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# BANK OF FINLAND DISCUSSION PAPERS

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Timo Tyrväinen  
10.9.1991

UNIONS, WAGES AND EMPLOYMENT:  
EVIDENCE FROM FINLAND

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# Abstract

Reduced form wage and employment equations derived from a bargaining model are estimated using the two-step method proposed by Engle and Granger (1987). Wages and employment are influenced by variables which determine profits, on the one hand, and the utility of the union, on the other hand. In addition, the bargaining power appears to matter. A positive effect of union strength on both wages and employment was discovered in the manufacturing industry.

The two-step method made it possible to evaluate the long-run as well as the short-run adjustment. Step response functions indicate that adjustment is not particularly slow in general. This appears to be true for wages but especially for employment. Hence, if the actual real wage-employment combination is considered inappropriate, it is not primarily due to "too slow" adjustment. Rather, it implies that the equilibrium is inappropriate.





# 1 Introduction\*

In the middle of the 1960s only one in every three Finnish workers was a union member. At present, the degree of unionization is more than 85 per cent, Sweden is the only country with a higher unionization rate. Finland has one large central confederation of unions primarily consisting of manufacturing workers. In addition, there are three confederations of unions representing mainly white-collar workers. The wage settlement procedure is highly centralized and synchronized. The period 1964–1990 saw only four years when no central agreement was reached. In these years settlements were concluded at industry level. Given this background, it seems only natural to analyze the Finnish labour market within a bargaining framework.

In the literature, there are two prevailing ways of selecting empirical equations.<sup>1</sup> One makes explicit assumptions concerning the utility functions of unions, production functions etc. and estimates various structural parameters. This is the method applied by, inter alia, Pencavel (1985), and Pencavel & Holmlund (1988). A competing method seeks merely to specify the relevant variables and to search for functional forms more or less on an ad hoc basis. The latter approach is followed by, inter alia, Bean & Layard & Nickell (1986) and Calmfors & Forslund (1990) and is also followed here.

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<sup>1</sup> Calmfors & Forslund (1990).

\*I would like to thank Steve Nickell, Richard Jackman, Andrew Oswald, Erkki Koskela, George Alogoskoufis, Palle Schelde Andersen, Robert Engle, Heikki Koskenkylä and Matti Virén for helpful comments and suggestions. Needless to say, all remaining shortcomings are on my own responsibility.

## 2 The Model

An example of the derivation of wage and employment equations under strictly specified assumptions is introduced in Appendix 1. Hence, only a brief description of the model and its underlying characteristics is given here. There are  $n$  identical firms which have constant returns to scale (Cobb-Douglas) production functions,  $F(L, M, K)$ , with three inputs, labour ( $L$ ), raw materials ( $M$ ) and capital ( $K$ ). Capital stock is taken as predetermined. Any investment undertaken during the period only influences the capital stock for the next period. Imperfect competition prevails in the product market. The firm maximizes profits which are defined as the difference between sales revenue and production costs:

$$\pi = \hat{P}[ZF(K, L, M)]F(K, L, M) - W(1+\tau_1)L - P_m M, \quad (i)$$

where  $\hat{Q} = \hat{P}^{-1}(P)Z^{-1} \equiv D(P)Z$  is a downward sloping demand curve of the separable form introduced by Nickell (1978, p. 21).  $Z$  is a parameter describing the position of the demand curve faced by the firm and  $\hat{P}$  = producer price of the firm,  $P$  = competitors' producer prices,  $W$  = nominal consumer wages,  $\tau_1$  = payroll taxes,  $P_m$  = prices of raw materials (incl. energy), and  $\hat{Q}$  = output of the firm which is endogenous. According to the marginal product condition, optimal use of inputs is determined by their relative prices. In so far as the firm uses raw materials optimally we can derive the following standard aggregate labour demand function<sup>2</sup>

$$L^d = L^d \left( \frac{W(1+\tau_1)}{P}, \frac{P_m}{P}, K, Z \right) \quad (ii)$$

-                      (-)    ?    +

In an organized labour market the firm bargains with a union. The welfare of a utilitarian union depends on the after tax real wage of its employed members and unemployment benefit received by the unemployed members. Hence, its utility function is  $U = U(W(1-\tau_2)/P_c, L, B)$  where  $P_c$  = consumer prices,  $\tau_2$  = income taxes, and  $B$  = replacement ratio (unemployment benefit in real terms).

There are several commonly used union models. They differ as regards the factors which are assumed to be bargained over. In the "right-to-manage" model wages are bargained over and the profit

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<sup>2</sup> All signs in this section are according to the model in Appendix 1. The ones which do not necessarily carry over to more general models are in parentheses.

maximizing firm sets employment unilaterally. The game is specified as a standard Nash solution of a cooperative game after Binmore et al. (1986):

$$\begin{aligned} \max_w & (U - \underline{U})^\beta (\pi - \underline{\pi})^{1-\beta} \\ \text{s.t.} & \pi_L = 0 \end{aligned} \quad (\text{iii})$$

where  $w$  is the real wage ( $W/P_c$ ) and  $\beta$  refers to the bargaining power of unions.  $\underline{U}$  is the fall-back utility of the union in the event an agreement is not reached. In Finland, the relevant alternative for an agreement is a strike not only in economy-wide but in local negotiations as well. So,  $\underline{U}$  is assumed to depend on strike allowances,  $\underline{U} = \underline{U}(S)$ .  $\underline{\pi}$  is the fall-back profit which reflects fixed costs during a production stoppage. When  $\underline{\pi}$  is deducted from  $\pi$  in (iii), fixed costs cancel out. For simplicity, fixed costs were already omitted from (i) above. Equation (iii) gives monopoly union model, and efficient bargaining model as special cases.

As a marked reduction in normal annual working time has occurred in Finland during our observation period, we feel that this matter should not be disregarded. Generally, the effect of shorter working time on wages and employment is theoretically not clear. Holmlund (1989) stresses the sensitivity of the results to assumptions about how working time is initially determined. So, the question of how wages and employment are effected by shorter regular working time is ultimately empirical. Our model does not give guidance in this respect.

The model below for equilibrium (real) wages consists of variables influencing profits, on the one hand, and the utility of the union, on the other hand. In addition a role is played by determinants of the fall-back utilities of the parties. Finally, the relative bargaining power matters. In its most general form, the model is

$$\begin{aligned} W^* = W(P_c, \tau_1, \tau_2, \frac{P_c}{P}, \beta, \frac{P_m}{P}, Z, H_N, B, S, K, t), \\ + \quad - \quad + \quad - \quad - \quad (-) \quad + \quad ? \quad + \quad + \quad + \quad + \end{aligned} \quad (\text{iv})$$

where  $H_N$  = normal working hours, and  $t$  = technical progress. Indirect taxes ( $= \tau_3$ ) are part of  $P_c/P$ .

In modelling the determination of real wages and employment we follow the tradition of Nickell & Andrews (1983) and Layard & Nickell (1986), despite obvious differences in specifications. The employment equation is commonly estimated in structural form like (ii) above with the real wage on the right-hand side. We prefer, however, to work with reduced forms as in Carruth, Oswald & Findlay (1986). This is mainly in

order to avoid simultaneity. For this reason we replaced  $W$  in equation (ii) with (iv). The resulting equation consists of the same variables as wage equation (iv) above:<sup>3,4</sup>

$$L^* = L(\tau_1, \tau_2, \frac{P_c}{P}, \beta, \frac{P_m}{P}, Z, H_N, B, S, K, t), \quad (v)$$

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Our aim is not to question the existence of a labour demand curve. When the employment equation was estimated in structural form (ii), with  $W/P_c$  on the right-hand side instrumented with variables indicated by (iv), a negative effect of wages on the use of labour was found. In this article we wish, however, to evaluate whether the data provides support for the assertion that in the longer run both wages and employment — and basically the combination of the two — adjust towards an equilibrium determined by the exogenous factors of the bargaining model.<sup>5</sup>

Discrimination between bargaining models and other models is not straightforward. For instance, market clearing models can be specified so that they produce equations which are very much like those above (see Tyrväinen (1988a)). The role of bargaining power is, however, the distinguishing feature of bargaining models. In right-to-manage model the impact of union power on employment is negative. The same is true for monopoly union model. In time-series estimations, discrimination of the

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<sup>3</sup> The unemployment variable could have been introduced as a factor influencing the bargaining power of unions, for example. It was, however, considered inconvenient to have an unemployment variable such as  $((L^s - L^d)/L^s)$  in an equation explaining employment,  $L^d$ . In so far as there are rigidities in labour supply,  $L^s$ , artificial explanatory power could have resulted. As we preferred to work with identical reduced forms for both wages and employment, unemployment was omitted not only from employment equation but from the wage equation as well.

