1970s and early 1980s. On the other hand, Manacorda and Petrongolo (1999) find that Norway, with exception of the last recession, has no remarkable change in the absolute difference between skill-specific unemployment rates. However, workers with vocational education are classified as unskilled in their analysis. As we have seen from figure 1, demand has shifted towards these workers and probably substituted workers with even less education.

Figure 2 shows education-specific unemployment percentages. There are two clear recessions, the first in the early 1980s and the second, which is deeper, in the late 1980s and early 1990s. In figure 3 workers with primary education are compared to workers with vocational education, and workers with secondary education to workers with lower university education. The top diagram shows the ratio between education-specific unemployment percentages, while the bottom shows absolute differences. The ratio of the unemployment percentage among workers with primary education to workers with vocational education increased from about 1.4 in 1976 to 2.5 in 1980. At the same time average unemployment remained at a very low level. In 1984, 8 years later, the ratio was back at its 1976 level. It is also interesting to see that a similar increase has occurred after 1994, and it is not yet reversed. The ratio of the unemployment percentage among workers with secondary education to workers with lower university education increased in 1976 as well. However, this mismatch is more sluggish, in 1998, more than 20 years later, the ratio has not yet returned at its pre-1976 level. This ratio has risen from about 1 in the first half of the 1970s to 3.9 in 1984, and has fallen slowly to 1.6 in 1998.

The absolute differences in unemployment show a similar, but not identical, pattern. The main picture is clear; the differences between both groups increased

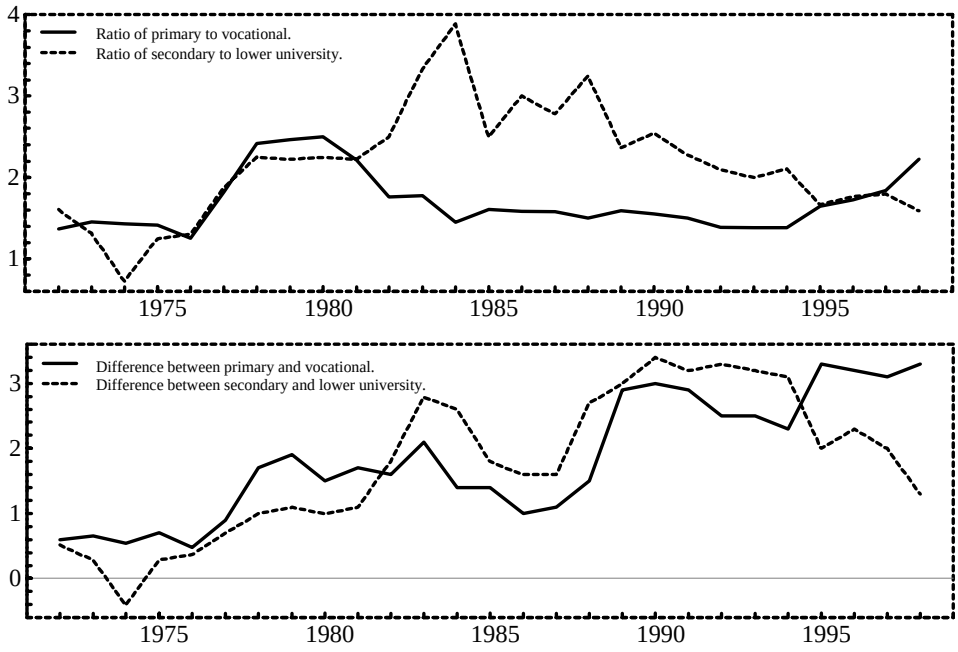


Figure 3: Ratios (top) and absolute differences (bottom) between education-specific unemployment percentages. *Source: Statistics Norway.*

Table 2: Correlations between unemployment percentages and participation rates by education in Norway 1977-1998. *Source: Statistics Norway.*

| Primary | Secondary | Vocational | Lower university | Higher university |
|---|---|---|---|---|
| -0.96 | -0.26 | 0.06 | -0.12 | -0.47 |

from about 0.5% in the first half of the 1970s to about 3% in the early 1990s. However, while the difference in unemployment between primary and vocational educated workers increased from 2.3% in 1994 to 3.3% in 1998, the difference between workers with secondary education and lower university education dropped from 3.1% to 1.3% during the same period.

