Decentralized Public Sector Wage Determination: Wage Curve and Wage Comparison for Norwegian Teachers in the Pre-WW2 Period

Torberg Falch

Abstract. The recent trend towards decentralization of European public sector wage determination relaxes some of the central administered wage setting mechanisms developed in the post-WW2 period. This paper discusses teacher wage determination in Norway in 1905–39, a period with a highly decentralized public sector wage formation. Separate wage equations for urban and rural areas are estimated. I find that the responsiveness to unemployment of the urban wage was of the same magnitude as in the post-WW2 period private sector wage formation. In addition, the internal teacher labour market and local economic conditions influence the wage level. The rural wage mainly followed the urban wage.

1. Introduction

OECD (1993, 1997) describes a recent trend towards decentralization of public sector wage determination. While wages have been determined by national bargaining or federal considerations for almost all public sector workers after WW2, the new development is towards local bargaining with flexibility in individual remuneration and some budget flexibility for the management.[1] Countries like the UK, Sweden and Australia have been engaged in major decentralization reforms, but in the UK centralized bargaining arrangements still cover the largest number

Torberg Falch, Department of Economics, Norwegian University of Science and Technology, N-7491 Trondheim, Norway. e-mail: Torberg.Falch@svt.ntnu.no

I thank Steinar Holden, Jørn Rattsø, and seminar participants at Norwegian University of Science and Technology for useful comments.

LABOUR 15 (3) 343–369 (2001) JEL H72, J45, N34

of employees in the local governments, see Dell'Aringa and Lanfranchi (1999). In other countries like Germany, France and Italy, collective bargaining outcomes still apply to all public sector employees regardless of functional sub-sector or level of government.

How will decentralization of wage setting institutions affect the wage formation? Will the response to labour market conditions be in line with the response in the private sector? The evidence indicates lower wage responsiveness to unemployment in centralized public sector institutions than in the private sector. Elliot and Duffus (1996) use micro-data to construct relative wage measures of public service employees in the UK in the period 1970–92, which have a distinct countercyclical pattern. Studies using aggregated wage measures of the Scandinavian public sector typically find no direct effect of unemployment, see Holmlund and Ohlsson (1992) and Johansen and Strøm (2001).[2] As indicated by Holmlund and Ohlsson, decentralized public sector wage determination could make the wage formation more similar to private sector wage formation. According to this view, the responsiveness to unemployment is positively correlated with local flexibility.

Traditionally, empirical analyses of the public sector focus on public expenditures with little regard for wage formation. This is especially true for European studies. Due to the scarce empirical literature on public sector labour markets, the evidence on the role of wage setting level is weak. In the USA, pay determination of state and local government employees does not involve federal interventions. Indeed, Katz and Krueger (1991) find that the wage of state and local government workers respond to unemployment in the same way as private sector wages, while the pay of the federal workers is independent of unemployment.[3]

This paper uses the historical record to investigate teacher wage determination in a decentralized setting. Account data of Norwegian local governments in the pre-WW2 period are merged with recently constructed data series for the general labour market. In this period, there was a high degree of autonomy in local economic policy, and central administered wage setting mechanisms were not much developed. Thus, when decentralization reforms are evaluated and further decentralization considered, evidence from the pre-WW2 period might be useful. I investigate the wage responsiveness both to unemployment and a measure of the internal teacher labour market condition. Previous European papers on the labour market for teachers, as Dahlby (1981) and

Bee and Dolton (1995) for the UK and Falch and Rattsø (1996) for Norway, find that the labour market condition for teachers influences teacher wages.

The economic turbulence in the interwar period has motivated economic research for decades, and for example Hatton (1988) and Dimsdale *et al.* (1989) discuss the determination of an aggregate wage measure of interwar Britain. They find evidence of a similar wage determination process as in the post-WW2 period. I am not aware of any empirical papers discussing how the macroeconomic fluctuations influenced the local public sector. Stability tests of the present empirical model will indicate whether the fluctuations influenced the wage setting structure.

The next section reviews the public sector institutional arrangements in pre-WW2 Norway. A demand model of local government behaviour is presented in Section 3. The combination of high teacher unemployment and no formal union bargaining motivates the use of an efficiency wage model. Such models emphasize wage comparison. Section 4 outlines the operationalization of the model, while the econometric results are presented in Section 5. Separate wage equations for the urban and rural areas are estimated because the schools differed. A key result is that the responsiveness to unemployment of the urban wage was of the same magnitude as in the post-WW2 period private sector wage formation. In addition, the labour market condition for teachers had a similar effect. Section 6 provides some concluding remarks.

2. Institutional features[4]

The Nordic welfare states were established during the first decades of the twentieth century. A welfare state gives the population rights to public services and transfers. Free compulsory primary school with equal quality across regions is a key element. This requires national harmonization and income transfers from the central government. The development in different areas of the countries is interdependent, and comparison across groups and regions is important for the economic policy. The main instruments of the central government are grants, regulation of local tax policy and minimum standards of local public services. However, the regulation of the local public sector was modest before WW2. Thus, since it is reasonable that budget flexibility influences wage

setting flexibility as argued by OECD (1997), the pre-WW2 wage determination system must be considered as highly decentralized.

In the empirical period of the present paper, 1905–39, the compulsory school was a 7-years primary education including a centrally determined minimum of subjects and teaching hours. The primary school system was quite stable up to 1936. The nationally-decided teaching plan differed between rural and urban municipalities, and the school year was longer in urban municipalities. The aim of the reform in 1936 was to decrease the differences between rural and urban areas and to achieve a general increase in school quality. Minimum required teaching hours per class increased by 20 per cent in rural municipalities and decreased by 40 per cent in urban municipalities, but were still higher in the cities.

Because of the short school year in rural areas,[5] teachers were mainly interested in the annual wage and not the hourly wage. The central government set a minimum annual wage, possible because teaching quality was expected to dependent on teacher salary. The minimum wage also served as the basis for the calculation of matching grants. The teachers organized a nationwide union including almost all teachers in 1892. Due to pressure from the teacher union, the central government increased the minimum wage both in the cities and the countryside in 1910 and 1920, and in 1922 the school subsidies expanded. However, the union had no formal bargaining rights before national bargaining started up after WW2. The minimum wage was reduced in 1928.

