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WAGE SETTING IN SWEDEN:
AN EMPIRICAL TEST OF A
BAREBONES UNION MODEL

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An Empirical Test of a Barebones Union Model

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1. Introduction

Until recently, most studies of wage determination in Sweden as elsewhere have used theoretical frameworks of the Phillips–curve type. This approach may be criticised on at least two grounds. First, a general critique of the approach points to the lack of consistent theoretical underpinnings. Second, despite the fact that the Swedish labour market is characterised by high degrees of unionisation and centralisation, the approach lacks an explicit modeling of the behaviour of labour market organisations. The main merit of the models, it seems, is that they "work" reasonably well in most empirical studies.

The main theoretical alternative to the Phillips–curve approach is the union and bargaining approaches developed in recent years, which take the behaviour of labour market organisations as their point of departure.¹ Within this framework two principal types of empirical studies have been made. First, there have emerged a number of reduced–form real–wage equations, which in contrast to the Phillips–curve predict a relation between the level of the real wage and the level of unemployment.² Second, a number of studies have employed structural form union or bargaining models to estimate parameters in the organisations' objective functions.³ While the evidence seems to suggest that real wage equations based on union and bargaining frameworks work, the number of structural form estimations is as yet too small to warrant any firm conclusions as to the usefulness of such studies.

The present paper is a contribution aimed at addressing precisely the question of the usefulness of estimating simple structural form models of wage setting. Such a union

¹ For general surveys of trade union models, see Oswald (1985), Pencavel (1985), Farber (1986) and Holmlund (1989).

² For a discussion of this class of models and a selective survey of empirical results, see Calmfors and Forslund (1989). See also Layard and Nickell (1986), and other studies in the same *Economica* volume.

³ Typical examples are Pencavel (1985), Carruth and Oswald (1985) and Svejnar (1986).

wage-setting model has been fitted to aggregate Swedish data for the period 1963 to 1987. If it can be shown that models in this class yield stable estimates of parameters in the objective functions of e.g. trade unions, such knowledge is of great potential value to policy-makers, as parameters of this kind in principle should be invariant with respect to policy regimes and thereby not be subject to the "Lucas critique".

Considerations of this kind have worked as a guideline when selecting the model to estimate. First, the model must be firmly based on theory so that the estimated parameters can be interpreted as true structural parameters. Second, it must be of a similar kind as models estimated in earlier studies so that the results are comparable. Third, the model should ideally be data-congruent in the sense of Hendry (1987), so that statistical inference is valid. It goes without saying that it may not be so easy to fulfill all three conditions simultaneously.

The presentation is structured as follows. Section II gives a general background to the choice of model. In Section III the theoretical model is presented. Section IV develops the basic statistical model and contains a brief presentation of the data. In Section V the results of the estimations are presented and in Section VI they are compared to earlier studies. The results are summarised in Section VII.

II. Alternative Models of Wage Bargaining

When modeling trade unions, a fundamental issue concerns the objectives of unions. There are two principal problems when doing this, the first is the ordinary social choice problem of identifying an objective function in the presence of (possibly) diverging interests among union members and between union members and union leaders. There is also the possibility that the union may care also about non-unionised workers. The second problem has normally been ignored, while the first has been treated in basically three different ways: (i) all members are assumed to be identical and the union maximises the expected utility of the representative member; (ii) when members differ in some respect, it is

assumed that they can be ordered in such a way that one can find a median member whose utility is maximised; (iii) a union objective function is simply postulated and not formally derived from the individual members' preferences.

A similar problem arises on the employers' side. To my knowledge, the only solution in the literature is the assumption that employers' organisations act so as to maximise the profits of the member firms. A more satisfactory approach would undoubtedly recognise that the same type of social choice problems apply to employers' organisations as to labour unions. It is obvious that firms often have conflicting interests, so that what one firm gains might very well harm another.

Given the objectives of the parties involved, what remains to specify is over which variables and how bargaining is performed. The analysis of the objectives of workers' and employers' organisations points to two variables of interest, real wages and employment, and that bargaining takes place over one or both of these. Two approaches dominate in the recent literature. In one, employment is determined by firms, given a real wage that is either set by the union (Oswald, 1982, the monopoly union model) or the result of bargaining (Nickell and Andrews, 1983, the right-to-manage model). In the other approach both employment and the real wage are simultaneously determined by bargaining between unions and firms (McDonald and Solow, 1981, the efficient bargain model).