Mismatch in the Norwegian labour market is probably higher than measured by unemployment because of the *discouraged worker* effect. During recessions less educated workers leave the labour market to a greater extent than others. Table 2 shows correlations between unemployment percentages and participation rates for the five educational groups. The correlation is -0.96 for workers with primary education, while it is -0.26 for workers with secondary education. For workers with vocational education or lower university education it is close to zero. Notice also that workers with higher university education has a relatively high negative correlation, -0.47. Hence, skill mismatch is likely to be underestimated when only considering education-specific unemployment, particularly between workers with vocational education and primary education. Nickell and Bell (1995) find similar results for the

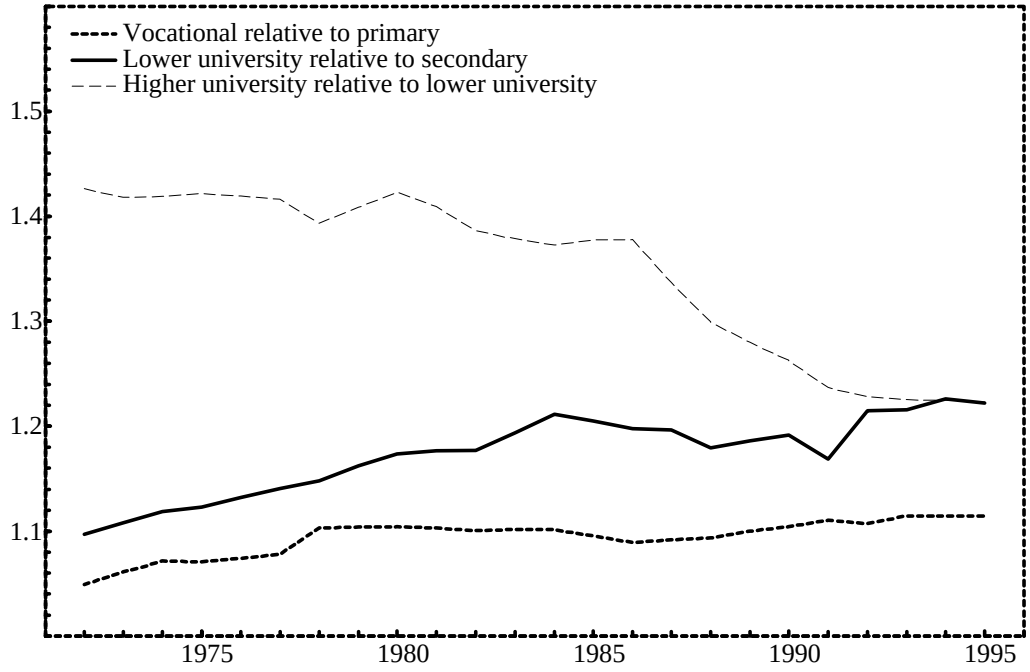


Figure 4: Relative hourly wages between educational groups in Norwegian manufacturing. *Source: Statistics Norway.*

UK and the US, the non-employment ratio between low and high educated workers follows the pattern of the unemployment ratio between the same groups, i.e. unskilled are leaving the labour force to a greater extent because of their inability to find work.

Turning now to Norwegian manufacturing, Figure 4 shows the development in relative hourly wages between the same educational groups between 1972 and 1995[11]. In light of the increased skill mismatch there are two striking features. First, relative to workers with lower university education, wages to workers with higher university education dropped from 138% in 1986 to 123% in 1992. Second, relative wages between the other groups have been stable. Workers with vocational education had on average only 111% of the hourly wage of workers with primary education in 1995, up one percent since 1978. Equivalently, relative to workers with secondary education, wages to workers with lower university education increased from 115% in 1978 to 122% in 1995.

To sum up, the Norwegian labour market has experienced mismatch problems during a period of structural changes in labour demand, skill mismatch has increased. In addition, workers with primary education are leaving the labour force to a greater extent when unable to find work. At the same time earnings dispersion in Norwegian manufacturing has been relatively stable. Although studied more formally in the next section, this gives a preconceived impression of little wage flexibility in Norwegian manufacturing.

[11] The data have a break in 1978.

## 3 Estimating wage flexibility in Norwegian manufacturing

Maintenance of international competitiveness is recognized as important in small open economies since the economic well being of the whole nation depends on fluctuating foreign product markets. The 'main-course' theory, also called the 'Scandinavian model of inflation', Aukrust (1977) and Lindbeck (1979), provided early attempts to formalize these mechanisms. Aukrust's 'main-course' theory says that long-run wages in a small open economy are determined by world market prices and productivity. In the more recent bargaining models wages are set in bargaining between unions and firms[12]. Thus, wages depend on both 'insider' factors, such as prices and productivity, and 'outsider' factors, such as outside wage and unemployment. The bargaining models, when unions are coordinated and wage setting is centralized, give a theoretical understanding to the 'main-course' theory, i.e. in the central wage bargaining in small open economies terms-of-trade variables, such as world market prices and productivity, and unemployment are all 'insider' factors.