3. A local demand model

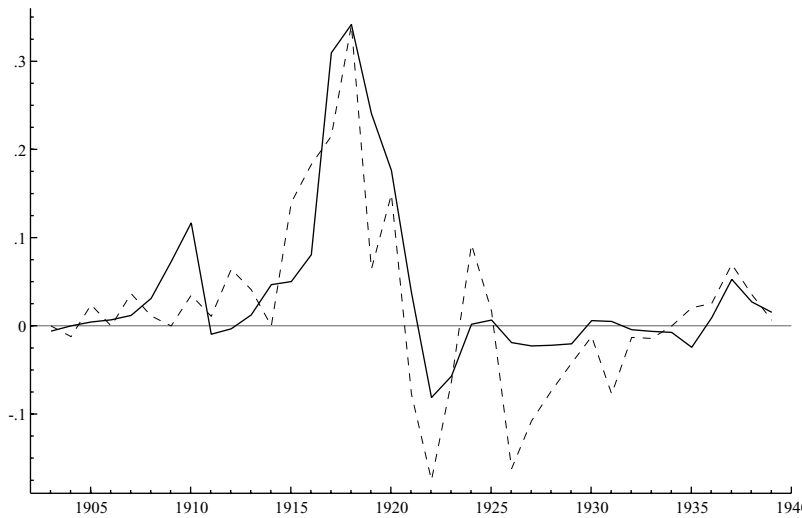
The purpose of this paper is to derive stable wage equations and not to discriminate between different theoretical models. This is partly because different labour market models often give similar hypotheses, and partly because mechanisms from several models can be at work at the same time. However, because models that take characteristics of the public sector as an employer into account are scarcely discussed in the literature, possible channels through which some mechanisms can be at work are presented in this section. While it is standard to assume that private firms maximize profit, the behaviour of the decision-makers in the public sector are determined by utility maximization in a political process. Profit is not a relevant concept in decisions regarding public sector

services. The political process is outside the scope of the present paper. The model formulation assumes that a public sector decision-maker maximizes a well-behaved utility function subjected to a budget constraint.

The high unemployment from 1921 (see Figure 4 below) indicates that the labour market was not in equilibrium between the world wars. Dimsdale *et al.* (1989) argue for Britain that one reason was large demand shocks, transmitted into unemployment because wages and prices are sticky. The inflexibility is partly assigned to union behaviour. Demand shocks also influence public sector adjustment, particularly via private sector income. Figure 1 shows some support of nominal wage rigidity. The growth in the nominal wage for teachers in urban areas exceeds the growth in consumer prices each year prices fall. Rigid nominal teacher wage may explain the high unemployment also among teachers in the interwar period. Because the teacher union had no bargaining rights before WW2, I will pursue an efficiency wage model inspired by Borjas (1980).

The objective function of the local government includes skill production in primary school. While it seems clear that teacher quality is important for student performance, see Hanushek *et al.* (1998), the evidence on the productivity of purchased school inputs is mixed. The most important purchased input is teachers. Card

Figure 1. Nominal urban teacher wage growth (—) and inflation (– – –)



and Krueger (1992) find that the return to education of white men born in 1920–49 in the USA is positively related to the teacher–pupil ratio in the state they were schooling. Hanushek (1986), on the other hand, concludes that no robust relationship exist between the teacher–pupil ratio and student performance, a result replicated in numerous recent studies as for example Hanushek *et al.* (1998). Why then varies the teacher–pupil ratio to a large degree? Public sector decision-makers may believe that more teachers improve schools, and consequently trade off the teacher–pupil ratio against other means. I assume that pupil skill Z is determined by teacher quality Q and the teacher–pupil ratio T/S (T is the number of teachers and S is the number of pupils). Assuming that primary school is the only local public service, the objective function of the local government is

$$U = U[Z(Q, T/S), C], U_1, U_2, Z_1, Z_2 > 0, U_{11}, U_{22}, Z_{11}, Z_{22} < 0, \quad [1]$$

where C is per capita consumption of private goods, and subscript denotes partial derivatives.

Will increased teacher wage increase teacher quality? Card and Krueger (1992), among others, find a positive relationship between return to education and the relative teacher wage.[6] In the following I will assume that teacher quality is positively related to the real teacher wage W/P (W is the nominal wage and P is the price of the private good) and a less favourable labour market condition μ, and negatively related to the real teacher wage in other local governments W_k/P and the real wage in the private sector W_m/P. A higher (relative) wage can attract teachers with better exams and more experience, reduce the turnover rate, and motivate the teachers to increase effort. μ is included because workers are expected to work harder when the probability of finding another job is small, see Layard *et al.* (1991).

$$Q = Q\left(\frac{W}{P}, \frac{W_k}{P}, \frac{W_m}{P}, \mu\right) \quad Q_1, Q_4 > 0, Q_{22}, Q_3 < 0, Q_{11} < 0. \quad [2]$$

Private income in the community is used on school spending and private consumption. The budget constraint is

$$\frac{I}{P} = \left(\frac{W}{P} - \frac{G}{P}\right)\frac{T}{S}\frac{S}{N} + C, \quad [3]$$

where I is private pre-tax income per capita, G is matching grants per teacher, and N is population size. In the period studied empirically, the grants from the central government were a share of the minimum wage. This is a teacher employment subsidy, independent of the wage level in the local government.

The budget constraint points to the pupil share of the population (S/N) as an important cost factor. Since primary school is compulsory, this share is exogenous for the local governments. For given income and grants, a higher pupil share reduces the money available to the components in the objective function of the local governments.

Consider the interesting case where the minimum wage is not binding. The decision problem of the local government can then be described as maximizing [1] with respect to T/S, W/P and C, subjected to [2] and [3]. The first order conditions give

$$\frac{U_1}{U_2} = \frac{T}{S}\frac{S}{N}\frac{1}{Z_1 Q_1}, \qquad [4]$$

$$\frac{Z_2}{Z_1} = \left(\frac{W}{P} - \frac{G}{P}\right)\frac{1}{T/S}\,Q_1. \qquad [5]$$

In optimum, the ratio between the marginal utility of skill production and private consumption (U_1/U_2) is equal to the increased costs of a wage rise (T/N) in relation to how much the wage rise increases production (Z_1Q_1). The ratio between the marginal productivity of the teacher–pupil ratio and teacher quality (Z_2/Z_1) is equal to the relative price. The relative price depends on T/S and Q because the budget constraint is multiplicative in T/S and W/P. A wage rise makes the quality better and the employment more expensive. This characteristic of the model makes the comparative statics ambiguous. If the wage level enters the production function in a labour augmenting way as defined by Solow (1979), that is $Z = Z[Q(\cdot)T/St]$, it follows from [5] that the quality elasticity with respect to the own wage level is given by

$$\frac{Q_1}{Q}\frac{W}{P} = \frac{W}{W-G}. \qquad [6]$$

The elasticity is equal to unity if $G = 0$. This is the parallel to the Solow condition discussed for profit maximization firms in Solow

(1979) and in a public sector context in Johansen and Strøm (1997). Equation [6] implies a wage level independent of the local components I/P and S/N in the local government's budget constraint. Appendix A shows that, independent of the functional form of the skill production function, increased S/N has a qualitatively similar effect on the wage as reduced I/P. The only hypothesis from the model is therefore opposite signs of the partial effects of the pupil share and income. Regarding the grants, the only effect is a negative substitution effect away from the wage when the income effect is equal to zero. The effect can, however, be positive if the income effect is positive.