In this paper I have chosen to estimate a version of the monopoly union model in which the objective function is of the expected-utility type. This route is followed for a number of reasons. First, it is straightforward to derive a simple structural-form representation of it. This may, of course, be the case also when the objective function is just postulated, e.g. as an augmented addilog function (Hersoug et al (1986)) or as a Stone-Geary function (Pencavel (1985), and Holmlund and Pencavel (1988)). The advantage of my preferred approach is that I find it easier to interpret the resulting parameters as structural ones. Second, the efficient bargain model, in which both employment and real wages are bargained over, does not seem to be a good description of

negotiations at the central (or industry) level in the Swedish economy – the employers' federation simply cannot sign binding agreements on employment levels in individual firms.

The most obvious problem with my approach is, that it ignores the fact that unions and employers do in fact bargain over the wage rate. A more ambitious task than the one I have chosen would therefore be to adopt a "sequential" approach, where first a test as to which model is the appropriate one is performed, and then a structural version of this model is estimated. Manning (1987) and Alogoskoufis and Manning (1987) devise a test that can discriminate between different bargaining models.⁴ Suffice it to say here that the data required to perform this test procedure just do not seem available (and are indeed very hard to construct).

III. A Monopoly Union Model for the Swedish Economy

I shall start out from a model set-up of the same type as Calmfors (1982) and Calmfors and Horn (1985, 1986). According to this model, the economy is divided into a public and a private sector. Total labour demand is the sum of private and public sector demand. All workers, both in the private and the public sector, are assumed to be organised in one, all encompassing, trade union. This is, of course, a violation of reality. Although about 90 per cent of the Swedish labour force is organised, workers have throughout the post-war period been organised in several wage earners organisations. My simplifying assumption could be interpreted either as an assumption that the central organisations do indeed cooperate, or that one (presumably the Swedish Trade Union Confederation – LO – organising blue collar workers) acts as a "wage leader" taking the

⁴ In their proposed test, the monopoly union model, the right-to-manage model as well as the efficient bargain model are seen as special cases, where the crucial difference between them lies in the bargaining power of unions and employers with respect both to employment and wages. The monopoly union, for instance, is the case where unions have no bargaining power over employment but dictate the real wage.

overall macroeconomic consequences into account when setting wages.⁵ The wage rate is assumed to be the same for workers in both the private and the public sector, reflecting the so called solidaristic wage policy pursued by the LO for the better part of the post-war period. Workers are assumed to be indifferent between employment in the public or the private sector. When unemployed, the trade union member receives an unemployment benefit from the government, which is always below the going wage rate. Members are assumed to supply working hours inelastically.

The union acts so as to maximise the expected utility of the representative member, who may end up as either employed or unemployed, subject to the constraints given by private and public sector labour demand. The model is static and the representative member derives utility from consumption of both private and public goods. When employed, the member's consumption of private-sector goods is equal to his real wage and when unemployed his private consumption equals the unemployment benefit. In addition to this, all consumers also receive a public good at zero price. The utility function is additively separable in private and public consumption. The representative member's expected utility, U , is the probability weighted sum of his utility as employed and unemployed, or

$$(1) \quad U = \frac{n}{m} \cdot [V(w) + Z(g)] + \left(\frac{m-n}{m}\right) \cdot [V(b) + Z(g)],$$

where $w = w_n/p^*$ is the after tax real wage rate, w_n the nominal wage rate, p^* the price the consumer pays for private goods, n total employment, m total union membership (assumed to be exogenous), b the real unemployment benefit, g the level of public consumption, V utility from private consumption and Z utility from public consumption. This formulation has as two special cases union "rent" maximisation and wage bill

⁵ This interpretation corresponds roughly to the conditions as depicted in the "Scandinavian Model of Inflation", see Edgren, Faxen and Odhner (1973).

maximisation. Rent maximisation, i.e. maximisation of $R = n[w - b]$, follows when utility is linear in the wage rate. Rent maximisation is equivalent to wage bill maximisation when unemployment benefits are equal to zero. Note also, that under the assumption of exogenous membership, maximisation of the representative member's expected utility is equivalent to maximisation of the sum of the members' utilities, i.e. of a utilitarian objective function.

The government employs labour in order to produce the public good. In addition to the production of public goods and payment of unemployment benefits, the government collects three types of taxes: an income tax, the amount of which depends on the nominal wage income of wage earners, a proportional payroll tax, and a proportional indirect tax. In order to make the model tractable, no government budget constraint is imposed. I instead assume that the union takes as given the level of public sector employment, the indirect tax rate, the payroll tax rate, the income tax function and the level of real unemployment benefits. This means that I by assumption rule out the implications for wage formation of accommodative stabilisation policies that can be financed in various ways, which have been stressed by e.g. Calmfors and Horn (1985, 1986). A more ambitious formulation of the model along such lines would incorporate endogenous government employment, and having the union take as given, not the level of public employment, but a function determining how it responds to various factors.