I use observations on wages and unemployment rates for five educational groups over the time period 1972–95 to estimate long-run wage curves in Norwegian manufacturing[13]. However, short-run dynamics may affect the estimates on long-run relationships if not modeled properly. Therefore, my reference point is the stylized aggregated wage-equation in equilibrium correction form introduced by Sargan (1964). Because of its special feature to encompass both the outcome of the wage bargaining model and the 'main-course' theory, it has become specially popular as a description of wage setting in small open economies[14]. Its popularity has resulted in numerous modifications, for application to Norwegian manufacturing wages see Nymoen (1989), Johansen (1995) and Bjørnstad and Nymoen (1999). These studies indicate that the aggregated wage-equation for Norwegian manufacturing wages should be specified as

$$\begin{aligned}(7)\qquad \Delta wc_t &= \gamma_0 - \gamma_1(wc - q - pr)_{t-1} - \gamma_2 u_{t-1} + \gamma_3 \Delta q_t \\ &\quad +\gamma_4 \Delta pr_t + \gamma_5 \Delta pc_t - \gamma_6 \Delta u_t + \gamma_7 z_t + \varepsilon_t.\end{aligned}$$

$wc$ is hourly wage cost; $q$ the producer price index; $pr$ labour productivity; $u$ the rate of unemployment; $pc$ the consumer price index. These variables are measured in logarithmic scale. Finally, $z_t$ is a vector of other explanatory variables, e.g. dummies for incomes policies, $\varepsilon_t$ is an error term, and the $\gamma$'s are non-negative parameters. The subscript $t$ indexes time.

The aggregated wage-equation (7) assumes homogenous labour covered by one single union. Skill heterogeneity opens for more decentralized wage setting where also education-specific unemployment affect wages:

$$\begin{aligned}(8)\qquad \Delta wc_{it} &= \gamma_{0i} - \gamma_{1i}(wc_i - q - pr)_{t-1} - \gamma_{2i} u_{t-1} - \gamma_{8i} u_{it-1} + \gamma_{3i} \Delta q_t \\ &\quad +\gamma_{4i} \Delta pr_t + \gamma_{5i} \Delta pc_t - \gamma_{6i} \Delta u_t - \gamma_{9i} \Delta u_{it} + \gamma_{7i} z_{it} + \varepsilon_{it},\end{aligned}$$

[12] See Nickell and Andrews (1983), Nickell (1984), Hoel and Nymoen (1988), and Nickell and Wadhwani (1990)

[13] In addition, I use relevant aggregated variables and policy dummies.

[14] See Nickell and Andrews (1983), Nickell (1984), Hoel and Nymoen (1988), Nymoen (1989) and Johansen (1997).

where the subscript $i$ indexes educational group. Now, $z_i$ also contains education-specific supply-side dummies. The equilibrium correction form enables us to determine the long-run and short-run determinants of wages jointly. In the long run the 'main-course' variables, $pr$ and $q$, and the unemployment rates are the explanatory variables, while cost of living, $pc$, in addition to the dynamic effects of the long-run variables make up the short-run part of the model.

The zero restrictions $\gamma_{1i} = 0$ imply that (8) reduces to skill-specific Phillips-curves. If on the other hand, $\gamma_{1i} > 0$, steady state equations for the product shares are:

$$wc_i - q - pr = \mu_i - \gamma_{ui} u_i - \gamma_i u + \gamma_{zi} z_i, \tag{9}$$

where $\mu_i = (\gamma_{0i} + (\gamma_{4i} - 1)\tau + (\gamma_{3i} + \gamma_{5i} - 1)\Delta pi) / \gamma_{1i}$, $\gamma_{ui} = \gamma_{8i}/\gamma_{1i}$, $\gamma_i = \gamma_{2i}/\gamma_{1i}$ and $\gamma_{zi} = \gamma_{7i}/\gamma_{1i}$. Steady state is defined as constant product shares for given unemployment rates and $z_i$, constant productivity growth rate, $\tau$, and growth rates in producer and consumer prices in accordance with the international rate of inflation $\Delta pi$. Formally:

i. $(\Delta(wc_i - q - pr)_t \mid_{\Delta u = \Delta u_i = \Delta z_i = 0}) = 0$,

ii. $\Delta pr_t = \tau$,

iii. $\Delta q_t = \Delta pc_t = \Delta pi$.

Notice that demand shifts, such as skill-biased technological changes, affect wage inequality only through skill mismatch in the long run. 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, demand conditions do not. In steady state, the skill premium is equal to the cost of attaining that skill.

Variables in the long-run part of an error-correction model must either be $I(0)$ or cointegrate. This is testable, and table 3 reports the relevant Augmented Dickey-Fuller tests (ADF-tests). The null of $I(1)$ is neither rejected for the wage shares nor for the unemployment rates. The education-specific wage shares are cointegrated with own-group unemployment and average unemployment with cointegrating parameters $\gamma_{ui}$ and $\gamma_i$, if:

$$(wc_i - q - pr) + \gamma_{ui}\, u_i \; + \gamma_i\, u \; \sim I(0).$$

In table 3 $\widehat{\ }$ denotes that the parameters are estimated in a static regression model. The null of non-stationarity is rejected for all groups.