<sup>4</sup> Pencavel & Holmlund (1988) let employment to depend on (lagged) actual hours. We, instead, use the normal hours. If *ceteris paribus* higher activity leads to higher employment as well as to more overtime work a positive relation between hours and employment emerges. If hours are adjusted more flexibly than heads, probability of this relation increases. If, however, *ceteris paribus* regular working time is reduced (by legislation), the share of overtime increases implying higher average unit labour cost. This may make it profitable for the firm to hire more workers each of whom works less hours. In this case a negative relation between employment and hours could be detected. As Tyrväinen (1988a) shows, actual hours and regular hours have developed very much differently in Finland. This is why we consider skeptically any results received in regressing employment on actual hours at least in the context of Finland. It is interesting to note that in different regressions Pencavel & Holmlund find first a negative and then a positive coefficient in Sweden.

<sup>5</sup> In more general systems most of the variables of the model can, of course, be considered as endogenous. Granger-causality will be discussed below.

monopoly union model is problematic as the union power is by definition constant (= unity) over time. Of course, even when a union acts as a monopolist unionization rate may vary when membership and employment do not change equiproportionally. Specifications with positive union effect on employment are also common in the literature (see Manning (1987) and Moene (1988), e.g.).

When the model in Appendix is solved under the assumption of perfect competition on the product market, the demand shift variable drops out (see Tyrväinen (1988a)). Hence, a significant presence of a variable describing aggregate economic activity would give support to the hypothesis of monopolistic competition. "It is this channel that distinguishes this model from the competitive special case, and consequently the search for the significant presence for aggregate demand variables is an important aspect of their empirical implementation" (Andrews (1987), p. 6).

### 3 Estimating Equations

Equations (iv)–(v) are assumed to determine the target levels implied by error correction models. The two-stage procedure presented by Engle & Granger (1987) is applied. The estimation period is 1965Q1–1989Q4. Mainly series of the Bank of Finland Quarterly Model of the Finnish Economy, BOF4, were used for the two sectors: 1) private sector, excl. agriculture and forestry, and 2) manufacturing industry.<sup>6</sup>

As wage settlements are concluded more or less simultaneously in Finland, there are peaks in the wage series in the contract quarters. This institutional feature is taken into account by means of a multiplicative dummy, DCONT.

Finally, we are ready to write the estimating wage equations. The employment equations are analogous. All the variables are in logarithmic form.

#### STAGE ONE/COINTEGRATING WAGE EQUATION (in log levels):

$$\begin{aligned} W_t = & a_1 P_{c,t} + a_2 \left( \frac{P_c}{P} \right)_t + a_3 \left( \frac{P_m}{P} \right)_t + a_4 Z_t + a_5 (1 + \tau_{1,t}) + \\ & a_6 (1 - \tau_{2,t}) + a_7 \beta_t + a_8 B_t + a_9 S_t + a_{10} H_{N,t} + a_{11} (K \& TIME)_t + \\ & \text{constant} + z_{W,t} \end{aligned}$$

where  $z_{W,t}$  is the residual of the equation and  $a_1 = 1$ , in so far as the first order homogeneity between prices and wages holds. This restriction is commonly applied but seldom tested.

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<sup>6</sup> In the middle of the 1980's, manufacturing accounted for 50 per cent of production in the aggregate private sector and for 34 per cent of the total employment.

STAGE TWO/ERROR CORRECTION EQUATION FOR WAGES (in log differences):

$$\begin{aligned}
 b_0(L)\Delta W_t = & b_1(L)\Delta P_{c,t} + b_2(L)\Delta\left(\frac{P_c}{P}\right)_t + b_3(L)\Delta\left(\frac{P_m}{P}\right)_t + \\
 & b_4(L)\Delta Z_t + b_5(L)\Delta(1+\tau_{1,t}) + b_6(L)\Delta(1-\tau_{2,t}) + \\
 & b_7(L)\Delta\beta_t + b_8(L)\Delta B_t + b_9(L)\Delta S_t + b_{10}(L)\Delta H_{N,t} + \\
 & b_{11}(L)\Delta(K\&TIME)_{t-1} + b_{12}DCONT + b_{13}z_{W,t-1}
 \end{aligned}$$

where  $z_{W,t-1}$  is the lagged residual of the level equation and  $b_{13} < 0$ .

The dynamics in error correction equations is determined freely. Four lags of all variables are included and  $b_i(L)$  summarizes the relevant lag polynomials. Definitions of the variables are in Appendix 2.



## 4 Estimations

Having assumed monopolistic competition in the product market, a variable ( $Z$ ) is required which determines the location of the downward sloping demand curve. Pencavel & Holmlund (1988) use household disposable income for this purpose. However, income is by and large a product of wages, on the one hand, and employment, on the other. Moreover, its third key component, the tax rate, is one of the right-hand side variables in our model. On the other hand, in so far as instantaneous adjustment is assumed to take place on the product market variations in inventories are abstracted away and aggregate output ( $Q$ ) could be a suitable proxy of the aggregate demand especially in the long run equations.

Generally speaking, there are many unresolved questions concerning the appropriate choice of the demand shift variable (see Holmlund (1989)). This is why we report alternative regressions. First, output is used. Second, the real disposable income of households is used as in Pencavel & Holmlund (1988). Finally, instrumental variable techniques have been used. In addition to exogenous variables of the model, we instrument output with imports of the countries important to Finnish exports and government real expenditure. For manufacturing industry we also include export prices of goods. The observed output is tracked well with the instruments chosen.

In conditions of imperfect competition, the endogenous pricing decisions of a firm are influenced by the (exogenous) prices of competitors. In aggregation over identical firms, the counterpart of competitors' producer prices is the aggregate producer price of the industry concerned. This is a fairly typical result of aggregation. A test of the Granger-causality (see Tyrväinen (1989b)) does not reject models where producer price and output are considered as exogenous with respect to wages and employment.<sup>7,8</sup>

The proxy chosen for union power is the unionization rate, UNION. In Finland, the picture given by the unionization rate closely corresponds to the qualitative conception of changes in union strength although the former is undoubtedly only a rough measure of the latter.<sup>9</sup> The size of strike allowances is determined on a case-by-case basis in Finland. Hence, it is not possible to construct a uniform time series for it.

Short-term post-sample forecasts simulated with equations similar to those in this paper were introduced in Tyrväinen (1989b). The actual

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<sup>7</sup> Similar results have been reported for Sweden in Pencavel & Holmlund (1988) and for Denmark in Andersen & Risager (1990).

<sup>8</sup> A complete set of results is available from the author upon request.

<sup>9</sup> Reference to alternative specifications is made in Tyrväinen (1988b).

outcome was tracked well with one exception. The actual number of persons employed in 1985 was 20 000 (around 1 per cent) less than predicted by the model. A survey (Borg (1988)) suggests that firms reacted strongly by reducing recruitment when a law improving employees' security against dismissal came into effect on 1 September 1984. It was indicated that as many as 20 000–30 000 jobs were involved. So, the results of our early forecasting exercise and the survey accord with each other. In this paper we include a dummy, DISD, in the employment equation to evaluate the matter more thoroughly.

The two-stage procedure of Granger & Engle makes use of the notion that a set of time series can form a stationary system as a linear combination, although separately the time series are not stationary. How about the time series of this study? Can they be made stationary, and if so, how many times must each series be differentiated in order to achieve stationarity? Table A1 in Appendix 3 presents the result of an ADF-test. It is clear from the table that we have a mixture of  $I(1)$  and  $I(2)$  variables in our regressions. This will be kept in mind when the results are evaluated.

## 4.1 Cointegrating Regressions

The first stage of the Granger & Engle procedure, level-form equations, is reported in Tables 1 and 2. The estimation period is generally 1965Q1–1989Q4. In choosing the preferred equations — marked with a star, \* — the size of the standard error has not been the sole criteria. More general features of the equations have been evaluated as well.