The technology of the private-sector is represented by a constant – returns, three factor production function with labour-augmenting technical change,

$$(2) \quad y = F(a n_p, k, m),$$

where y is private sector production, n_p private sector employment, a an index of technical change, k the capital stock and m the input of raw materials. I assume that the sector is a price taker both in the product market and in the market for raw materials, and that the

capital stock is exogenously determined.⁶ Given profit-maximising behaviour in the private sector, this implies a labour demand equation of the following general form,⁷

$$(3) \quad n_p = N_p \left(\frac{k}{a}, \frac{w_c}{pa}, \frac{p_m}{p} \right),$$

where w_c is the nominal wage cost to employers, $p = p^*/(1+t)$ the output price that producers of private goods receive, t the indirect tax rate, and p_m the price of raw materials.

Equilibrium in the model obtains when the union maximises (1) subject to (3) and an exogenously given public-sector labour demand. We thus have the following optimisation problem for the union:

$$(4) \quad \text{Max}_{w_n} \quad \frac{n}{m} \left[V \left(\frac{w_n - T(w_n)}{p(1+t)} \right) + Z(g) \right] + \left(\frac{m-n}{m} \right) [V(b) + Z(g)]$$

s.t.

$$(5) \quad n = n_g + N_p \left(\frac{k}{a}, \frac{w_n(1+s)}{pa}, \frac{p_m}{p} \right)$$

where in addition to previously defined symbols $T(\cdot)$ is the income tax function, which I assume to be linear so that $T(w_n) = T_0 + T' w_n$, t the indirect tax rate, s the payroll tax rate and n_g is public sector employment. This problem has the following first order condition for an interior optimum:

$$(6) \quad \Omega = nV'(w) \frac{(1 - T')}{p(1+t)} + \frac{n_w(1+s)}{pa} \{V(w) - V(b)\} = 0$$

⁶ This means that a potentially important link between real wages and investment is ignored, see eg. van der Ploeg (1985), and Persson and Svensson (1987).

⁷ See Appendix 1 for details.

where $w = \frac{w_n - T(w_n)}{p(1+t)}$ is the real wage and n_w is the partial derivative of the private-sector labour demand w.r.t. the nominal wage. If we normalise the price level to unity, (6) reduces to

$$(6') \quad \Omega = \frac{nV'(w)(1 - T')}{(1 + t)} + n_w \frac{(1 + s)}{a} \{V(w) - V(b)\} = 0.$$

As usual, in equilibrium, the representative member balances the utility increase of a marginal rise in the real after tax wage against the expected utility loss following the raised probability of getting unemployed at a marginally higher wage. The second order condition for an interior optimum, $\Omega_w < 0$, is

$$(7) \quad \Omega_w = \frac{2n_w(1 + s)V'(w)(1 - T')}{a(1 + t)} + \frac{nV''(w)(1 - T')^2}{(1 + t)^2} + \frac{n_{ww}(1 + s)}{a} \{V(w) - V(b)\} < 0.$$

This condition is here just assumed to be fulfilled, but with the functional forms used in the empirical study, this is always the case.

IV The Empirical Model, the Data and the Estimation Method

In order to get the model in estimable form, specific functional forms for the individual members' utility functions and the labour demand schedule have to be specified. In doing this there is always a danger that the forms chosen are too simplistic to be able to characterise the data. Despite this, a very sparsely parameterised utility function is chosen—a function of the constant relative risk aversion type,

$$(8) \quad V(\cdot) = (1 - \gamma)^{-1}(\cdot)^{1-\gamma}.$$

This form is chosen for two reasons: First, it has been used in previous studies by Carruth and Oswald (1985), and Farber (1978a and 1978b), and so my results can easily be compared to theirs; second, it gives rise to a rather simple expression for the first-order condition.

For the labour demand schedule a linear representation is chosen. The reason for not choosing the more commonly used log-linear form ⁸ is that a log-linear labour demand schedule in combination with a utility function with constant relative risk aversion implies that the real wage rate is an almost constant mark-up over the unemployment compensation, an implication which is falsified directly by eye-econometrics. Given the assumption of constant returns, labour demand has a unitary elasticity with respect to the capital stock. This restriction cannot be imposed on a linear labour demand schedule, which implies a non-constant elasticity with respect to the capital stock. Because of this the equation is instead rewritten to explain the labour capital ratio:

$$(3') \quad n_p/k = \beta_0 + \beta_1 \left[\frac{w_n(1+s)}{pa} \right] + \beta_2 \frac{p_m}{p} + \beta_3 a + \epsilon_2,$$

where ϵ_2 is an error term.