In equation (8) we ruled out that demand-side factors other than skill mismatch affect relative wages in the long run, and indeed, the results of the cointegration analysis support this assumption. It is evident from figure 1 that education-specific labour demand is non-stationary. Adding a non-stationary variable to the long-run solution would clearly make no sense since a non-stationary variable can not explain a stationary variable.

By estimating the $\gamma_{ui}$'s wage flexibility may be identified in the following way

- $\gamma_{ui} = 0, \forall i$, wages do not adjust to skill mismatch.

Table 3: Augmented Dickey-Fuller tests, 1975–1995.

$$\Delta X_t = a + (b-1)X_{t-1} + c_1 \Delta X_{t-1} + c_2 \Delta X_{t-2} + \nu_t$$

$$\mathrm{H}_0 : X_t \sim I(1) \text{ or } b = 1$$

| $X_t =$ | $t - ADF$ [1] | | | | |
|---|---|---|---|---|---|
| $u_t$ | $-0.76$ | | | | |
| $i =$ | Primary | Vocational | Secondary | Lower university | Higher university |
| $(wc_i - q - pr)_t$ | $-0.60$ | $-1.32$ | $-0.22$ | $-0.15$ | $-0.15$ |
| $u_{it}$ | $-0.82$ | $-0.66$ | $-1.25$ | $-0.42$ | $-0.29$ |
| $(wc_i - q - pr)_t + \widehat{\gamma_{ui}}\, u_{it} + \widehat{\gamma_i}\, u_t$ [2] | $-3.05*$ | $-3.24*$ | $-3.26*$ | $-3.43*$ | $-3.27*$ |

Notes:

1) The t-value on the lagged level, * indicates that the null is rejected at 5%-level, the critical t-value is -3.01.

2) The $\widehat{\gamma_{ui}}$'s and $\widehat{\gamma_i}$'s are estimated in static regression models.

- $\gamma_{ui} > 0, \forall i$, wages adjust to skill mismatch.
- $\gamma_{ui} > 0$ for some $i$, and $\gamma_{uj} = 0$, $i \neq j$, wages may adjust to skill mismatch, though slower than in the case above. The degree of flexibility depends on the parameters, the substitution possibilities and the price elasticities.

Pesaran and Smith (1995) recommend single equation estimation if the time dimension of a panel is sufficiently large to avoid inconsistency in the estimated coefficients. However, common derivative coefficients seems reasonable for variables that are not education-specific. Thus, following a general-to-specific procedure, I first estimate each wage-equation separately by OLS. Then, statistically accepted derivative coefficients are imposed. Finally, model reductions are made by removing insignificant explanatory variables. Model 1 in table 4 reports the estimated parameters of the long-run part of the model estimated by the Least Squares Dummy Variables method (LSDV). The complete estimation results and all the homogeneity tests are reported in appendix A. In table 4, the variables are as before, and $\mu_i$, $\gamma_{ui}$ and $\gamma_i$ are the parameters to be estimated.

The results in model 1 indicate a large response of own-group unemployment in the wage-equation for workers with higher university education (in addition to the effect of average unemployment)[15]. The numerically large estimate on $\gamma_{u,Higher\ university}$ is due to the fact that their relative wage has fallen after 1987, a period where average unemployment has increased. However, unemployment among

[15] Price elasticities for skilled labour are probably smaller than for unskilled labour since skilled labour usually is assumed to be fixed, i.e. a decline in wages to unskilled workers is more effective in reducing skill mismatch compared to an equal increase in wages to skilled workers. Lindquist and Skjerpen (2000) estimate price elasticities for factor demand in Norwegian manufacturing. They find that both the own-price and the cross-price elasticities for unskilled labour are about twice as high as for skilled labour. In their analysis skilled labour covers both workers with vocational and university education, the price elasticities for workers with higher university education are probably even smaller.

Table 4: Wage curves for five different educational groups in Norwegian manufacturing estimated by LSDV, 1974–1995. Standard error in parentheses.

$$wc_i = \mu_i + q + pr - \gamma_{ui}u_i - \gamma_i u$$

| $i =$ | Model 1 | | | | | Model 2 |
|---|---|---|---|---|---|---|
| | Primary | Vocational | Secondary | Lower university | Higher university | Higher university |
| $\widehat{\mu_i} =$ | −0.007 (0.042) | 0.088 (0.042) | 0.224 (0.041) | 0.362 (0.042) | 0.590 (0.042) | 0.694 (0.039) |
| $\widehat{\gamma_{ui}} =$ | 0 (−) | 0 (−) | 0.037 (0.011) | 0 (−) | 0.114 (0.011) | 0 (−) |
| $\widehat{\gamma_i} =$ | 0.195 (0.018) | 0.195 (−) | 0.195 (−) | 0.195 (−) | 0.195 (−) | 0.191 (−) |
| $STEP87$ | | | | | | −0.154 (0.013) |

these workers stayed at a very low level until 1989. Therefore impulse dummies are included for 1987 and 1988, but there are still negative residuals in the four following years, i.e. the model overestimates the wage growth for workers with higher university education for the whole period between 1987 and 1992. The top two diagrams in figure 5 show the recursive stability of the estimated coefficients of $\mu_{Higher\ university}$ and $\gamma_{u,Higher\ university}$ in Model 1 in table 4. In 1989 both estimates shift. Parameter instability may indicate either a missing explanatory variable or a *structural break/regime switch*.