The CRDW and ADF test statistics of all the relevant equations below exceed the critical levels known at the 1 per cent significance level (see Hall (1986), Engle & Yoo (1987) and Blangiewicz et al. (1990)). The cointegration hypothesis can be accepted without problems.

Tyrväinen (1988a, 1988b) report regressions which are similar to those reported in this paper with an observation period which was 5 years (20 observations) shorter than here. The qualitative results are not effected by the length of the estimation. In addition, the cointegration regressions below were also carried out so that the more recent observations were given more weight than those located in the more distant past. When all the series were multiplied by the unionization rate, the results differed only slightly from those reported in Tables 1–2. The conclusion was exactly the same with a shorter estimation period (Tyrväinen (1988a)). As the unionization rate rose from 33 per cent in 1965 to more than 85 per cent in the middle of 1980's, these results as well provide evidence for the stability of the equations.

TABLE 1. COINTEGRATING EQUATIONS: WAGES

Estimation period: 1965Q1—1989Q4, except 1971Q1—1989Q4 in equation (10)

Estimation method: OLS, except TSLS in equations (3), and (8)

Independent variables	Dependent variable: log (W/CPI)									
	Private sector				Manufacturing industry					
	(1) *	(2)	(3) inst.	(4)	(5) *	(6)	(7)	(8) inst.	(9)	(10) *
log(CPI/P)	-.284	-.271	-.374	-.237	-.255	-.187	-.092	-.153	-.154	-.191
log(P <sub>w</sub> /CPI)	.032	.045	.061	-	-	.049	.040	-	-	.043
log(1+ $\tau_1$ )	-.314	-.317	-.685	-.719	-.400	-.217	-.137	-.133	-.324	-.903
log(1- $\tau_2$ )	-.476	-.458	-.466	-.308	-.344	-.401	-.433	-.438	-.361	-.302
log(P <sub>m</sub> /P)	-.130	-.127	-.156	-	-.223	-.172	-.140	-.210	-	-.186
log(TOT)	-	-	-	.263	-	-	-	-	.164	-
log(Q)	.226	-	.077	-	.085	.073	-	.239	-	-
log(YD)	-	.312	-	.285	-	-	.338	-	.354	.151
log(UNION)	.105	.113	.218	.093	.275	.267	.228	.226	.173	.487
log(K&TIME)	.486	.444	.555	.565	.434	.385	.219	.268	.281	.303
log(B/CPI)	.086	.061	-	.108	-	-	-	-	.048	-
DSTAB	-.029	-.026	-.043	-.237	-.048	-.048	-.041	-.046	-.039	-
Constant	7.365	-6.293	-5.630	-6.695	-4.195	-4.122	-4.526	-5.181	-4.937	-3.551
R <sup>2</sup>	.995	.995	.995	.996	.984	.984	.985	.984	.984	.943
R <sup>2</sup> C	.995	.995	-	.996	.983	.983	.984	-	.983	.936
ADF	6.14	6.70	6.17	6.86	6.38	7.31	7.05	7.22	7.01	6.57
CRDW	1.463	1.501	1.401	1.525	1.418	1.422	1.486	1.427	1.426	1.967
SE	.0207	.0201	.0217	.0188	.0350	.0350	.0340	.0356	.0350	.0336

CPI = consumer price index, P = producer prices, P<sub>m</sub> = import prices of raw materials and semifinished products (incl. energy), TOT = terms of trade = P<sub>x</sub>/P<sub>m</sub> where P<sub>x</sub> = export prices of goods and services (export prices of goods only for manufacturing industry), P<sub>h</sub> = prices of dwellings,  $\tau_1$  = employers' social security contributions,  $\tau_2$  = marginal rate of income taxes, Q = output, YD = households' real disposable income, UNION = U/N = unionization rate, K = capital stock, K&TIME which measures the contribution to the productivity of capital stock and technical progress is (K\*\*0.4088)\*EXP(0.00582\*TIME) in the private sector. In manufacturing it is (K\*\*0.3658)\*EXP(0.00811\*TIME). B = unemployment benefits, DSTAB is a stabilization policy dummy which receives the value of one in 1968Q2—1970Q4, and is 0 elsewhere.

In equations (3) and (8) output (Q) has been instrumented. Other independent variables of the equation have been used as instruments. Additional instruments are government real expenditure and imports of countries important for Finnish exports. In manufacturing industry export prices of goods are among instruments as well.

#### 4.1.1 Wages

In the level-form regressions of wages, the signs of the coefficients of all key variables correspond to our a priori expectations. Also, they are highly significant by usual criteria. Higher income taxes add to wage pressures although not with a one-to-one impact. A rise in employers' social security contributions is shifted partly backwards to lower wages.<sup>10</sup> Indirect taxes ( $\tau_3$ ) contribute to the divergence in deflators relevant for employees and employers. An increase in the relative price between consumption and production ( $P_c/P$ ) only partly lowers consumption real wages, and hence, higher labour costs result. The data rejects the wedge restriction which would imply that the coefficients of factors contributing the wedge ( $(1+\tau_1)$ ,  $(1-\tau_2)$ ,  $(P_c/P)$ ) are equal in absolute value.

The impact of relative import prices of raw materials is small which could be expected because of their small import share.

The proxy for union power, the unionization rate, is of special interest for us. Its coefficient is positive in all wage equations, in the range 0.1–0.3, and highly significant by the usual criteria. An inverse effect of the normal working hours on the wage level implying that total earnings do not drop hand in hand with hours worked was found in all regressions. As the coefficient was quite imprecisely defined, however, it was left out from the final equations. The positive wage effect of unemployment benefits implied by the bargaining model is clearcut in the private aggregate sector

As already discussed, three alternative ways to introduce the effect of the product demand were experimented with. As the Table shows, the results are not sensitive to the choice in concern. The equations are almost unchanged also when unionization rate is instrumented with its past values and other exogenous variables of the model.

One of the most interesting findings of this study concerns operationalization of the price deflator,  $P_c$ , relevant to the union. Tyrväinen (1989b) estimated wage equations for 1971Q1–1984Q4 and used the deflator of private consumption stemming from the National Accounts. When the estimation period was prolonged this measure appeared to be inappropriate. When the deflator was replaced by the consumer price index (CPI) the results of the earlier study were restored. This deserves some comments. To begin, the deflator is the more comprehensive measure but this quarterly series is published with a

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<sup>10</sup> Ingberg (1984) estimates that social security contributions influence wages with a weight of about one quarter. Ingberg applies the approach of Holmlund (1983), who obtains a result for Sweden according to which about half of an increase in social security contributions is transmitted to wages within a year's time. This is the short-run effect. Holmlund points out that in the longer term employees will probably bear the burden in full (op. cit. p. 13). Ingberg's results should also be interpreted as short-run effects. A long-run coefficient of -0.7 can be solved from his various equations.

considerable time lag. As the CPI which is monthly series is published with a lag of one month only its use appears to be more straightforward for the wage setters.

In addition, there are substantial differences in the way of calculating the deflator and the CPI. For the present discussion the most important point refers to how the cost of housing is measured. When the new CPI (1985=100) was introduced in 1988 the most significant revision concerned the measurement of housing costs. Half of housing expenses is now considered to arise from capital costs, of which depreciation accounts for two-thirds. The weight of the latter is 4.8 percentage points in the CPI. The "cost" of depreciation is calculated by multiplying the replacement value of the dwelling by a constant depreciation coefficient. The replacement value follows movements in house prices. As prices of dwellings rose by more than 60 per cent from 1987Q3 to 1989Q1 a sizeable gap between the two price measures emerged which also generated additional wage claims on the union side.

In equation (1)–(3), (6)–(7) and (10) the real prices of dwellings, however, play an independent role. This could indicate that unions give an even larger weight to house prices than the CPI. This conclusion is, however, complicated by the fact the Finnish economy was heavily overheated in 1988–1989. There were two reasons for that. The liberalization of the financial markets lead to a credit boom and, simultaneously, the terms-of-trade improved substantially. The first of these factors is difficult to measure whereas the latter is more straightforward.

We have proxied above the strength of demand with the output variable. Because of capacity constraints excessive demand, however, largely boosted imports which lead to a deterioration of the current account. So, output obviously underestimates the product demand in 1988–1989. It may well be that the housing prices capture this effect. To evaluate this we replaced the relative price term  $P_m/P$  by  $P_x/P_m$  or the terms-of-trade in equations (4) and (9). Consumer goods were excluded from the import prices as before. In addition, export prices of services were excluded when manufacturing sector was concerned. In the resulting equations the real housing price lost its explanatory power. This appears to indicate that the term in concern at least partly captures the demand effects discussed above.