Plugging (3') into the first order conditions for optimum, using the utility function (8) gives:

$$(6'') \quad \Omega = \frac{n(1-T')}{p(1+t)} \left[\frac{w_n - T(w_n)}{p(1+t)} \right]^{-\gamma} + \frac{\beta_1(1+s)k}{pa(1-\gamma)} \left\{ \left[\frac{w_n - T(w_n)}{p(1+t)} \right]^{1-\gamma} - b^{1-\gamma} \right\} = \epsilon_1,$$

where ϵ_1 is an error term. The basic estimated model consists of the two equations (3') and (6'') with the additional assumption that the error terms ϵ_1 and ϵ_2 are "well behaved".

⁸ See e.g. Holmlund (1989).

The model has one testable cross-equation restriction: β_1 appears in both equations. In addition β_1 must be negative for the second order condition to hold; otherwise it would be optimal for the union to choose an infinitely high wage. The sign of β_2 is a priori ambiguous. On the one hand, there is an output effect of an increased relative input price, which tends to decrease labour demand. On the other hand, there is a substitution effect, the direction and magnitude of which depends on the substitutability of labour for raw materials. The expected sign of β_3 is negative, but note that β_3 does not tell the whole story about the effect of technical change on labour demand; technical progress also effectively lowers labour costs as is seen in the square bracket defining real labour cost in the labour demand equation.⁹

The figures for total and private sector employment are the number of employed according to the national accounts; income taxes are calculated applying the tax rules in various years to the average annual income of an industrial worker; the price is the output price deflator for the private sector from the national accounts; indirect taxes are the VAT's; the nominal wage rate is calculated as the total wage sum for the private sector divided by the actual number of hours worked according to the national account statistics; the real unemployment benefit is calculated as the maximum nominal after-tax benefit level for an industrial worker divided by the same price index as the one used to calculate the real wage; the payroll tax rate is derived by dividing wage sums for the private sector including payroll taxes with the number excluding them, all taken from the national accounts; the capital stock and the rate of technical change are taken from Hansson (1989) and unpublished calculations by the same author; and the price index for raw material inputs used is the import price index.

The means and standard deviations of the variables are reproduced in Table 1.

The model is estimated using annual observations for the years 1963 – 1987, which

⁹ This is shown in Appendix 1.

Table 1. Some descriptive statistics

Variable	mean	standard. deviation
p_m/p	90.10	9.48
p	0.77	0.45
p_m	72.20	47.20
w_n	32.70	21.90
$\frac{w_n - T(w_n)}{p(1+t)}$	23.80	1.40
$\frac{w_n(1+s)}{pa}$	36.40	4.10
T'	0.47	0.12
$\frac{w_n - T(w_n)}{w_n}$	0.30	0.04
t	0.17	0.06
n_p	25981.00	618.00
n_g	10203.00	3116.00
n	36183.00	2663.00
a	1.39	0.20
k	87.20	17.60
b	15.1	2.50
n_p/k	311.90	73.20
$(1+s)$	1.26	0.14

means that I have only 25 observations. This is unfortunate, but the alternative to use quarterly data has another drawback – the length of contract periods in the Swedish labour market has never fallen short of a year, and has on several occasions been greater (cf. Calmfors and Forslund, 1989). As the model formulation presumes that the union sets not only the centrally negotiated wage rate, but also correctly anticipates wage drift and accordingly sets the wage rate so that, including anticipated wage drift, the wage rate reaches the target level, annual data seems to me to be the best compromise. Despite the low number of observations the model has been estimated using Full Information Maximum Likelihood (FIML) methods in TSP version 4.0. This method is chosen mainly for convenience – FIML is the only method in TSP (or other packages that I know of) that can handle estimations of equations in implicit form.

V. Estimation Results

In the first step, the model consisting of equations (3') and (6'') was estimated. The estimated parameters are reproduced in Table 2, Model 1. Looking only at parameter estimates and standard errors, the model seems to be doing fairly well: all parameters are significantly different from zero and have the expected signs. Furthermore the estimate of the degree of relative risk aversion falls well within a "reasonable" interval (reasonable here meaning broadly consistent with earlier estimates).¹⁰ To make the results easier to interpret, elasticities evaluated at sample means are reported in Table 3. These confirm the positive impression: The elasticity of employment w.r.t. the capital stock is 1.00, exactly what would follow from constant returns to scale, the elasticity of employment w.r.t. the real wage is -0.73 and the elasticity w.r.t. imported inputs is negative but numerically smaller than the real wage elasticity. The elasticity with respect to technical change is -0.41 , and, finally the elasticity of substitution between employment and real

¹⁰ See the comparison with other studies below

Table 2. The estimated parameters.