The wage demand equation can be summarized as

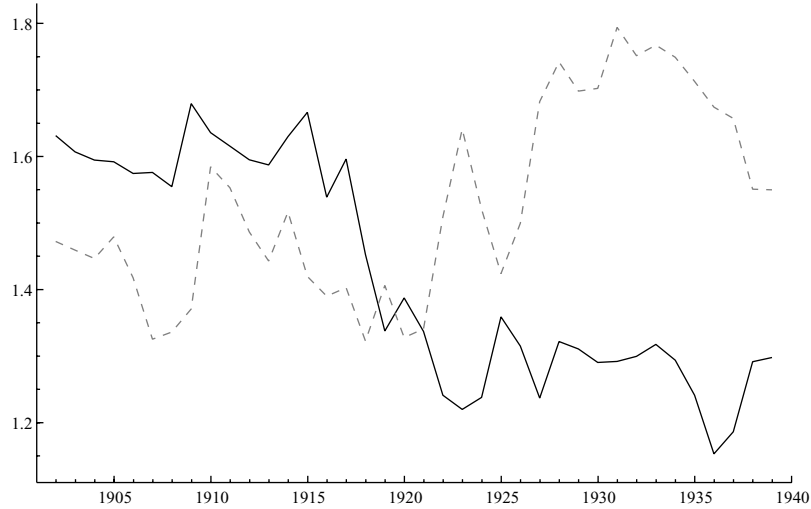
$$\frac{W}{P} = \frac{W}{P}\left(\underset{?}{\frac{I}{P}}, \underset{?}{\frac{S}{N}}, \underset{?}{\frac{G}{P}}, \underset{+}{\frac{W_k}{P}}, \underset{+}{\frac{W_m}{P}}, \underset{-}{\mu}\right), \quad [7]$$

where the comparative static effects, more closely discussed in Appendix A, are indicated under the variables. It follows from the model that $(W/P)_1 > 0$ if $(W/P)_2 < 0$ and $(W/P)_1 < 0$ if $(W/P)_2 > 0$. Notice, however, that this demand model effectively assumes that teacher supply is not binding in the local government decision–making. If the supply is binding, and the supply schedule is upward sloping, a rise in the demand for teachers will increase the wage level. Since both I/P and S/N is positively related to teacher demand under reasonable conditions,[7] a binding teacher supply may yield a positive effect on teacher wages of both private income per capita and the pupil share of the population.

4. Data and econometric specification

Account data for urban and rural municipalities are utilized to calculate annual wages for primary school teachers. Urban and rural teacher wage equations are estimated in the next section. An alternative strategy is to estimate relative wage equations. This type of modelling would give different results and require demand factors for the private sector to be included in the analysis. Figure 2 presents the teacher relative wages. The teacher wage in urban municipalities relative to the wage in manufacturing

Figure 2. Relative urban teacher wage on rural teacher wage (—) and the wage in manufacturing (– – –)



increased during the deflation in 1921–33, but the relative wage was almost equal in the start and the end of the empirical period. The urban wage was 1.6 and 1.3 times higher than the rural wage in 1905 and 1939, respectively. Several aspects may explain a higher wage in the urban areas. First, teaching hours per teacher was higher in the cities. Second, private income per capita was higher and the pupil share of the population was lower in urban areas than in rural areas. In addition, the price level is likely to have been higher. Transportation costs gave higher price of food in cities, which was the most important good in the price index, and housing values were probably higher. Unfortunately, only a price index for cities is available.

Two measures of the labour market condition are included in the model. First, the general unemployment rate (UNEM) is assumed to have a negative effect on all wages in the economy. Second, an index of the labour market condition for teachers (GRAD) is calculated as the number of graduated students in relation to the number of teachers leaving the profession. Teacher graduation was a policy instrument for the central government. Around 1930, no students were offered teaching training courses in an attempt to reduce teacher unemployment. Figure 3 presents the evolution of the gradation ratio and the unemployment rate. No measure of

Figure 3. Unemployment rate (—) and teacher graduation ratio (– – –)

teacher unemployment is available, but according to historians, unemployment among teachers rose markedly in the early 1920s. One reason may be high values of GRAD. Many students graduated compared to the number of teachers leaving the profession in this period.

To control for teacher composition effects, the share of female teachers (FEMALE) is included in the analysis. The production function of skill may be affected by the composition of teachers. Females are likely to be less mobile than males. Thus, the outside option for females is smaller, which is likely to reduce the productivity gain of increased wage. Female teachers were lower paid than males before WW2, and the unemployment initiated a debate of whether married women should leave teaching.

Appendix B presents data sources, mean values, and time series properties. The population was about 2.5 times higher in rural municipalities than urban municipalities, and private income per capita was about 2.7 times lower. All variables, except the pupil shares of the population and the shares of female teachers, seem to be integrated of order one. The pupil and female shares seem to be integrated of order two. These variables have different evolution over time than ordinary economic variables; they move like big waves. They are therefore modelled in a more flexible way than the other variables.

The estimation procedure is to reduce the general dynamic error correction equations and to a structural model including only variables significant at the 10 per cent level.

$$\begin{aligned}\Delta w_{ut} = {} & \alpha_0 D_t + \alpha_1 (w_u - p_u)_{t-1} + \alpha_2 (i_u - p_u)_{t-1} \\ & + \alpha_3 (g_u - p_u)_{t-1} + \alpha_4 (w_r - p_u)_{t-1} + \alpha_5 (w_m - p_u)_{t-1} \\ & + \alpha_6 p_{ut-1} + \alpha_7 F_{ut-1} + \alpha_8 \mu_{t-1} + \alpha_9 \Delta E_{ut} + \alpha_{10} \Delta w_{rt} \\ & + \sum_{j=0}^{1} \alpha_{11j} \Delta F_{ut-j} + \varepsilon_{ut}, \end{aligned} \quad [8]$$

$$\begin{aligned}\Delta w_{rt} = {} & \beta_0 D_t + \beta_1 (w_r - p_u)_{t-1} + \beta_2 (i_r - p_u)_{t-1} \\ & + \beta_3 (g_r - p_u)_{t-1} + \beta_4 (w_u - p_u)_{t-1} + \beta_5 (w_m - p_u)_{t-1} \\ & + \beta_6 p_{ut-1} + \beta_7 F_{rt-1} + \beta_8 \mu_{t-1} + \beta_9 \Delta E_{rt} + \beta_{10} \Delta w_{ut} \\ & + \sum_{j=0}^{1} \beta_{11j} \Delta F_{rt-j} + \varepsilon_{rt}, \end{aligned} \quad [9]$$

Small letters indicate logarithmic form, Δ is a differential operator, ε_{ut} and ε_{rt} are i.i.d. error terms, and u and r denote urban and rural areas, respectively. F is a vector of $(s-n)$ and female, μ is vector of unem and GRAD, E is vector of i, g, w_m, p_u and μ, and D is a vector of a constant and dummy variables for 1910 (D10), 1920, 1928 and 1936. The dummy variables capture the school reform and minimum wage changes described in Section 2.[8]

If the error correction terms (capturing variables integrated of order one) are not stationary, there is no cointegration. In this case, the expected values of α_1 and β_1 are zero. The error correction based test for cointegration suggested by Kremers *et al.* (1992) utilize this property by using the t-values of α_1 and β_1 as test statistics for cointegration. The test statistic does not have a standard distribution, and Kremers *et al.* suggest that the critical value of the Dickey–Fuller test statistic is used. The first two columns of Table 1 presents the parsimonious structural model estimated with full information maximum likelihood. Non-cointegration is rejected, the restrictions on the general equations [8] and [9] are clearly not rejected, and the other test statistics are comfortable.