Bargaining models imply an equilibrium relation between real wages and employment. First order homogeneity in our wage equations appears to hold in 1971–1989. The devaluation of the Finnish Markka with more than 30 per cent in 1967 and the stabilization policies in 1968–1970, however, substantially influenced the price-wage relation in 1967–1970. Accordingly, the first order homogeneity conjecture is rejected as far as the second half of the 1960's is concerned.

### 4.1.2 Employment

Employment can be measured by two different concepts, the number of employed persons and the number of hours worked. If hours per head change, these two series may differ from each other. Changes may be due to not only cyclical variation in economic activity but also to legislation and agreements concerning normal working hours. Employment measured in time units (hours) appears to be closer to the concept relevant for the production function, the profit function and household income. From the point of view of economic policy, the number of employed persons is the key variable. Equations have been estimated for both heads (N) and hours (H).<sup>11</sup>

As the results can be found in the table, we only comment on them briefly here. The negative effect of employers' social security contributions on employment was discovered in the aggregate private sector. This is in accordance with the wage equations, according to which an increase in the payroll tax is only partly shifted backwards to lower real wages. Similarly, an increase in CPI/P which includes the effect of indirect taxes reduces employment. This influence appears to be larger in manufacturing industry than in the aggregate private sector.

The coefficient of normal working hours was negative in all regressions. This implies that shorter normal working time may have induced an increase — albeit modest — in the number of employed persons.<sup>12</sup> The effect is, however, small and the coefficient varied considerably from one equation to another. This is why we have omitted normal hours from the reported equations.

In general, the equations are not sensitive to the choice of the demand shift variable. The output elasticity of employment is, however, fairly low in comparison with conventional results. This is because we are dealing with reduced-form equations where employment is not explained by wages. If an exogenous increase in product demand raises wages, the adjustment required for employment is smaller than in the conventional structural form equations. Finally, technical progress has reduced the amount of labour needed for a given level of output.

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<sup>11</sup> An interesting topic for further research is whether the determination of heads and hours actually follows different mechanisms. Pencavel & Holmlund (1988) discovered some differences whereas our results below do not give this kind of indication.

<sup>12</sup> Wadhvani (1987) finds a similar although somewhat stronger effect for the UK.

TABLE 2. COINTEGRATING EQUATIONS: EMPLOYMENT

Estimation period: 1965Q1—1989Q4

Estimation method: OLS, except TSLS in equations (13), (16), (19) and (22)

Independent variables	Dependent variable:													
	N = number of employed persons							H = hours worked						
	Private sector				Manufacturing industry			Private sector			Manufacturing industry			
	(11) *	(12)	(13) inst.	(14)	(15) *	(16) inst.	(17)	(18) *	(19) inst.	(20)	(21) *	(22) inst.	(23)	(24)
log(CPI/P)	-.279	-.280	-.289	-.261	-.551	-.523	-.472	-.276	-.283	-.255	-.512	-.513	-.423	-.499
log(P <sub>i</sub> /CPI)	-	-.015	-.011	-	-.162	-.201	-.136	-	-	-	-.163	-.162	-.123	-.133
log(1+ $\tau_1$ )	-.279	-.277	-.297	-.282	-	-	-	-	-	-	-	-	-	-
log(1- $\tau_2$ )	-	-	-	-	-	-	-	-	-	-	-	-	-	.189
log(P <sub>m</sub> /P)	-.017	-.024	-.022	-.001	-.077	-.112	-	-.006	-.007	-.013	-.067	-.067	-	-
log(Q)	.369	.378	.326	-	.394	.577	-	.459	.441	-	.549	.545	-	-
log(YD)	-	-	-	.300	-	-	.541	-	-	.474	-	-	.662	.640
log(UNION)	.035	.031	.033	.023	.124	.093	.140	-.072	-.071	-.091	.014	.015	.037	.063
log(K&TIME)	-.215	-.210	-.153	-.074	-.264	-.382	-.353	-.382	-.365	-.308	-.505	-.502	-.533	-.466
DISD	-.014	-.014	-.014	-.008	-.024	-.029	-.010	-	-	-	-	-	-	-
DN	.009	.012	.017	.029	-	-	-	-	-	-	-	-	-	-
Constant	4.342	4.262	4.528	6.007	4.065	2.839	5.403	3.381	3.486	5.431	2.722	2.748	4.645	4.650
R <sup>2</sup>	.968	.968	.968	.952	.959	.951	.948	.637	.636	.540	.818	.818	.764	.770
R <sup>2</sup> C	.965	.965	-	.948	.956	-	.944	.617	-	.516	.806	-	.751	.755
ADF	5.60	5.88	5.62	6.25	4.72	5.29	5.14	8.50	6.49	2.76	7.00	7.00	7.40	7.42
CRDW	.994	1.064	.957	1.101	.670	.818	.902	1.972	1.970	1.877	1.521	1.521	1.488	1.499
SE	.0086	.0086	.0087	.0105	.0181	.0198	.0203	.0178	.0178	.0199	.0305	.0305	.0346	.0343

CPI = consumer price index, P = producer prices, P<sub>m</sub> = import prices of raw materials and semifinished products (incl. energy), P<sub>i</sub> = prices of dwellings,  $\tau_1$  = employers' social security contributions,  $\tau_2$  = marginal rate of income taxes, Q = output, YD = households' real disposable income, UNION = unionization rate, K = capital stock, K&TIME which measures the contribution to the productivity of capital stock and technical progress is  $(K^{**0.4088}) \cdot \text{EXP}(0.00582 \cdot \text{TIME})$  in the private sector. In manufacturing it is  $(K^{**0.3658}) \cdot \text{EXP}(0.00811 \cdot \text{TIME})$ . D<sub>N</sub> is a dummy referring to a change in statistics and is 1 in 1965Q1—1975Q4, and 0 elsewhere. DISD is a dummy referring to an act improving workers' security against dismissals. It is 1 from 1984Q4 onwards and is 0 elsewhere.

In equations (13), (16), (19) and (22) output (Q) has been instrumented. Other independent variables of the equation have been used as instruments. Additional instruments are government real expenditure and imports of countries important for Finnish exports. In manufacturing industry export prices of goods are among instruments as well.

It was stated above that indirect evidence indicates that the law improving employees' security against dismissal since 1984 have reduced the recruitments. A dummy taking account of this is a key r-h-s variable in all employment equations. The negative impact would have involved around 1.5 per cent of the private sector employees or approximately 20 000–25 000 persons. In manufacturing industry the relative effect appears to be even larger. This is in accordance with earlier evidence.

Stronger unions appear to have increased employment in the manufacturing industry.<sup>13,14</sup> When reviewing the entire private sector, union power obtained a (positive) coefficient close to zero. One although not necessarily the only way to interpret this is to argue that outside the manufacturing industries the union effect on employment would have been negative as the right-to-manage model implies.

The positive employment impact found for Finnish manufacturing contradicts the right-to-manage hypothesis. In the literature, there are several sources for evaluations concerning this result. The generalized model in Manning (1987) analysis the bargaining as a sequential process where the union's influence on wages and employment may be different. In our context the change in union influence on employment may have overruled that on wages. As there are no signs of bargaining over employment on aggregate level this is more attempting interpretation than the one implied by the efficient bargaining model. On the other hand, in a slightly different set-up than ours Moene (1988) shows that an increase in the bargaining power of the union leads to higher employment whenever work stoppages are used as threats in the Nash solution (iii) above. As discussed above, in Finland this argument could be relevant. Finally, if one wishes to verify the favourable effects of increasing "corporatism" (see Calmfors & Driffill (1988)) in an empirical context, Finland would be an obvious candidate. There is hardly any other industrialized economy where the characteristics of the labour market have changed so much since the middle of the 1960s.

The explanatory power of equations for hours worked remains clearly weaker than that of the wage and employment equations. This is due to strong quarterly variation which occurs although the series have been seasonally adjusted. The coefficients are in general close to those obtained for employment. The union impact on hours is negative in the aggregate private sector and zero in manufacturing.

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<sup>13</sup> Alogoskoufis & Manning (1991) find a similar effect for the UK. In their structural form employment equation the coefficient of union density was +0.12 with a t-value of 2.70.