Model	γ	β_0	β_1	β_2	β_3	ρ_1	ρ_2	δ_1	δ_2	SER	DW	Log likelihood
1	3.36 (0.045)	919.0 (15.54)	-5.85 (0.45)	-0.70 (0.30)	-237.9 (17.8)					0.54, 7.90	1.17, 0.66	-285.6
2.	6.78 (0.007)	311.6 (145.7)	-2.36 (0.12)	-0.12 (0.32)	-25.8 (85.8)	-0.006 (0.01)	0.94 (0.002)			$6.4 \cdot 10^{-4}$, 4.19	2.16, 1.68	-237.4
3.	9.70 (0.60)	918.9 (20.9)	-5.56 (1.26)	-0.83 (0.33)	-238.0 (33.8)			0.84 (4.53)		$2.0 \cdot 10^{-9}$, 7.81	0.60, 0.71	-290.2
4.	7.63 (0.37)	933.3 (907.6)	-0.88 (1.06)	-0.14 (0.30)	-165.0 (53.0)	0.84 (0.04)	1.02 (0.05)	15.60 (5.58)		$2.0 \cdot 10^{-9}$, 6.59	1.74, 1.15	-217.6
5.	5.76 (0.06)	864.0 (22.8)	-4.14 (1.44)	-0.79 (0.23)	-237.3 (32.7)				$2.3 \cdot 10^{-3}$ ($1.4 \cdot 10^{-3}$)	$5.3 \cdot 10^{-4}$, 9.41	0.08, 0.52	-291.1
6.	4.94 (0.05)	933.0 (1105.3)	-3.19 (1.22)	-0.28 (0.37)	-169.0 (73.4)	0.85 (0.05)	1.01 (0.05)		$1.3 \cdot 10^{-3}$ ($7.1 \cdot 10^{-4}$)	$4.5 \cdot 10^{-4}$, 5.73	2.17, 1.41	-213.2

Note: The numbers in the brackets are estimated standard errors. SER is the standard error of the first order condition and the labour demand equations respectively and DW is the Durbin-Watson statistic for the equations in the same order. In both cases the statistics for the two equations are separated by a comma.

Table 3. Elasticities evaluated at sample means.

Model Elasticity	1	2	3	4	5	6
ϵ_n, w	- 0.73	- 0.30	- 0.70	- 0.11	- 0.52	- 0.41
ϵ_n, k	1.00	0.60	1.00	2.22	1.01	1.86
$\epsilon_n, p_m/p$	- 0.22	- 0.04	- 0.25	- 0.04	- 0.24	- 0.09
ϵ_n, a	- 0.41	0.18	- 0.45	- 0.70	- 0.62	- 0.42
σ	1.34	0.58	0.19	0.95	*	*

Note. The asterisk for the elasticity of substitution in models 5 and 6 indicates that the numbers are very small but negative, clearly inconsistent with the model approach.

Table 4 The Estimated Models

Model 1:

$$\Omega \equiv \frac{n(1-T')}{p(1+t)} \left[\frac{w_n^{-T}(w_n)}{p(1+t)} \right]^{-\gamma} + \frac{\beta_1 k(1+s)}{ap(1-\gamma)} \left[\left[\frac{w_n^{-T}(w_n)}{p(1+t)} \right]^{1-\gamma} b^{1-\gamma} \right] = \epsilon_1$$

$$\Lambda_1 \equiv n_p/k = \beta_0 + \beta_1 \left[\frac{w_n(1+s)}{p_a} \right] + \beta_2 p_m/p + \beta_3 a + \epsilon_2$$

Model 2:

$$\Omega_t - \rho_1 \Omega_{t-1} = \eta_1 \text{ assuming } \epsilon_{1,t} = \rho_{1,t-1} + \mu_{1,t}$$

$$\Lambda_2 \equiv (n_p/k)_t - p_2(n_p/k)_{t-1} = \eta_2 \text{ assuming } \epsilon_{2,t} = p_2 \epsilon_{2,t-1} + \mu_{2,t}$$

Model 3:

$$\Delta \equiv \frac{n(1-T')}{p(1+t)} \left[\frac{w_n^{-T}(w_n)}{p(1+t)} + \delta_1 \right]^{-\gamma} + \frac{\beta_1 k(1+s)}{ap(1-\gamma)} \left[\left[\frac{w_n^{-T}(w_n)}{p(1+t)} + \delta_1 \right]^{1-\gamma} (b + \delta_1)^{1-\gamma} \right] = \epsilon_1$$

+ Λ_1

Model 4:

$$\Delta_t - \rho_1 \Delta_{t-1} = \eta_1$$

+ Λ_2

Model 5:

$$\Gamma \equiv \frac{n(1-T')}{p(1+t)} \left[\frac{w_n^{-T}(w_n)}{p(1+t)} \right]^{-\gamma} + \frac{\beta_1 k(1+s)}{ap(1-\gamma)} \left[\left[\frac{w_n^{-T}(w_n)}{p(1+t)} \right]^{1-\gamma} b^{1-\gamma} + \delta_2 \right] = \epsilon_1$$

Model 6:

$$\Gamma_t - \rho_1 \Gamma_{t-1} = \eta_1$$

+ Λ_2

wage in the objective function, $\sigma \equiv \frac{V_w}{n \frac{V_n}{V_n}}$, is 1.34. This means that on average, the union is willing to trade a 1 per cent increase change in wages for a 1.34 per cent fall in employment.