Table 1. Results of estimation

Estimation method	**FIML**		**FIML**		**OLS**	**OLS**	**OLS**
Dependent variable	Δw_{ut}	Δw_{rt}	Δw_{ut}	Δw_{rt}	Δw_{ut}	Δw_{rt}	Δw_{ut}
$(w_u - p_u)_{t-1}$	−0.420	0.793	−0.441	0.794	−0.419	0.794	−0.404
	(9.35)	(4.66)	(5.89)	(4.57)	(8.96)	(4.83)	(8.91)
$(w_r - p_u)_{t-1}$	—	−0.645	0.027	−0.646	—	−0.645	—
		(4.78)	(0.35)	(4.69)		(4.96)	
$(i_u - p_u)_{t-1}$	0.118	—	0.112	—	0.118	—	0.100
	(7.52)		(3.74)		(7.22)		(5.41)
p_{ut-1}	—	0.086	—	0.086	—	0.085	—
		(3.31)		(3.26)		(3.43)	
$(s_u - n_u)_{t-1}$	0.460	—	0.445	—	0.460	—	0.416
	(6.00)		(4.40)		(5.75)		(5.20)
female_{ut-1}	−4.104	—	−3.954	—	−4.098	—	−3.797
	(6.65)		(4.87)		(6.38)		(5.98)
unem_{t-1}	−0.033	—	−0.033	—	−0.033	—	−0.053
	(2.75)		(2.62)		(2.67)		(3.29)
$(\text{unem})^2_{t-1}$	—	—	—	—	—	—	0.012
							(1.83)
GRAD_{t-1}	−0.026	—	−0.026	—	−0.026	—	−0.024
	(7.04)		(6.17)		(6.77)		(5.99)
Δw_{ut}	—	0.850	—	0.849	—	0.847	—
		(9.67)		(9.46)		(10.3)	
Δw_{rt}	—	—	0.022	—	—	—	—
			(0.17)				
Δg_{ut}	0.106	—	0.098	—	0.106	—	0.114
	(4.04)		(2.21)		(3.86)		(4.30)
Δg_{rt}	—	0.196	—	0.196	—	0.199	—
		(2.55)		(2.49)		(2.72)	
$(\Delta p_u + \Delta w_m)_t$	0.162	—	0.161	—	0.162	—	0.164
	(7.32)		(6.09)		(7.00)		(7.43)
$\Delta\Delta(s_u - n_u)_t$	−1.263	—	−1.297	—	−1.273	—	−0.923
	(3.71)		(3.73)		(3.58)		(2.37)
D10_t	0.082	—	0.082	—	0.082	—	0.083
	(4.90)		(4.26)		(4.73)		(5.01)
D36_t	—	0.090	—	0.091	—	0.089	—
		(2.63)		(2.59)		(2.71)	
σ	0.0144	0.0321	0.0144	0.0327	0.0150	0.0309	0.0143
AR(1)	0.216	0.061	0.235	0.053	0.413	0.885	0.173
AR(2)	0.097	0.172	0.112	0.158	0.248	0.766	0.082
NORM	0.653	0.872	0.693	0.877	0.657	0.829	0.303
RESTR	0.752		0.752		0.884	0.702	—
$\text{AR}_V(1)$	0.936		0.943		—	—	—
$\text{AR}_V(2)$	0.678		0.673		—	—	—
NORM_V	0.907		0.917		—	—	—
ENC_V	0.653		0.493		—	—	—

Note: The estimation period is 1905–1939. FIML is full information maximum likelihood and OLS is ordinary least square implemented in PcFiml and PcGive, see Doornik and Hendry (1997) and Hendry and Doornik (1997). Absolute t-values in parentheses. σ is the standard error of the equation, AR(j) is LM-tests for autocorrelated residuals of order j on F-form, and NORM is a χ^2-test for residual normality. Subscript V denotes test on the residual vector. ENC is an LR-test for overidentifying restrictions imposed on the system, and RESTR is an F-test of the restrictions on the general model/equations. p-values presented for all test statistics.

5. Results

The wage formation in urban and rural areas is different. The long run income elasticity with respect to the urban wage is 0.28, in line with the US cross-section evidence. At mean values, a rise in income of 10 NOK increases the wage with 9.3 NOK.[9] The long run effect of the pupil share of the population is also positive with an elasticity of about unity. Both a positive effect of income and the pupil share is inconsistent with the demand model outlined. This may be a result of a binding teacher supply, dominating the effect of the fact that the pupil share is a cost factor in the budget constraint. Notice, however, that the acceleration in the pupil share has a negative impact, indicating that other mechanisms are at work in the very short run.

Both the general unemployment and the labour market condition for teachers have significant long run effects on the urban teacher wage. The responsiveness to unemployment is remarkable similar to recent evidence for the private sector. The long run unemployment elasticity calculated from Table 1 is −0.079. This is close to the estimate of about −0.1 by Blanchflower and Oswald (1994) and others. Johansen (1995) finds an elasticity of −0.071 for Norwegian manufacturing in the period 1964–90, while the result for interwar Britain in Dimsdale *et al.* (1989) is −0.054. However, the result in the present paper stands in contrast to the evidence of the post-WW2 public sector wage formation, and the reason may be the decentralized structure of the wage determination.

The long run elasticity of the index of the teacher labour market condition is −0.11 measured at mean value of GRAD. This is of similar size as the effect of industry unemployment in the US reported by Blanchflower and Oswald (1994).[10] It is also surprisingly close to the elasticity of the teacher vacancy rate of 0.09 found for the post-WW2 period by Falch and Rattsø (1996). For the UK, Dahlby (1981) and Bee and Dolton (1995) test the effect of excess demand of teachers, defined as the difference between the teacher–pupil ratio target and the actual teacher employment. They find a strong positive effect of this variable with an elasticity of about 0.4. The responsiveness to internal market forces seems to be independent of the level of wage determination, and whether there is excess supply of teachers (pre-WW2 period) or excess demand of teachers (post-WW2 period in both the UK and Norway).