If a missing explanatory variable changes fundamentally a regime switch and a missing variable are 'two sides of the same coin'. Therefore a regime switching model is estimated by replacing the impulse dummies with $STEP87$, a step dummy that is equal to 0 before 1987 and 1 after. The estimated wage curve for workers with higher university education in the regime switching model, model 2, is reported in the last column in table 4, the other wage curves remain unchanged and is therefore not reported. Now, $\gamma_{Higher\ university}$ is statistically insignificant (the t-value is only 0.25). The bottom diagram in figure 5 shows that the estimated coefficient of $\mu_{Higher\ university}$ is stable throughout the estimation period. In model 2 the estimated relative hourly wages between workers with higher university education and primary education was constant until 1987 then it dropped from 2 to 1.7. One explanation of the apparent regime switch may be the renewed focus on centralized wage settlements after the wage-laws in 1988 and 1989 which cumulated into a formalized agreement between the national labour union, LO, the national employers' organization, NHO, and the government, called the *Solidarity alternative*. During this period public wages fell relatively and almost 60% of the workers with higher university education work in public sectors. Thus, for this group, workers in public sectors may be wage leaders. Kahn (1998) refers to the Norwegian case as a case of recentralization during a period where other countries underwent decentralization.

Accepting model 2, only wages to workers with secondary education is affected by education-specific unemployment rates, the effect is numerically small, but significant (the estimated t-value is -3.4). The education-specific unemployment elasticity of pay to workers with secondary education is approximately -0.037. This

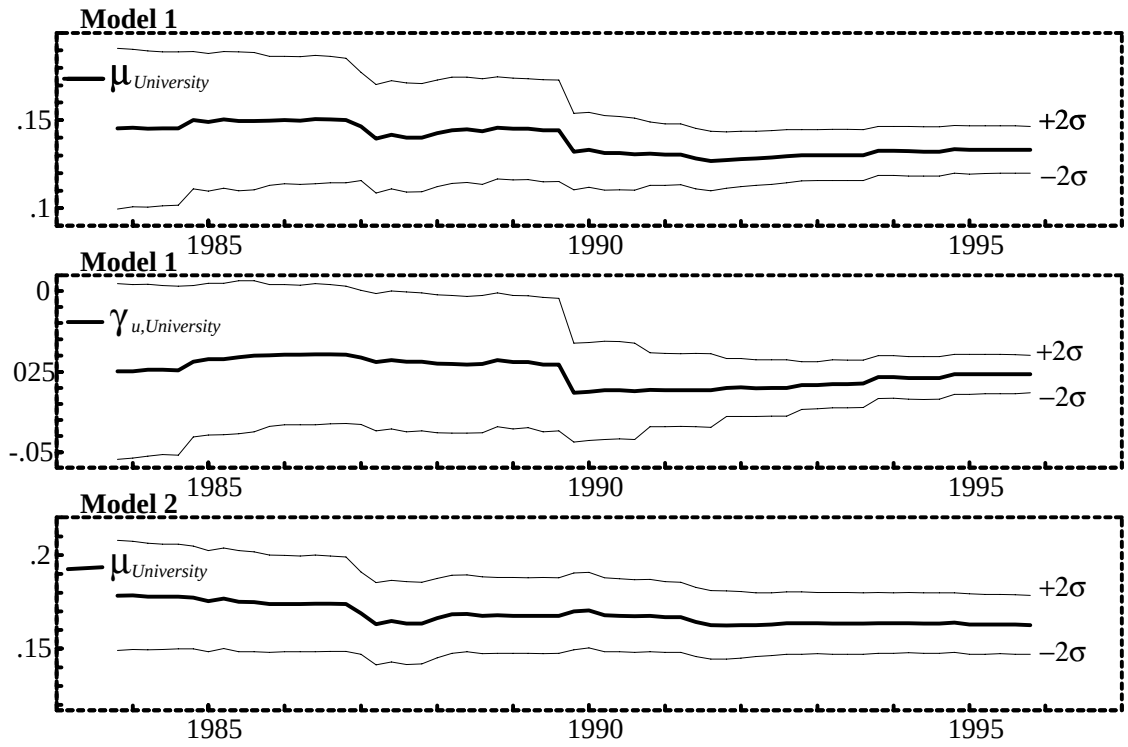


Figure 5: Recursive stability of the estimated coefficient of $u_{Higher\ university}$ (top) and the constant (middle) in model 1 and the constant in model 2 (bottom)