These parameter estimates do not, however, tell the whole story about the model's confrontation with data. First, the cross-equation restriction of a common β_1 , is forcefully rejected by a likelihood ratio test. Second, both equations exhibit serial correlation as measured by very low DW statistics. A look at the residuals also reveals that with the exception of the first year in the sample, 1963, the model consistently overpredicts wages and underpredicts employment. It is a well known fact that the DW statistic tests not only for first order auto-regressive error processes, but also specification errors such as omitted variables or misspecified dynamics (see eg Sargan, 1964, and Hendry and Mizon, 1978). Due to the extreme simplicity of the estimated model, it is indeed likely that we have a case of both omitted variables and misspecified dynamics, in which case the low DW statistics are most appropriately interpreted as a rejection by the data of the model.

The diagnostic statistics (in a broad sense) thus call for some reformulation of the model. I have tried a number of such reformulations, all of which have in common that they preserve most of the basic structure of the original model. In Model 2, I assume that the original model is correct, except that both error terms follow first-order autoregressive processes, i.e.

$$\epsilon_{1,t} = \rho_1 \epsilon_{1,t-1} + \mu_{1,t}$$

(9)

$$\epsilon_{2,t} = \rho_2 \epsilon_{2,t-1} + \mu_{2,t}$$

where $\mu_{1,t}$ and $\mu_{2,t}$ are white noise. It is then straightforward to estimate the system

$$\Omega_t - \rho_1 \Omega_{t-1} = \eta_1$$

(10)

$$\Lambda_2 \equiv (n_p/k)_t - \rho_2 (n_p/k)_{t-1} = \eta_2,$$

where η_1 and η_2 are white noise. A look at the first-order condition (6'') reveals that the model puts more or less a straitjacket on the data in the sense that effectively there is no constant term in the equation. I have estimated two versions of the model where this is no longer the case. First, a slightly more general utility function has been used. It is of a form that nests the constant relative risk aversion utility function as a special case. To see this, define the degree of relative risk aversion as

$$(11) \quad R(w) \equiv -\frac{wV''(w)}{V'(w)}. \text{ Apply this to the utility function}$$

$$(12) \quad V(w) = \frac{1}{1-\gamma} [w+\delta_1]^{1-\gamma}. \text{ It is then clear that}$$

$$(13) \quad R(w) = \gamma w(w+\delta_1)^{-1},$$

and thus

$$(14) \quad R'(w) = \gamma(w+\delta_1)^{-1} \left[1 - \frac{w}{w+\delta_1}\right] \geq 0 \text{ as } \delta_1 \geq 0.$$

This shows that we have constant relative risk aversion in this utility function if and only if $\delta_1 = 0$. This reformulation thus introduces a constant term in the first-order condition and also provides a test for the constancy of relative risk aversion. This model is referred to as Model 3 in Table 2. This model is also transformed in the same manner as model 1 to allow for first order autoregressive error processes, and the resulting model is referred to as

Model 4 in Table 2.

The second way in which a constant term has been added to the first-order condition is to allow for the possibility that there be other differences between the states of employment and unemployment than the difference between the real wage and the unemployment benefit. I do this by introducing a parameter δ_2 in the objective function in the following way:

$$(1') \quad U = \frac{n}{m} [V(w) + z(g)] + \frac{(m-n)}{m} [V(b) - \delta_2 + z(g)].$$

$\delta_2 < 0$ could be interpreted to capture that disutility is attached to work and $\delta_2 > 0$ that disutility is attached to being unemployed. The Model thus derived is labeled Model 5 in Table 2. Model 6 is Model 5 under the assumption that the errors follow first order autoregressive processes. For convenience, all the various models have been summarised in Table 4.

A first general observation from the estimation of the additional models in Table 2 is that the parameter estimates are fairly unstable and vary a lot as the result of even minor changes in specification, as evidenced by a comparison of eg Models 1,3 and 5. Another general observation is that the DW statistics are low in the models where no correction is made for autocorrelation. Further evidence on this issue is that, in all cases, likelihood ratio tests reject the basic models in favour of the alternative where the errors are assumed to follow first-order autoregressive processes. This is not, of course, to be interpreted as a confirmation of the hypothesis of first-order autoregression. On the contrary, I find it very likely that further formal testing against some more general specification would reject this simple formulation of the error processes. The problem when following a "simple to general" modelling strategy is that the number of possible generalisations in principle is infinite, so I stop with the generalisations made here. What seems to be clear at this point is that statistical inference from Models 1,3 and 5 is not

valid.