The external labour market influences the urban wage mainly via unemployment. The only response to the manufacturing wage is a small short run effect.[11] The other comparison wage included, the rural teacher wage, has no effect. The elasticity of only 0.16 of inflation on nominal wage growth indicates high degree of nominal inertia.[12] When all nominal explanatory variables increase with 10 per cent, the immediate effect on the urban wage is only 4.3 per cent. This rigidity can explain some of the persistent high teacher unemployment.[13] On the other hand, there is a relative fast adjustment to long run equilibrium measured by the coefficient of the error correction term. Three years after a shock, the disequilibrium is reduced by 80 per cent.

The urban teacher wage seems to be very sensitive to the share of female teachers. If the share decreases from mean 0.64 with one standard deviation to 0.62, the wage level increases with almost 30 per cent in the long run. If this should be a pure composition effect, it implies a female wage of approximately 1/9 of the male wage. The size of the effect is puzzling, but it is constant over time and independent of whether the female share is increasing or decreasing. The effect may reflect a combination of a composition effect and lower outside option for female teachers than for male teachers.

For the rural teacher wage, both the pupil share and income have insignificant effects. This is not in conflict with the demand model outlined. The rural wage is determined by wage comparison; the urban teacher wage is the main determinant. The short run elasticity is 0.85, while the long run elasticity is in fact above unity.[14] The second estimation in Table 1 shows the results when the rural wage is included in the urban wage equation. Both the *t*-values of the long and short run effects are below 0.5. There is causality only from the urban wage to the rural wage. Because the urban wage is highest, this is consistent with a hypothesis that workers compare themselves first and foremost with workers in a better position.

Tests of parameter and model stability are of specific interest in the pre-WW2 period because of the great fluctuation in economic conditions. In order to investigate stability, the model is re-estimated with OLS. OLS gives almost identical parameters as full information maximum likelihood as reported in Table 1. Figure 4 shows that the effect of the graduation ratio on the urban wage does not change around 1930, the period without any graduation. The unemployment effect is reasonable stable during the interwar

Figure 4. Recursive estimates urban teacher wage ± 2 standard errors

period, albeit the effect is somewhat reduced over time. Using the sample up to 1925, the long run unemployment elasticity is −0.11. This may reflect that the wage curve is more convex than implied by the log-linear model specification used. In the last column of Table 1, the square of the log unemployment is included, which

turns out to be significant at 10 per cent level. Figure 5 shows that the coefficient on unemployment in this model is stable, while the coefficient on its square is imprecisely determined until some years with high unemployment are included. For sample values, the unemployment elasticity is in the range −0.17 to 0.01.

More thorough tests of the stability of the models are offered in Figures 6 and 7. For the urban wage equation, there are no

Figure 5. Recursive estimates urban teacher wage ± 2 standard errors

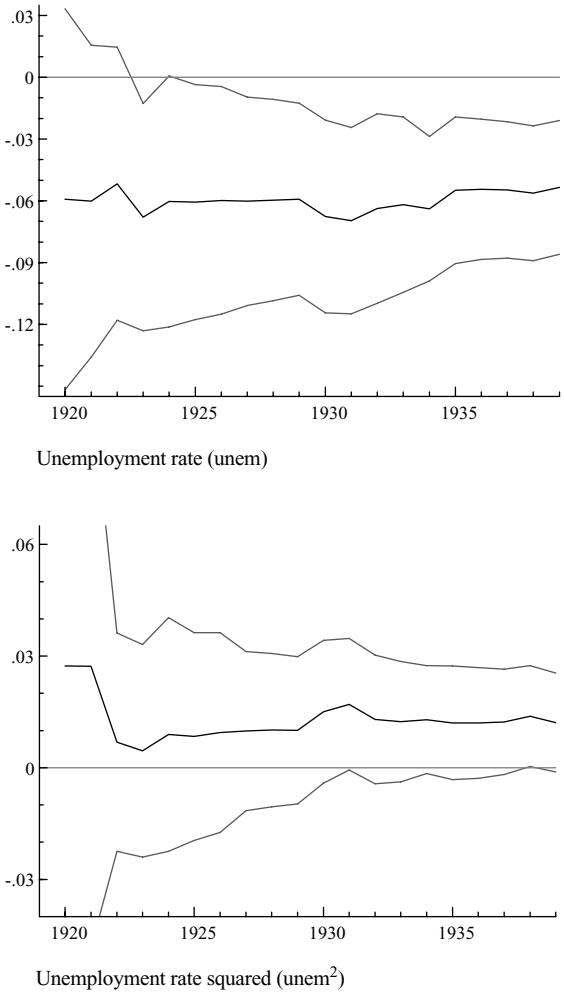
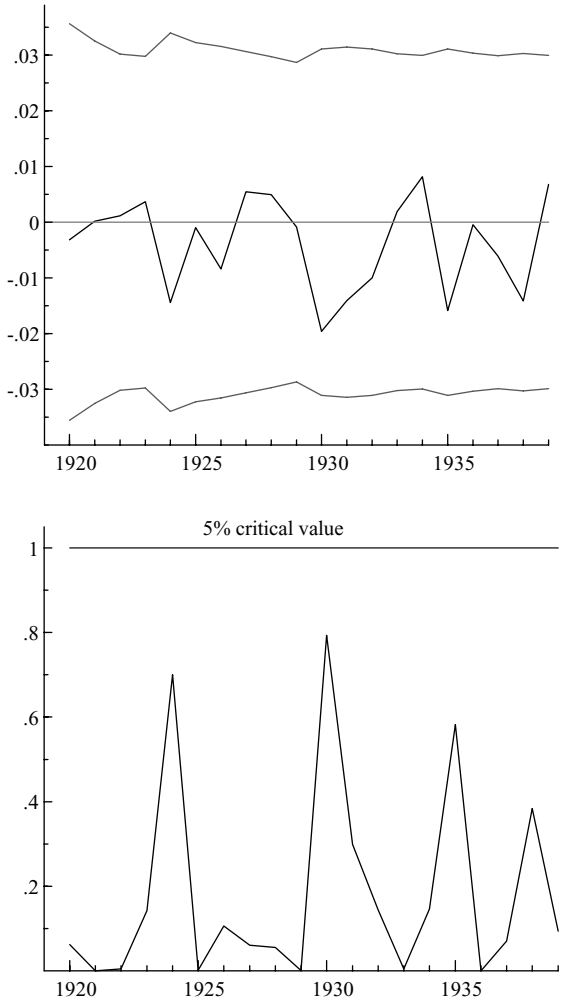
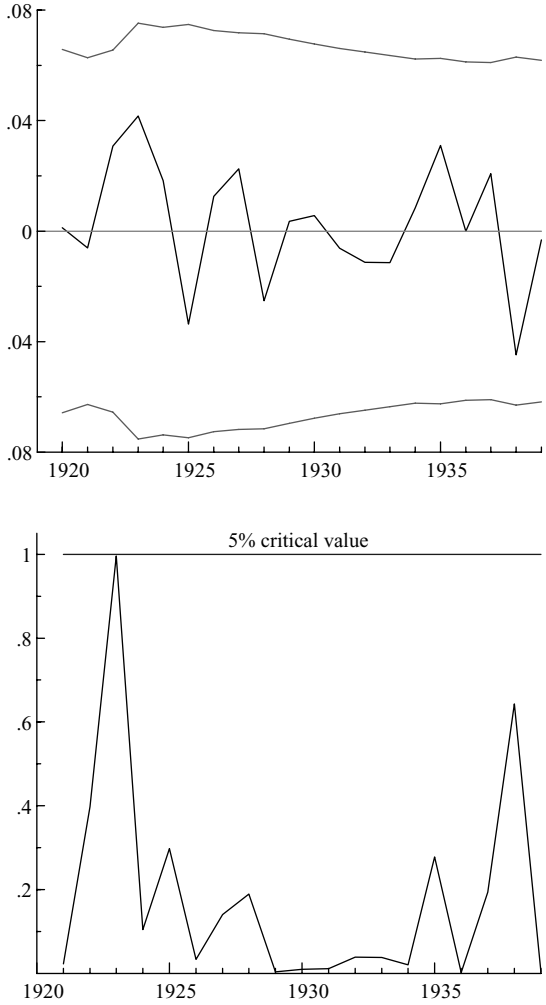