means that a hypothetical doubling of unemployment among these workers would be associated with a fall in their relative remuneration of approximately 3.7%. The estimated equilibrium correction coefficient is 0.23 and implies that about half of the deviation from the equilibrium relationship is corrected for within 3 years of the shock. Hence, there are no, or very little, heterogeneity in the wage curves except for the fixed effects. Linking this to the observed patterns of skill mismatch and relative wages in figures 3 and 4, respectively, I conclude that:

**Conclusion 1** *There is no statistically significant wage flexibility between workers with primary education and vocational education in spite of the observed skill mismatch between these groups.*

**Conclusion 2** *Real wage elasticity with respect to own-group unemployment is estimated to -0.037 for workers with secondary education. However, the estimate is small in light of the observed skill mismatch between workers with secondary education and university education.*

**Conclusion 3** *Estimated equilibrium wages to workers with higher university education dropped 15% after 1987. The drop is treated as an unexplained regime switch.*

Since Norwegian wage setting is very centralized, homogeneous $\gamma_i$'s are tested as a joint hypothesis, and not rejected for any $i$ (the F-statistic is $F(4,73) = 0.39[0.81]$). The estimated elasticity of pay with respect to average unemployment is -0.19 for all groups in both models in table 4. Using quarterly data, Nymoen

(1989) reports a long-run unemployment elasticity of -0.21, while reestimated 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 Blancflower and Oswald (1994) estimates an elasticity of -0.1 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[16]. Hence, the estimate in table 4 (-0.19) is high, but does not contradict to other findings. A reasonable conclusion is:

**Conclusion 4** *Real wage elasticity with respect to average unemployment is estimated to -0.19 for all groups which indicates a high degree of centralization and coordination in collective bargaining.*

# 4 Concluding Remarks

Historically, one primary consideration in small open economies have been to counteract shocks in terms-of-trade. This has been feasible by a high degree of centralization and coordination in wage setting because of the common interests across groups. Thus, the benefits of wage flexibility has been outweighed. However, during the last decades evolvement of high-technology industries and trade in computer technology may have caused pervasive skill-biased demand shifts throughout the developed world. At the same time, many countries experienced skill mismatch due to wage rigidity. Small open economies have subsequently reconsidered their wage setting institutions. While most countries underwent decentralization during the 1980s and 1990s, Norway recentralized the wage setting during the late 1980s and early 1990s. However, there seems to be room for necessary wage flexibility in Norway as more than 50 percent of total wage increases takes place on firm level[17]. The main question addressed here is: How flexible are wages in respect to skill mismatch in Norwegian manufacturing?

While average unemployment has been low compared to other countries and wage inequality has been stable (or even narrowed), skill mismatch has increased. Education specific unemployment rates show that workers with primary education and workers with secondary education lost ground to vocational and university educated workers, respectively. I conduct an econometric analysis of the determinants of wages to workers in five educational categories in Norwegian manufacturing. I find no or little effect of skill mismatch on relative wages which indicates low focus on skill-specific imbalances in wage settlements. On the other hand, I estimate a real wage elasticity with respect to average unemployment of -0.19 for all groups. The results indicate that Norwegian wage setting is highly centralized and coordinated.

During the period of recentralization in the late 1980s and early 1990s workers with higher university education in Norwegian manufacturing have experienced a drop in hourly wages relative to all other groups. This drop is estimated to 15% of

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

[17] See Holden (1989) and Rødseth and Holden (1990). Holden (1989) show that the central wage settlement has a strong impact on wages, and that this effect is not offset by wage drift.

the equilibrium wage level. One explanation might be that, for this group, workers in public sectors are wage leaders. Almost 60% of the workers with higher university education work in public sectors. During the period of recentralization wages in public sectors fell relatively. Hence, the regime switch might be a switch to more centralization.

Finally, I want to point out that although wages in countries with decentralized wage setting is more flexible the benefits of decentralized wage setting must not be exaggerated. There are three main reasons for this, first, equilibrium unemployment, and usually, also actual unemployment, among unskilled workers might be lower in countries with centralized wage setting. Nickell and Bell (1995, Table 2a) show that the unemployment rate among unskilled workers was 10.7% in the US compared to 4.6% in Norway on average between 1979 and 1991, while average unemployment rate was 6% and 3.1% respectively. Second, countries with centralized wage setting are often more egalitarian. Wages to unskilled workers might be higher than in countries with decentralized wage setting even if unemployment is higher. Unskilled workers might be better off when wage setting is centralized. Third, income policies and policies concerning the labour supply are important elements in the centralized wage setting, particularly in Norway. Hægeland et al. (1999) focus on large changes in the Norwegian education system to explain the stability in wage inequality. Although skill mismatch has increased non-trivially, the wage setting system together with education policies may be more efficient in counteracting skill mismatch than alternative systems.