<sup>14</sup> This appears to indicate lower productivity as employment for a given output is higher.



## 4.2 Error Correction Equations

In the second stage of the Granger & Engle procedure an ECM is regressed where the lagged residual of the level-form equation determines the long-run properties of the system. No restrictions are imposed on dynamics. The initially overparametrized ECM is simplified and reparametrized step by step until a parsimonious presentation of the data generating process is achieved (see e.g. Hendry (1986)).

Table A2 in Appendix 3 reports the parsimonious error correction equations. The top of the table indicates the level-form regression with which the difference equation is connected. An example of the initial overparametrized error correction equations is reported in Tyrväinen (1988a).

According to Granger ((1986), p. 217) "Data generated by an error correction model ... must be cointegrated". In this respect, it is noteworthy that the error correction term is highly significant in all our equations. Its magnitude should, however, not be considered as the sole indicator of the speed of adjustment implied by the equation in concern. The dynamics is generated through various channels. In addition to the lagged residual, the contemporary and the lagged coefficients of the shock variable matter as do also the lags of the dependent variable. To evaluate the properties of these error correction equations, simulation of step response functions is required.<sup>15</sup> The convergence is obtained as the difference between the shock solution and the control solution.

Dynamic simulations produced fairly well-behaving paths as can be seen in Figure 1. As far as real wages are concerned the speed of adjustment varies. In some cases the adjustment has by and large taken place within 1 1/2 years whereas in some cases the process is still going on in the third or even fourth year. However, most of the adjustment has generally taken place during the first two years. It is of special interest that inflating only appears to lead to a short-lived and minor reduction in real wages.

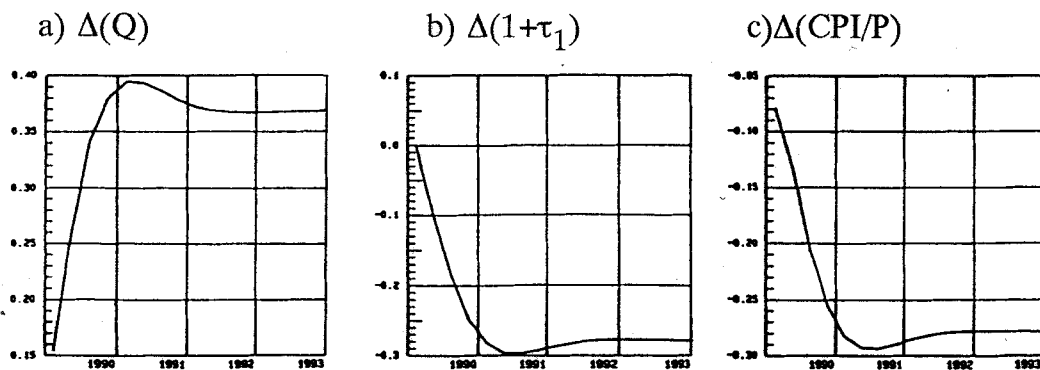
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<sup>15</sup> It is surprising that in the literature there appears not to be a single example of a study applying the two-step method which would have evaluated the properties of the empirical equations by means of dynamic simulations. On the other hand, in so far as the two-stage procedure is concerned dynamic simulation is not primarily a method of stability analysis. The error correction model has been built in a way which ensures convergence towards the long-run solutions implied by the cointegrating regressions provided that the error correction terms receive right signs as in our case.

Figure 1. **Step response functions simulated for real wages and employment**

The figures show the adjustment paths obtained by means of dynamic simulation after a shock has been fed into the system. The shock was induced as a permanent shift of 10 per cent in the level of an explanatory variable in 1990Q1. The simulations which concern private sector are based on equations (1) & (25), and (11) & (28).

### Employment



### Wages

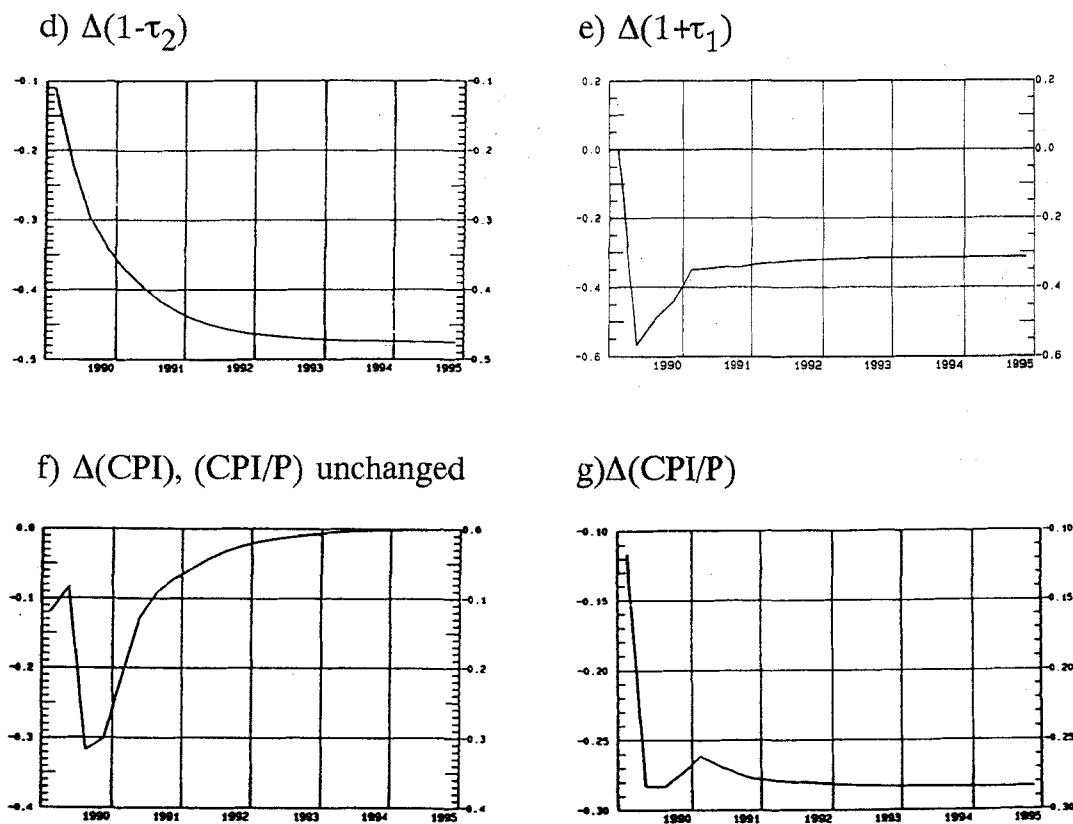


Figure 2a.

**Wage equation in real levels (1), private sector**

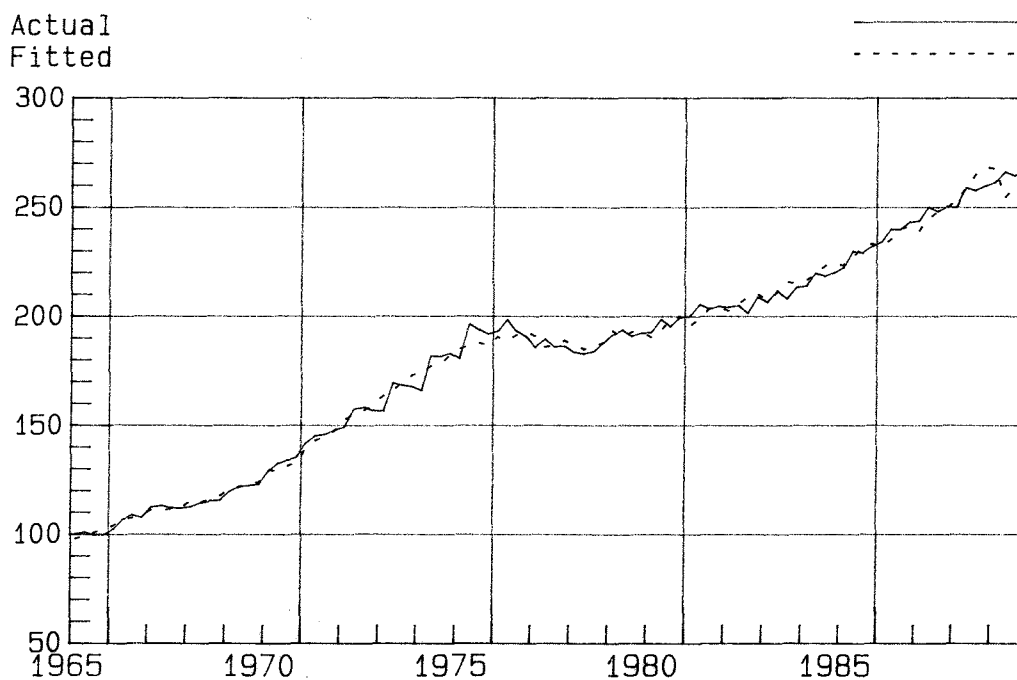


Figure 2b.