Figure 6. One step recursive residuals and recursive constancy statistics, urban teacher wage



obvious outliers of the residuals as shown in Figure 6, and the standard errors of the regression varies little.[15] In addition, the recursive Chow statistics are well below 5 per cent critical values. Figure 7 shows that the recursive Chow statistics for the rural wage are small except for 1923 when the test is marginally insignificant at 5 per cent level. Overall, the wage equations seem to stable during the interwar period.

Figure 7. One step recursive residuals and recursive constancy statistics, rural teacher wage



6. Conclusion

This paper has estimated stable teacher wage equations for the pre-WW2 period. Compared to European public sector labour markets in the post-WW2 period, the wage formation was extremely decentralized. In addition to local wage determination,

the central government used few instruments to alter local economic policy. While the rural wage mainly followed the urban wage, a combination of labour market conditions and internal economic conditions such as private sector income explain the urban teacher wage formation. In contrast to the post-WW2 evidence, the unemployment responsiveness estimated is in line with the private sector wage responsiveness. The elasticity of the unemployment rate of -0.08 is remarkable close to the results in the wage curve literature. In addition, the internal teacher labour market condition measured by a teacher graduation ratio has an effect of similar size.

The centralization of wage determination after WW2 was a result of a common understanding between the national teacher union and the public sector. The union demanded a formal frame for wage determination where they could participate. It is reasonable that the public sector wanted to internalize the external effect of wage competition. Each local government does not have incentives to take into account the effect their wage level has on the general wage level. In addition, the national government may have wanted for equity reasons to prevent economic rich municipalities, mainly the cities, to use the wage level to recruit the best teachers. Similar evidence can be found for example among the state governments of West Germany during the 1960s, see Blenk (1987). The richer states offered wages that could not be matched by the poorer states in order to attract suitable workers. As a result, the federal government achieved the unification of state pay scales. However, with centralized wage setting, relatively less attractive areas are unable to use the wage level to recruit workers. In the former Norwegian system, the rural local governments where wage followers, while in the present system, the rural areas are forced to have the same wage as urban areas even though the teacher vacancy rate has been highest at the countryside.

Appendix A: Comparative statics

Equations [3], [4] and [5] define the reduced form of the local government optimal teacher wage when the second order condition is fulfilled. This appendix will prove that most comparative static effects are ambiguous. To simplify the expressions, I will assume that the utility function is separable ($U_{12} = 0$). The implicit

function theorem is utilised to derive expressions determining the sign of the partial effects.

(1) Effect of increased income

$$\operatorname{sign}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,I/P}=\operatorname{sign}\left\{U_1\left[Z_{12}Q_1\left(\frac{W}{P}-\frac{G}{P}\right)-Z_{22}\frac{T}{S}\right]-\lambda\left(\frac{W}{P}-\frac{G}{P}\right)\frac{S}{N}\right\}. \quad [A.1]$$

λ is the Lagrange-multiplicator, interpreted as the local government's marginal utility of income. It is easy to show that school spending is increasing in private income per capita. The teacher wage (W/P), the teacher–pupil ratio (T/S), or both have to increase. The marginal utility of T/S is diminishing ($Z_{22}<0$), working in the direction of increased wage. However, a rise in the wage increases the shadow price of T/S (last part of Equation [A.1]), working in the opposite direction. The income effect is ambiguous because the budget constraint is multiplicative in the choice variables. In addition, the sign of Z_{12} depends on whether Q and T/S are substitutes or complements in production. If the wage level enters the production function in a labour augmenting way, $Z=Z[Q(\cdot)T/St]$, it is easy to show that the income effect is zero.

(2) Effect of increased pupil share

$$\operatorname{sign}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,S/N}=\operatorname{sign}\left\{\left[\frac{\lambda}{U_{22}S/N}-\left(\frac{W}{P}-\frac{G}{P}\right)\frac{T}{S}\right]\frac{\mathrm{d}\,W/P}{\mathrm{d}\,I/P}\right\}. \quad [A.2]$$

The sign of the effect of the pupil share is the opposite of the sign of the income effect because the pupil share does not alter the relative shadow price between W/P and T/S. It is easy to show that this result is independent of the value of U_{12}.

(3) Effect of increased grants

$$\operatorname{sign}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,G/P}=\operatorname{sign}\left\{\lambda\frac{T}{S}\left[U_{22}\left(\frac{W}{P}-\frac{G}{P}\right)^{2}\left(\frac{S}{N}\right)^{2}+U_{11}Z_2^2+U_1Z_{22}\right]-\left(\frac{W}{P}-\frac{G}{P}\right)^{-1}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,S/N}\right\}. \quad \text{(A.3)}$$

The last part of [A.3] is the income effect. The first part is a negative substitution effect. When the teacher employment subsidy G increases, the cost of teacher employment is reduced. If the income effect is non-positive, the effect of G is negative.