A third general observation pertains to Models 5 and 6. If Models 1,3 and 5 are rejected on statistical grounds, Models 5 and 6 raise a logical problem: The estimates of δ_2 imply that the utility gain from being employed which arises from a real wage higher than unemployment benefits is not enough to compensate for the disutility of work. Hence, the marginal utility of employment actually turns out negative. This is of course not consistent with the assumption of equilibrium which underlies the analysis.

The general observations above leaves as with two models: Models 2 and 4. A likelihood ratio test, however, directly rejects Model 2, so I limit my specific comments to Model 4. As can be seen in Table 2, a majority of the parameters of interest are significantly different from zero, the real disturbing exception being β_1 , the partial derivative of the labour-capital ratio w.r.t. the wage. The point estimate of β_1 is -0.88 , which implies a real wage elasticity of labour demand equal to -0.11 (cf. Table 3). As is clear from the comparisons with other studies in the next section, this is a rather low number. The estimate of β_2 is negative but not significantly different from zero. This is, however, a case that cannot be ruled out on theoretical grounds, see the discussion in Section IV. The point estimate of β_3 is negative and the total effect of technical change, expressed as the elasticity at sample means, is -0.70 (cf. Table 3). A "mechanical" explanation for this is that, due to the low elasticity of labour demand with respect to labour costs, the cost reducing effect of technical change is dominated by the reduction in labour requirements implied by labour augmenting technical change. The elasticity of employment with respect to the capital stock is very high, 2.22. I have no good explanation to offer for this finding. The estimates of the parameters capturing autoregression are both quite close to unity, and in the case of the labour demand equation not significantly different from unity. Imposing the restriction that the parameter is equal to unity in the labour demand equation is however rejected in a likelihood ratio test. The positive estimate of δ_1 implies increasing relative risk aversion. Evaluated at the sample

mean of the real wage, the estimates means that relative risk aversion equals 4.61. The elasticity of substitution between employment and real wages in the objective function is 0.95, meaning that the union is willing to trade a 0.95 per cent change in employment for a 1 per cent change in the real wage.

VI Comparisons with Other Studies.

Earlier studies on trade union objective functions can be distinguished in at least two dimensions: the type of objective function used and the level of data aggregation. With respect to the type of objective function, two approaches dominate: a Stone–Geary utility function, defined over wages and employment, or an expected utility formulation with constant relative risk aversion. With respect to aggregation, the data used is either for a single union (e.g. miners in Britain or the typographical Union in the U.S.) or more nationwide (e.g. Swedish manufacturing or the Norwegian private sector).

To my knowledge there is no earlier study employing an expected utility approach on nationwide data, so I will compare my results with on the one hand estimates of similar models on different types of data and on the other with different types of models on similar kinds of data.

Studies of interest in the first category include Farber (1978a and 1978b), and Carruth and Oswald (1985). Farber derives estimates of the degree of relative risk aversion between 3 and 4, while Carruth and Oswald report estimates close to unity. None of these estimates is compatible with rent (or wage bill) maximisation, which imply a zero degree of relative risk aversion. However, a caveat applies to Farber's results. He does not report any diagnostic statistics on his models, and as we have seen from my estimations, the estimates of the degree of risk aversion seem to be sensitive to changes in specifications. Leaving this aside, both Farber, and especially Carruth and Oswald get degrees of relative risk aversion which are lower than mine. If we on the other hand evaluate the elasticity of substitution of real wages for employment at sample means, the results are fairly similar:

Farber's estimates imply an elasticity of substitution equal to 1.34 (incidentally exactly the same number as my Model 1 estimate) and Carruth and Oswald get estimates from their static model that give an elasticity of substitution in the interval 0.7–0.8.

Three studies of interest in the second category are Pencavel (1985), Holmlund and Pencavel (1988) and Holmlund (1989). All estimate models for Swedish mining and manufacturing employing log–linear labour demand schedules and Stone–Geary objective functions. In some respects their results are rather similar to mine. The real wage elasticity of labour demand is generally found to be below unity and in most cases greater than 0.5 in absolute value. The Stone–Geary form also permits estimation of a measure of relative risk aversion, which however is constrained to be between zero and unity, and where a number close to unity implies a high degree of risk aversion, and thus is not directly comparable to my estimates.¹¹ Their estimates are, however, generally close to unity, and thereby well in accordance with my high estimates of γ . The elasticities of substitution of wages for employment on the other hand tend to fall in an interval between 0.05 and 0.40, which is somewhat lower than most of my estimates.