**Residual of the equation above**

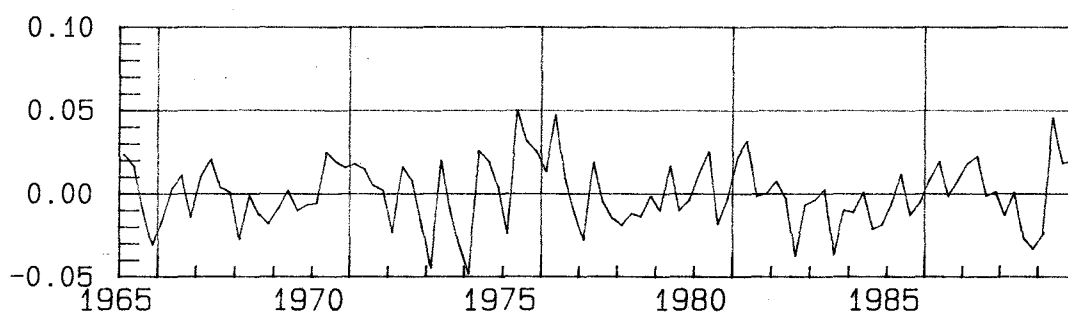
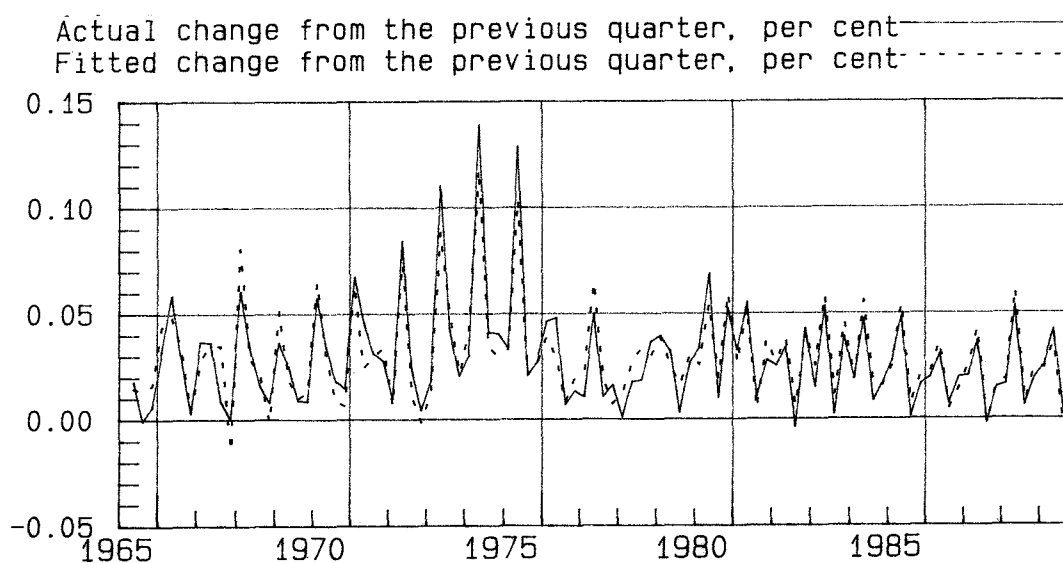


Figure 2c.

**ECM on (nominal) wages (25)**



Employment appears to adjust slightly faster than real wages.<sup>16</sup> The effects of shocks are largely transmitted within one year and the adjustment has fully taken place within two years.

Figure 2 presents the level-form wage equation (1), its error term and the fit of the error correction equation (25). Attention is drawn to the excellent explanatory power of the error correction equation. The high significance level of the error correction term additionally confirms that the error correction hypothesis is well adapted to the Finnish wage dynamics.

Figure 3 introduces the fit of the level-form regression (11) for employment as measured by heads. The residual and the ECM equation (28) are shown below. It can be seen that the actual employment was overestimated in the latter half of the 1970s which was a period of record tight economic policy. The residual confirms the casual evidence of labour hoarding in 1976. Subsequently, a counter effect materialized after economic policy had been sharply tightened. Equilibrium was restored only in 1980. Otherwise, the level-form regression tracks the actual employment well and the standard error is small. Also, the error correction equation works quite nicely.

It is sometimes claimed that the use of the two-stage estimation procedure is dubious. In an early simulation study Banerjee et. al. (1986) argue that the superconsistency property of the coefficients in the first-stage cointegration regression shows up only poorly in small samples. Based on more recent Monte-Carlo simulations, Phillips & Hansen (1990) state that "the reverse is true" (p. 120). Asymptotics are not only relevant but also seem to provide good approximations even for samples as small as 50.

Doubts have been cast on the cointegration tests as well (see Oxford Bulletin of Economics and Statistics, Vol. 48, No. 3, Special Issue on Cointegrated Variables). New light is, however, shed by Blangiewicz & Charemza (1990) on the small sample properties of the ADF test in a multivariate case. Here, the critical values related to the ADF cointegration test do not differ much from the earlier estimates. As far as our test results are concerned, none of them is effected.

A final comment related to the robustness of the results concerns the fact that we have both  $I(1)$  and  $I(2)$  variables in the regressions. Thus, it could be thought that some  $I(2)$  variables on the right-hand side form a linear combination which is  $I(1)$ . It may be reasonable to argue that  $Q$  is  $I(2)$  because  $K$  is  $I(2)$  via the production function. Whether these kind of relations will appropriately work their way through in estimations deserves special attention when the coefficient estimates are evaluated.

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<sup>16</sup> This appears to be in accordance with recent results of Pehkonen (1990) and Pencavel & Holmlund (1988) which argue that the weight of wages in unions' utility functions is substantially larger than the weight of employment. This kind of model generates larger fluctuations in employment than in real wages.

Figure 3a.

**Employment equation in levels (11), private sector**

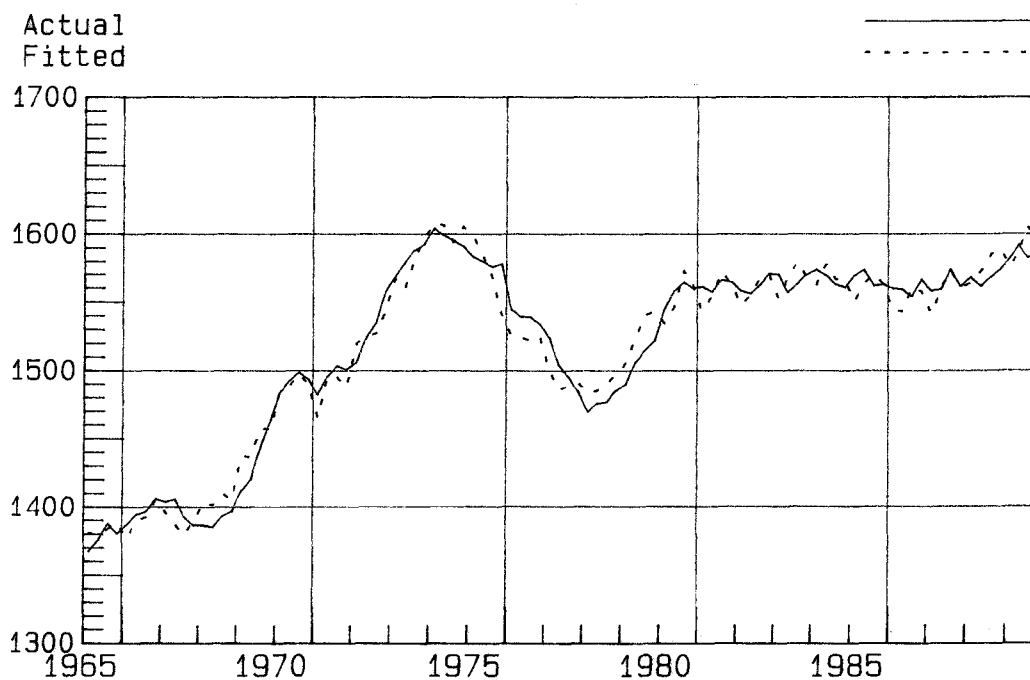


Figure 3b.