(4) Effect of increased comparison wages

The effects of the comparison wages W_k/P and W_m/P are qualitatively equal. The sign of the effect of W_k/P is given by

$$\operatorname{sign}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,W_k/P}=\operatorname{sign}\left\{-Q_2(U_{11}Z_1Z_2+U_1Z_{12})U_{22}^{-1}\left(\frac{W}{P}-\frac{G}{P}\right)^{-1}\times\left(\frac{S}{N}\right)^{-1}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,I/P}-U_1\left[(Z_{11}Q_1Q_2+Z_1Q_{12})\left(\frac{W}{P}-\frac{G}{P}\right)-Z_{12}Q_2\frac{T}{S}\right]\times\left[U_{22}\left(\frac{W}{P}-\frac{G}{P}\right)^{2}\left(\frac{S}{N}\right)^{2}+U_{11}Z_2^2+U_1Z_{22}\right]\right\}. \quad \text{[A.4]}$$

The first part can be interpreted as an income effect. The sign of the second part is in general ambiguous, but it is positive if $Z_{21}=Q_{12}=0$. Then only the direct effect of decreased productivity when W_k increases remains ($Q_2<0$). If the wage level enters the production function in a labour augmenting way and $Q_{12}=0$,

[A.4] reduces to

$$\operatorname{sign}\frac{\mathrm{d}\,W/P}{\mathrm{d}\,W_{\mathrm{k}}/P}=$$

$$\operatorname{sign}\left\{Q_2\left[U_{22}\left(\frac{W}{P}-\frac{G}{P}\right)^2\left(\frac{S}{N}\right)^2+U_{11}Z_2^2+U_1Z_{22}\right]\right\}>0. \quad [A.5]$$

In this case, the effects of the comparison wages are positive.

(5) Effect of increased unemployment

An equation describing the sign of the partial effect will be similar to [A.4], where Q_4 and Q_{14} replace Q_2 and Q_{12}, respectively. Because $Q_4 > 0$, the effect will be negative under the assumptions discussed regarding the effects of the comparison wages.

Appendix B: Variable definitions, data sources, and descriptive statistics

W_{u} and W_{r} — annual teacher wages in urban (u) and rural (r) municipalities. Calculated as total teacher wage costs per teacher. Account data for wage costs in urban municipalities are only available each fifth year up to 1925. The wage share of total spending is about 0.8 up to 1910 and 0.7 from 1915, and is interpolated in the intervening years. The wage for rural municipalities includes calculated fringe benefits, far most common in rural areas. Sources are NOS Statistics on Education and NOS Municipal Finances.

G — grants. Calculated as total grants to primary school divided by the number of teachers in primary school, source is NOS Municipal Finances.
I — calculated private income per capita in the tax assessment, source is NOS Statistical Survey 1948.
P_{u} — index of the cost of living in the cities. Up to 1915, the index is based on 117 different cost items in the capital Oslo with weights based on 103 working class families. Data was

collected from 6 towns in the period 1916–28 and 36 towns thereafter. The weights were changed in 1929. Source is Hodne *et al*. (1995).
S — number of pupils. Source is NOS Statistics on Education.
FEMALE — share of female teachers. Calculated as the number of female teachers in relation to the total number of teachers. Source is NOS Statistics on Education.
N — population. Source up to 1930 is NOS Municipal Finances. Thereafter only total population of the country is available. The development in urban and rural areas are interpolated utilising the development in the number of taxpayers, source is NOS Statistical Survey 1948.
UNEM — general unemployment rate. The number of unemployed as a percentage of the labour force is calculated by Grytten (1995) for 1919–39. For the prior period, the mean unemployment rate of the ten largest trade unions is linked to this data series. Source is NOS Statistical Survey 1948.
GRAD — graduation ratio. Calculated as the number of graduated teacher students in relation to the number of teachers leaving primary school. Source is NOS Statistics on Education.

Table B1. Mean values and unit root tests

	Mean	***I*(1)**	***I*(2)**		***Mean***	***I*(1)**	***I*(2)**
w_u	4 335	−1.54	−3.07*	w_m	2 803	−1.94	−2.40
w_r	3 251	−1.76	−2.26	$w_m - w_u$	0.66	−1.78	−5.57*
$w_u - w_r$	1.40	−1.37	−5.98*	$w_m - p_u$	69 674[a]	−0.64	−4.59*
$w_u - p_u$	107 775[a]	−0.69	−4.56*				
$w_r - p_u$	80 797[a]	−0.78	−4.58*	p_u	0.04[a]	−1.87	−2.90
i_u	1 312	−2.37	−1.70	$s_u - n_u$	0.12	0.30	−1.21
i_r	489	−1.94	−2.40	$s_r - n_r$	0.15	0.52	−1.56
$i_u - p_u$	32 613[a]	−2.21	−4.32*	n_u	762 560	−2.32	−2.72
$i_r - p_u$	12 133[a]	−1.06	−4.99*	n_r	1875 922	−1.17	−3.20*
g_u	1 445	−1.45	−3.95*	$female_u$	0.64	−1.27	−1.62
g_r	2 057	−1.71	−2.75	$female_r$	0.31	−1.82	−1.38
$g_u - p_u$	35 927[a]	−1.03	−4.80*	unem	4.65	−0.99	−5.06*
$g_r - p_u$	51 112[a]	−0.74	−4.47*	GRAD	1.65	−1.88	−5.83*

Note: Augmented Dickey–Fuller tests with 4 lagged differences, where the last lag is skipped until it is significant at 5% level. I(1) and I(2) denote that the null hypotheses are integration of order 1 and 2, respectively. Small letters denote logarithmic form, but mean values are not logarithmic form. * denotes significant test statistic at 5% level, and [a] denotes values in 1996NOK.

W_m — annual wage for blue-collar workers in manufacturing. W_m includes the wage for men up to 1914 and the wage for both men and women thereafter. The source of the daily wage is Hodne *et al.* (1995). Yearly working days are constructed according to the national agreement on the number of holidays.

Table B1 presents mean values and time series properties.

Notes

[1] Since many aspects are involved in wage determination, decentralization is not a simple concept. Some aspects of pay determination systems may be rigid, while other aspects may be flexible. OECD (1997) measures decentralization in four different ways; the level (central versus local) of pay determination, the level of pay bill management, the flexibility in pay bill adjustment at the central level, and the flexibility in individual pay determination. In the period 1990–94, decentralization increased in 12 out of the 16 countries reviewed.

[2] Holmlund and Ohlsson (1992) and Johansen and Strøm (2001) discuss both local and central government wage determination. The only case of a significant effect of unemployment is for the Norwegian central government.

[3] Most public sector labour market studies in the US focus on the effect of the occurrence of wage bargaining, see for example Kasper (1970) and Gyourko and Tracy (1991) for the teacher labour market.

[4] Falch (1998) gives a more detailed description of the public sector institutions in the pre-WW2 period.

[5] At mean, the annual school time for the pupils in rural areas increased from about 400 hours in 1905 to 650 hours in 1939, while it was stable around 1000 hours in urban areas.

[6] Notice, however, that the evidence in the literature is mixed. Hanushek *et al.* (1999), for example, find different effects of teacher wages in different specifications, but conclude that 'salary policies do not appear to offer much promise for improvement in student performance' (p. 45).

[7] A rise in S/N will increase the demand for teachers per capita if the elasticity of S/N with respect to T/S is larger than -1.

[8] The price level enters explicitly in [8] and [9], homogeneity of degree zero in nominal values is not imposed.