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# Appendixes

## A Complete estimation results

Tables 5 and 6 show the complete estimation results for model 1 and model 2 respectively. $wc_i$ are education specific wage-costs, $q$ is the GDP deflator, $pr$ is average productivity, all in Norwegian manufacturing. $u$ and $u_i$ are average and education specific unemployment rates respectively and $pc$ is the consumer price index, these are aggregated up to national level. All variables are in logs. The dummy variables are the log of yearly working hours, $h$, wage laws ($WL = 1$ in 1979, 1988 and 1989, otherwise 0), and an impulse dummy in 1993 for a large reduction in the tax rate on the use of labor ($D93$). $D94 - D95$ catch the transitory effect of the increased focus on incomes policies in the 1994 settlements. A dummy for 1978, $D78$, corrects for a break in the data. The other dummies are without economic interpretation. Tests for homogeneity are reported in the last columns. Also tests for joint homogeneity are reported. The homogeneity tests are conducted at an early stage of the general-to-specific estimation procedure. All homogeneity restrictions are statistically accepted. The residual diagnostic test statistics at the bottom of the tables include tests for autocorrelated residuals ($F_{ar,1-1}$ and $F_{ar,2-2}$), for normally distributed ($\chi^2_{nd}$), for heteroscedasticity due to squares of the regressors ($F_{het}$), and finally the regression specification test ($F_{reset}$). As indicated in the tables, the normality tests are Chi-square tests, the other tests are F-distributed under their respective null hypotheses. The statistics are explained in Doornik and Hendry (1999).

## B Data

$wc_i$ = log of average hourly wage costs for workers in education group $i$ in manufacturing, nominal kroner. Source: Statistics Norway.

$u$ = log of total unemployment in per cent of labour force. Source: Statistics Norway.

$u_i$ = log of unemployment in per cent of labour force among workers in education group $i$. Source: Statistics Norway.

$pc$ = log of consumer price index. Source: Statistics Norway.

$q$ = log GDP deflator for manufacturing. Source: Statistics Norway.

$pr$ = log of average labor productivity in manufacturing. Source: Statistics Norway.

$h$ = log of yearly normal working hours according to tariff regulation. Source: Statistics Norway.

$WL = 1$ in 1979, 1988 and 1989, otherwise 0.

$STEP87 = 1$ after 1987, otherwise 0.

$Dxx = 1$ in 19xx, otherwise 0.

Table 5: Wage equations by education groups, 1974–1995, model 1. Standard error in parentheses and p-values in brackets.

| Left hand side variables is $\Delta wc_i$ | | | | | | |
|---|---|---|---|---|---|---|
| Variables | $i =$ Primary | Vocational | Secondary | Lower university | Higher university | Homogeneity tests: $F(4,28) =$ |
| $Const.$ | −0.002 (0.001) | 0.020 (0.008) | 0.051 (0.007) | 0.082 (0.005) | 0.133 (0.007) | |
| $(wc_i - q - pr)_{-1}$ | −0.226 (0.019) | −0.226 (−) | −0.226 (−) | −0.226 (−) | −0.226 (−) | 0.12 [0.97] |
| $u_{-1}$ | −0.044 (0.003) | −0.044 (−) | −0.044 (−) | −0.044 (−) | −0.044 (−) | 0.21 [0.93] |
| $u_{-1i}$ | − | − | −0.008 (0.003) | − | −0.026 (0.003) | |
| $\Delta wc_{-1i}$ | 0.184 (0.029) | 0.184 (−) | 0.184 (−) | 0.184 (−) | 0.184 (−) | 0.29 [0.88] |
| $\Delta pc_{-1}$ | 0.335 (0.057) | 0.335 (−) | 0.335 (−) | 0.335 (−) | 0.335 (−) | 0.70 [0.60] |
| $\Delta u$ | −0.013 (0.005) | −0.013 (−) | −0.013 (−) | −0.013 (−) | −0.013 (−) | 0.90 [0.47] |
| $\Delta h$ | −0.616 (0.052) | −0.616 (−) | −0.616 (−) | −0.616 (−) | −0.616 (−) | 0.12 [0.98] |
| $\Delta u_i$ | − | − | − | − | −0.017 (0.003) | |
| $WL$ | −0.037 (0.002) | −0.037 (−) | −0.037 (−) | −0.037 (−) | −0.037 (−) | 0.21 [0.93] |
| $D93$ | −0.015 (0.003) | −0.015 (−) | −0.015 (−) | −0.015 (−) | −0.015 (−) | 0.64 [0.64] |
| $D74 + D75$ | 0.039 (0.003) | 0.039 (−) | 0.039 (−) | 0.039 (−) | 0.039 (−) | 0.17 [0.95] |
| $D78$ | 0.006 (0.006) | 0.024 (0.006) | −0.048 (0.007) | −0.048 (0.006) | −0.068 (0.007) | |
| $D87 + D88$ | − | − | − | − | −0.042 (0.005) | |
| $D91 - D92$ | − | − | 0.035 (0.004) | − | − | |
| $D94 - D95$ | −0.005 (0.002) | −0.005 (−) | −0.005 (−) | −0.005 (−) | −0.005 (−) | 0.54 [0.71] |