**Residual of the equation above**

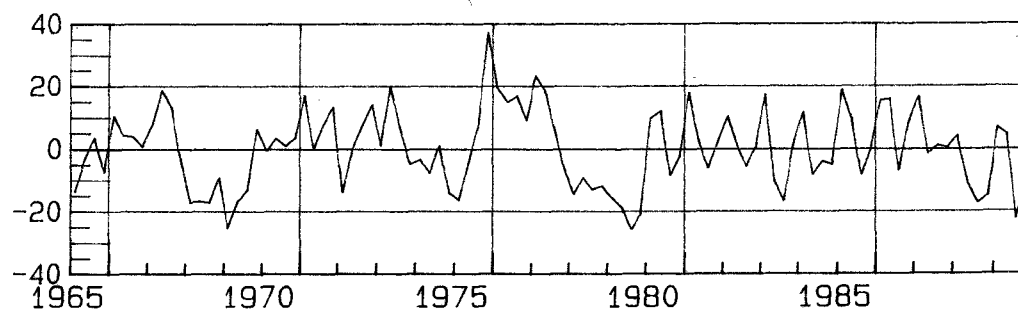
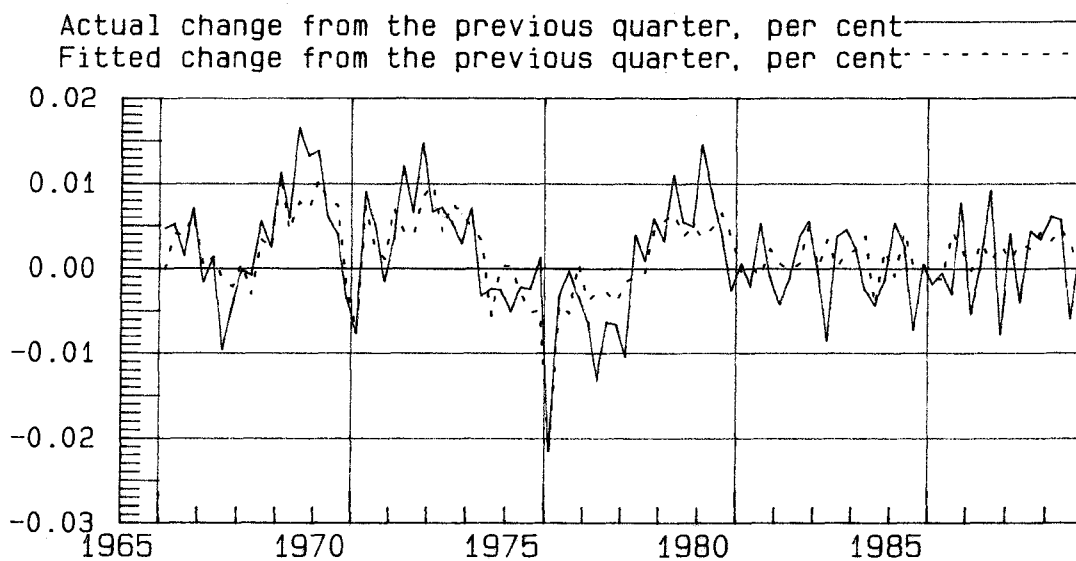


Figure 3c.

**ECM on employment (28)**



As it happens the results are generally 1) in accordance with theoretical considerations, 2) do not contradict earlier evidence from Finland, 3) do make common sense, and finally 4) fit the data well. Hence, the potential problems discussed above appear not to emerge in this context.

The two-stage method is particularly useful when the equations examined are complicated. Especially when it is desired to determine the lag structure freely, the degrees of freedom are often too small for reliable unrestricted estimation of the coefficients of all variables — both in level and difference form — in a single ECM regression. When there are many multicollinear variables both in levels and in differences in a regression, the results are very sensitive even for small changes in the data matrix: not only the magnitudes but even the signs of coefficient estimates are fragile.<sup>17</sup> Hence, the common procedure whereby a two-stage estimation is checked by regressing an ECM in the traditional fashion in one stage may in some cases lead to false conclusions.

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<sup>17</sup> The error correction models corresponding to systems (1) & (25), (11) & (28) and (18) & (30) were also estimated using the traditional estimation technique in one stage. The initial forms of the new equations contained all the relevant variables in level form as well as the difference terms with four lags. The parsimonious equations differed from those obtained with the two-stage method. In many cases the signs of the coefficients differed from those implied by theory, or their magnitude was implausible.

## 5 Conclusions

The model applied in this paper works well with one exception. Against our a priori expectations, in manufacturing industry stronger unions appear to have a positive effect not only on wages but on employment as well. Hence, the right-to-manage hypothesis is rejected as far as manufacturing industry is concerned.<sup>18</sup> As the union density rate — used as the proxy for union power — is a key right-hand side variable we can draw a further conclusion. The result also rejects the monopoly union model, where the union power in wage determination is by definition (constantly) one. If there were no variation in union power, it would be captured wholly by the intercept of the equation. This is especially so in Finland as union wages are applied for non-unionized workers as well.

The hypothesis of monopolistic competition in product markets gains support, since the demand shift factor — no matter how it is proxied — is a key explanatory variable. Higher income taxes add to wage pressures although not with a one-to-one impact. A rise in employers' social security contributions is shifted partly backwards to lower wages. Indirect taxes ( $\tau_3$ ) contribute to the divergence in deflators relevant for employees and employers. An increase in the relative price between consumption and production ( $P_c/P$ ) only partly lowers consumption real wages, and hence, higher labour costs result. As an increase in the (tax) wedge is not fully absorbed by wages lower employment results. The data rejects the wedge restriction which would imply that the coefficients of factors contributing the wedge ( $(1+\tau_1)$ ,  $(1-\tau_2)$ ,  $(P_c/P)$ ) are equal in absolute value. Higher import prices of raw materials and energy reduce both real wages and employment.

According to dynamic simulations adjustment lags are generally not particularly long. This implies that developments in actual employment — in so far as they are considered unfavourable — cannot be attributable primarily to "too slow" adjustment.<sup>19</sup> Rather it is the equilibrium which is inappropriate.

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<sup>18</sup> Having evaluated the matter in light of more recent research we conclude that the bargaining procedure concerned lies between the efficient-bargaining and the right-to-manage models, which follows the conclusion of Alogoskoufis & Manning (1991) for the UK. In a test where the "general bargain model" of Manning (1987) nests the "efficient bargain model" which in turn nests the "labour demand curve model", the latter two specifications were clearly rejected.

<sup>19</sup> This result is in accordance with studies (e.g. OECD (1986)) according to which real wages in Finland are more flexible than in most other OECD countries.

# Appendix 1

As an example, the derivation of the wage and employment equations with explicitly defined functional forms is reported below. In addition to signs of the parameters several parameter restrictions are achieved. In the empirical work these restrictions are, however, not tested. Because the underlying specification includes a complicated set of joint hypothesis, the parameter restrictions for the regression equations become intractable in practice.

A three factor Cobb-Douglas technology  $F(L,K,M)$  relates output to inputs of labour, capital and raw-materials. Gross production or the supply of commodities can be written as

$$Q = Y^a M^{1-a} \quad \text{where } 0 < a < 1, \quad (1')$$

and  $Y$  is value added which is

$$Y = AL^\alpha, \quad \text{where } 0 < \alpha < 1 \quad (2')$$

Here,  $A = Be^{(\lambda t)}K^{(1-\alpha)}$ . The explicit formula for gross production is received by substituting  $A$  and (2') to (1'). That is

$$Q = G^a e^{\gamma a t} L^{a\alpha} K^{a(1-\alpha)} M^{(1-a)}. \quad (3')$$

The technology in concern implies constant returns to scale as  $\alpha + a(1-\alpha) + (1-a) = 1$ . Technological development is embodied in parameter  $t$ .