[9] This is surprisingly close to the results in for example Kasper (1970) and Gyourko and Tracy (1991). Kasper finds a partial effect of about 0.95 using state data. Gyourko and Tracy estimate quasi-elasticities using both individual and school district data. At mean value of median family income, their results imply an income elasticity in the range 0.26–0.54.

[10] Notice that excluding unem or GRAD from the model does not alter the effect of the other labour market condition variable.

[11] It cannot be rejected that the effect of the change in the manufacturing wage is equal to the effect of inflation (p-value with a Wald-test is 0.86). When they are included separately, the standard errors are high, indicating some multi-collinearity problems. The partial correlation coefficient between the variables is 0.90.

[12] Homogeneity of degree zero in nominal values in the long run is not rejected. When the urban price level p_u is included in the model, the t-value is 0.2.

[13] Nominal inertia may be strongest when prices are falling, which is a testable hypothesis. When separate price terms are included for negative and positive inflation, both coefficients are positive, and in contrast to the hypothesis, the coefficient on $\Delta p_u \mid \Delta p_u < 0$ is largest. But I cannot reject that the response to inflation is independent of whether the inflation is positive or negative.

[14] The rural wage equation is not homogenous of degree zero in nominal values in the long run. This can be a result of the fact that only a price index for urban areas is included in the model. The equation is homogenous if the cost of living in rural areas changed with 1.13 times the change in urban areas (that is, $P_r = P_u^{1.13}$). This can be plausible due to changed relative price of food and housing rent. Food probably became relatively cheaper in the cities during the period because of improved communications. Housing values probably became relatively lower in the cities because the population growth mainly occurred in the countryside during the depression. The cities' share of the population fell from 30 per cent in 1920 to 28 per cent in the 1930s.

[15] Figure 6 presents the results for the baseline model excluding the square of log unemployment. For the model including the square of log unemployment, the figure is almost identical.

References

Bee M. and Dolton P. (1995) 'The Remuneration of School Teachers: Time Series and Cross-Section Evidence', *Manchester School of Economics and Social Studies* 63: 1–22.

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

Blenk W. (1987) 'Labour Relation in the Public Service of the Federal Republic of Germany', in Treu T. (ed.), *Public Service Labour Relations: Recent Trends and Future Prospects*, Geneva: International Labour Office.

Borjas G. J. (1980) 'Wage Determination in the Federal Government: The Role of Constituents and Bureaucrats', *Journal of Political Economy* 88: 1110–1147.

Card D. and Krueger A. (1992) 'Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States', *Journal of Political Economy* 100: 1–40.

Dahlby B. G. (1981) 'Monopsony and the Shortage of School Teachers in England and Wales, 1948–1973', *Applied Economics* 13: 303–319.

Dell'Aringa C. and Lanfranchi N. (1999) 'Pay Determination in the Public Service: An International Comparison', in Elliot R., Lucifora C. and Meurs, D. (eds.), *Public Sector Pay Determination in the European Union*, London: Macmillan Press.

Dimsdale N. H., Nickell S. J. and Horsewood N. (1989) 'Real Wages and Unemployment in Britain During the 1930s', *The Economic Journal* 99: 271–292.

Doornik J. A. and Hendry D. F. (1997) *Modelling Dynamic Systems Using PcFiml 9.0*, London: International Thomson Publishing.
Elliot R. F. and Duffus K. (1996) 'What Has Been Happening to Pay in the Public-Service Sector of the British Economy? Developments over the Period 1970–1992', *British Journal of Industrial Relations* 34: 51–85.
Falch T. (1998) 'Six Essays on the Political Economy of Education', PhD Thesis, University of Oslo, Oslo.
Falch T. and Rattsø J. (1996) 'Sources of Cost Expansion: Primary Education in Norway 1946–1990', *Education Economics* 4: 161–185.
Grytten O. H. (1995) 'The Scale of Norwegian Interwar Unemployment in International Perspective', *Scandinavian Economic History Review* 43: 226–250.
Gyourko J. and Tracy J. (1991) 'Public Sector Bargaining and the Local Budgetary Process', *Research in Labor Economics* 12: 117–136.
Hanushek E. A. (1986) 'The Economics of Schooling: Production and Efficiency in Public Schools', *Journal of Economic Literature* 24: 1141–1177.
Hanushek E. A., Kain J. F. and Rivkin S. G. (1998) 'Teachers, Schools, and Academic Achievement', *Working paper* 691, National Bureau of Economic Research.
Hanushek E. A., Kain J. F. and Rivkin S. G. (1999) 'Do Higher Salaries Buy Better Teachers?', *Working paper* 7082, National Bureau of Economic Research.
Hatton T. J. (1988) 'A Quarterly Model of the Labour Market in Interwar Britain', *Oxford Bulletin of Economics and Statistics* 50: 1–25.
Hendry D. F. and Doornik J. A. (1997) *Empirical Econometric Modelling Using PcGive 9.0 for Windows*, London: International Thomson Publishing.
Hodne F., Grytten O. H. and Alme J. (1995) 'Norwegian Real Wages: Trends in Prices and Wages 1850–1950', in Scholliers P. and Zamagni V. (eds.), *Labour's Reward. Real Wages and Economic Change in the 19th- and 20th-Century Europe*, Cheltenham: Edward Elgar.
Holmlund B. and Ohlsson H. (1992) 'Wage Linkages Between Private and Public Sectors in Sweden', *Labour* 6: 3–17.
Johansen K. (1995) 'Norwegian Wage Curves', *Oxford Bulletin of Economics and Statistics* 57: 229–248.
Johansen K. and Strøm B. (1997) 'Efficiency Wages, Wage Comparison, and Public Sector Budgeting', Norwegian University of Science and Technology, Trondheim.
Johansen K. and Strøm B. (2001) 'Wages and Politics: Evidence from the Norwegian Public Sector', *Oxford Bulletin of Economics and Statistics*, 63: 311–331.
Kasper H. (1970) 'The Effects of Collective Bargaining on Public School Teachers' Salaries', *Industrial and Labor Relations Review* 24: 57–73.
Katz L. F. and Krueger A. B. (1991) 'Changes in the Structure of Wages in the Public and Private Sectors', *Research in Labor Economics* 12: 137–172.
Kremers J. J. M., Ericsson N. R. and Dolado J. J. (1992) 'The Power of Cointegration Tests', *Oxford Bulletin of Economics and Statistics* 54: 209–224.
Layard L., Nickell S. and Jackman R. (1991) *Unemployment. Macroeconomic Performance and the Labour Market*, Oxford: Oxford University Press.

OECD (1993) *Pay Flexibility in the Public Sector*, Paris: OECD.
OECD (1997) *Trends in Public Sector Pay in OECD Countries*, Paris: OECD.
Solow R. M. (1979) 'Another Possible Source of Wage Stickiness', *Journal of Macroeconomics* 1: 79–82.