VII. Conclusions

I shall end by a quote from John Pencavel's 1985 survey of union models: ".....it should be evident from this review of the microeconomic research on behavioral models of trade unionism and from the difficulties raised by their macroeconomic application that our knowledge of the way in which wages and employment are determined in unionised labour markets is meager. In view of this, it would seem ill–advised to place much reliance on those models for the purpose of macroeconomic policy evaluation and prescription."

Does this verdict still hold? According to my interpretation of various studies, including the present one, there are at least two findings that seem rather robust. First, all

¹¹ If $\Gamma(w, n) = \ln(w)^\theta \ln(n)^{1-\theta}$, then $R(\ln(w)) = 1-\theta$. Holmlund and Pencavel derive estimates of θ between 0.122 and 0.2.

studies reject rent or wage bill maximisation as union objectives and indicate that unions' objective functions are much more concave. Second, it seems to be a well established fact that the elasticity of labour demand with respect to the product real wage is well below unity, using Swedish aggregate time-series data. This finding also seems rather robust using other than Swedish data as long as the capital stock is treated as exogenous. See for example Newell and Symons (1985) and the survey in Holmlund (1989). This is definitely inconsistent with Cobb-Douglas representations of the production technology. On the other hand, estimates of the degree of relative risk aversion or the elasticity of substitution in the trade unions' objective functions vary considerably, as is clear both from comparing my different models and by looking at the earlier literature. It is indeed tempting to conclude that, hardly surprising, trade union objectives cannot be represented by a simple, stable function of just a few variables. Still, it is also surprising that these simple formulations "work" at all, and as a matter of fact, it is not obvious that the ordinary neo-classical labour demand schedule fares better than the first-order condition for optimum in my estimations. Given the amount of research resources put into estimations of neoclassical labour-demand models based on more flexible functional forms in recent years, it is perhaps reasonable to follow the same route for objective functions of trade unions.

Appendix 1. Derivation of the labour demand schedule in the text.

By assumption we have a profit maximising, price-taking firm using a linearly homogeneous, three-factor technology with labour augmenting technical change and a given capital stock. These assumptions together imply the following optimisation problem:

$$\begin{aligned} & \text{Max}_{n_p, m} \quad p F(an_p, k, m) - w_c n_p - rk - p_m m \\ & \text{s.t.} \quad k = \bar{k} \end{aligned}$$

This problem yields two first-order conditions:

$$(A1.1) \quad \frac{w_c}{pa} = F_1(an_p, k, m)$$

$$(A1.2) \quad p_m/p = F_3(an_p, k, m),$$

where F_1 and F_3 are partial derivatives of the production function.

As F is homogeneous of degree one, we know that F_1 and F_3 are homogeneous of degree zero, so that (A1.1) and (A1.2) can be rewritten as

$$(A1.1') \quad w_c/pa = F_1(n_p, k/a, m/a)$$

$$(A1.2') \quad p_m/p = F_3(n_p, k/a, m/a)$$

Equations (A1.1') and (A1.2') can be solved for n_p and m/a as functions of k/a , w_c/pa and p_m/p , i.e. equation (3) in the paper.

Equations (A1.1) and (A1.2) can also be written as

$$(A1.1'') \quad w_c/pa = F_1(an_p/k, 1, m/k)$$

$$(A1.2'') \quad p_m/p = F_3(an_p/k, 1, m/k).$$

This means that we can solve them to get

$$(A1.3) \quad a n_p/k = g(w_c/pa, p_m/p)$$

and thus

$$(A1.4) \quad n_p/k = g(w_c/pa, p_m/p)a^{-1}.$$

Linearising (A1.4) implies a negative coefficient for technical change, i.e. $\beta_3 < 0$ as claimed in the paper. This means that the direct effect of labour augmenting technical change, is to reduce labour requirements. On the other hand, labour effectively becomes cheaper, which tends to increase labour demand. The net effect is the sum of the two.

Appendix 2. Elasticities of substitution for the different objective functions.

In the paper, three different objective functions are used. The elasticity of substitution is defined as

$$(A2.1) \quad \sigma \equiv \frac{w}{n} \frac{V_w}{V_n}$$

Evaluating this expression for the three objective functions used in the paper gives

$$\sigma_1 = \frac{1 - \gamma}{\left[1 - \left(\frac{b}{w} \right)^{1-\gamma} \right]}$$

$$\sigma_2 = \frac{(1 - \gamma)w(w + \delta_1)^{-\gamma}}{(w + \delta_1)^{1-\gamma} - (b + \delta_1)^{1-\gamma}}$$

$$\sigma_3 = \frac{w^{1-\gamma}}{(1-\gamma)^{-1}(w^{1-\gamma} - b^{1-\gamma}) + \delta_2}$$

These are the expressions used to calculate the elasticities in Table 4.

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