Diagnostics:

| | |
|---|---|
| $R^2$ | = 987 |
| $\sigma\%$ | = 0.56 |

Test for joint homogeneity, p-value in brackets:

| | |
|---|---|
| $F(48, 28)$ | = 0.61 [0.94] |

Misspesification tests, p-values in brackets:

| | |
|---|---|
| $F_{ar,1-1}(1, 84)$ | = 0.68 [0.41] |
| $F_{ar,2-2}(1, 84)$ | = 1.54 [0.22] |
| $\chi^2_{nd}(2)$ | = 1.26 [0.53] |
| $F_{het}(35, 49)$ | = 1.05 [0.44] |
| $F_{reset}(1, 84)$ | = 0.03 [0.86] |

Table 6: Wage equations by education groups, 1974–1995, model 2. Standard error in parentheses and p-values in brackets.

| Left hand side variables is $\Delta wc_i$ | | | | | | |
|---|---|---|---|---|---|---|
| | $i =$ | | | | | Homogeneity tests: |
| Variables | Primary | Vocational | Secondary | Lower university | Higher university | $F(4,28) =$ |
| $Const.$ | −0.004 (0.009) | 0.019 (0.008) | 0.051 (0.007) | 0.083 (0.006) | 0.163 (0.008) | |
| $(wc_i - q - pr)_{-1}$ | −0.234 (0.018) | −0.234 (−) | −0.234 (−) | −0.234 (−) | −0.234 (−) | 0.74 [0.57] |
| $u_{-1}$ | −0.045 (0.003) | −0.045 (−) | −0.045 (−) | −0.045 (−) | −0.045 (−) | 0.21 [0.93] |
| $u_{-1i}$ | − | − | −0.009 (0.003) | − | − | |
| $\Delta wc_{-1i}$ | 0.155 (0.030) | 0.155 (−) | 0.155 (−) | 0.155 (−) | 0.155 (−) | 0.40 [0.81] |
| $\Delta pc_{-1}$ | 0.357 (0.058) | 0.357 (−) | 0.357 (−) | 0.357 (−) | 0.357 (−) | 0.78 [0.55] |
| $\Delta u$ | −0.014 (0.005) | −0.014 (−) | −0.014 (−) | −0.014 (−) | −0.014 (−) | 0.70 [0.60] |
| $\Delta h$ | −0.633 (0.054) | −0.633 (−) | −0.633 (−) | −0.633 (−) | −0.633 (−) | 0.45 [0.63] |
| $WL$ | −0.036 (0.003) | −0.036 (−) | −0.036 (−) | −0.036 (−) | −0.036 (−) | 0.10 [0.98] |
| $D93$ | −0.016 (0.003) | −0.016 (−) | −0.016 (−) | −0.016 (−) | −0.016 (−) | 0.79 [0.54] |
| $D74 + D75$ | 0.040 (0.003) | 0.040 (−) | 0.040 (−) | 0.040 (−) | 0.040 (−) | 0.26 [0.90] |
| $D78$ | 0.008 (0.007) | 0.025 (0.006) | −0.047 (0.006) | −0.047 (0.007) | −0.061 (0.007) | |
| $STEP87$ | − | − | − | − | −0.036 (0.003) | |
| $D91 - D92$ | − | − | 0.035 (0.004) | − | − | |
| $D94 - D95$ | −0.005 (0.002) | −0.005 (−) | −0.005 (−) | −0.005 (−) | −0.005 (−) | 0.44 [0.78] |

Diagnostics:

| | |
|---|---|
| $R^2$ | = 985 |
| $\sigma\%$ | = 0.58 |

Test for joint homogeneity, p-value in brackets:

| | |
|---|---|
| $F(48,28)$ | = 0.66[0.90] |

Misspesification tests, p-values in brackets:

| | |
|---|---|
| $F_{ar,1-1}(1,86)$ | = 0.01 [0.91] |
| $F_{ar,2-2}(1,86)$ | = 1.23 [0.27] |
| $\chi^2_{nd}(2)$ | = 0.10 [0.95] |
| $F_{het}(31,55)$ | = 1.08 [0.39] |
| $F_{reset}(1,86)$ | = 0.28 [0.60] |