The price of gross production, producer price ( $P$ ), can also be written as a weighted combination of the value added deflator ( $P_Y$ ) and the prices of commodities and semi-products ( $P_m$ ):

$$P = P_Y^a P_m^{1-a}, \quad (4')$$

and accordingly the value added deflator is equal to

$$P_Y = P^{\frac{1}{a}} P_m^{\frac{1-a}{a}}.$$

The profit of the firm is defined as the difference between its returns and production costs:



$$\pi = PQ - \hat{W}L - P_m M - C \quad (5')$$

$\hat{W}$  includes payroll taxes. When substituting the value added identity,  $P_Y Y = PQ - P_m M$ , into (5'), we get an alternative expression for profits

$$\pi = P_Y Y - \hat{W}L - C. \quad (5'')$$

The firm stays in business only if its profits exceed an exogenously given minimum level  $\pi_0$ . For an active enterprise  $\pi \geq \pi_0$ . Let us assume that the threat point in the Nash-solution refers to a situation in which the firm gives up because this minimum profit condition has been violated. Here, the profit (= loss) equals constant production costs,  $\pi = -C$ .

In Finland, strike is the relevant alternative to an agreement. When the uncertainty aspect of a bargaining process is the risk of a breakdown in negotiations, a von Neumann-Morgenstern specification is a utility function consistent with the game in concern (see Binmore et al. (1986)). The union maximizes a utilitarian welfare function. Its welfare depends on its members' after-tax real wage  $\tilde{w}$  and employment. Membership  $M$  is taken as exogenous. The utility function is

$$U = U(\tilde{w}, L) = L \cdot u(\tilde{w}) + (M - L) \cdot u(\tilde{w}_a) \quad (6')$$

where  $\tilde{w}_a$  is the alternative wage of the members with no union job. For simplicity, we assume at the moment that when the bargaining breaks down, all the union members receive this alternative income and  $\underline{U} = M \cdot u(\tilde{w}_a)$ . So, for the union the excess pay off over the threat payoff is

$$U - \underline{U} = L \cdot (u(\tilde{w}) - u(\tilde{w}_a)).$$

Labour and raw-materials are used so that their relative marginal products equal to their relative prices, that is

$$\frac{F_L}{F_m} = \frac{\hat{W}}{P_m} \quad (7')$$

According to (7'), the optimal use of raw-materials can be solved as

$$M^* = \frac{1-a}{\alpha a} \cdot L \cdot \frac{\hat{W}}{P_m} \quad (8')$$

The firm sells its products on imperfectly competitive markets. It optimizes with regard to the price of its own product,  $\hat{P}$ , facing a well-behaved log-linear downward sloping demand curve, which is defined as:

$$\hat{Q}^d = f(\hat{P})X^{(-1)} = \gamma_0 \hat{P}^\gamma X^{(-1)}, \quad (9')$$

$$\text{where } X = P^\gamma Z^{-\gamma_1}, \quad \gamma_1 > 0.$$

$Z$  is the shift parameter and  $P$  is the price of competitors. It is often assumed that the absolute value of the price elasticity of demand is greater than one,  $\gamma < -1$ . However, if the demand curve is kinked, it may be that  $-1 < \gamma < 0$ . A similar result may occur due to aggregation, even when the firm is competitive. Hence, the elasticity of demand in relation to prices can be anything between zero and (minus) infinity (See Layard & Walters (1978)).

The demand curve (9') gives us the following pricing rule:

$$\hat{P} = \gamma_0^{-\frac{1}{\gamma}} \hat{Q}^{\frac{1}{\gamma}} X^{\frac{1}{\gamma}} \quad (10')$$

As the technology is identical in all firms, the deflator of value added is, thus

$$\hat{P}_Y = \mu_0 \hat{Q}^\mu X^\mu P_m^{-\frac{(1-a)}{a}} = \mu_0 A^{a\mu} L^{\alpha a\mu} M^{(1-a)\mu} X^\mu P_m^{-\frac{1-a}{a}} \quad (11')$$

$$\text{where } \mu_0 = \gamma_0^{-\frac{1}{a\gamma}} \text{ and } \mu = \frac{1}{a\gamma}, \text{ and } -1 < \mu < 0, \text{ if } \gamma < -1.$$

Equation (8') implying optimal use of raw-material inputs is substituted into price equation (11'). The production function and the pricing rule can be used in writing the formula for profits (5")

$$\pi = e_1 A^{1+a\mu} L^{(1-a+\alpha a)\mu+\alpha} \hat{W}^{(1-a)\mu} P_m^{-\frac{(1-a)(1+a\mu)}{a}} X^\mu - \hat{W}L - C,$$

where  $e_1 = \mu_0 \frac{(1-a)}{\alpha a}^{(1-a)\mu}$ . From this we solve the formula for the marginal product of labour,  $\pi_L$ . In equilibrium, the firm operates on the labour demand curve, where  $\pi_L = 0$ .

For the sake of notational simplicity, we consider below a symmetric bargaining game. The parameter  $\beta$  measuring asymmetry in bargaining is discussed in length in Tyrväinen (1988a,b) where the implications of its introduction are analyzed (see also Manning (1987)). The optimization exercise is carried out in terms of value-added (see Andrews (1987)). According to the Nash cooperative solution the problem is as follows:

$$\max_W (U(\tilde{w}, L) - \underline{U})(\pi(\hat{w}, L) - \underline{\pi}) = (N \cdot (u(\tilde{w}) - u(\tilde{w}_a))) (\hat{P}_Y Y - \hat{W}L)$$

s.t.

$$L = e_2 A^{-\frac{1+a\mu}{(1-a+\alpha a)\mu+\alpha-1}} \hat{W}^{\frac{1-(1-a)\mu}{(1-a+\alpha a)\mu+\alpha-1}} P_m^{\frac{(1-a)(1+\alpha\mu)}{a[(1-a+\alpha a)\mu+\alpha-1]}} X^{\frac{\mu}{(1-a+\alpha a)\mu+\alpha-1}}$$

$$\text{where } e_2 = (e_1(1-a+\alpha a)\mu+\alpha)^{-\frac{1}{(1-a+\alpha a)\mu+\alpha-1}}$$

The optimization condition incorporates the right-to-manage hypothesis, according to which firms use labour optimally. Having solved the target wage, optimal employment is found by substituting  $W^*$  into the equilibrium condition above. In logarithmic form, the equations for equilibrium employment and wages are:

$$\log(L^*) = b_0 - b_1 \log(1 + \tau_1) + b_1 \log(1 - \tau_2) - b_1 \log(1 + \tau_3) + \\ b_2 \log(\tilde{w}_a) + b_3 \log(P_m) + b_4 \log(P) + b_5 \log(Z) + b_6 \log(A)$$

and

$$\log(\hat{W}^*) = b_{10} - b_{11}\log(1 + \tau_1) + b_{11}\log(1 - \tau_2) - b_{11}\log(1 + \tau_3) + \\ b_{12}\log(\tilde{w}_a) + b_{13}\log(P_m) + b_{14}\log(P) + b_{15}\log(Z) + b_{16}\log(A)$$

The signs are  $b_1 > 0$ ,  $b_2 < 0$ ,  $b_3 < 0$ ,  $b_4 > 0$ ,  $b_5 > 0$ ,  $b_{11} < 0$ ,  $b_{12} > 0$ ,  $b_{13} < 0$ ,  $b_{14} > 0$ ,  $b_{15} > 0$ ,  $b_{16} > 0$ .  $b_6$  cannot be generally signed.  $b_6 > 0$ , when the price elasticity of the product demand  $\gamma < -1$ . Earlier in this section we concluded that  $\gamma$  can get also values between  $(0, -1)$ . In that case  $b_6 < 0$ .

In the text the wage equation is written for the consumption wage instead of the product wage. Account of this purely technical transformation has been taken as far as the signs are concerned.

## Appendix 2

### DEFINITIONS AND SOURCES OF SERIES

The source is the data base of the quarterly model of the Bank of Finland (BOF4) if not otherwise indicated.

- 1)  $\tau_1$  = rate of employer's social security contribution  

$$= \frac{\text{social security contributions}}{\text{wage sum}}$$
- 2)  $\tau_2$  = marginal income tax rate of the "representative tax payer"
- 3)  $W$  = nominal average (consumption) wage  

$$= \frac{\text{wage sum}}{\text{hours worked}}$$
- 4)  $P$  = producer price  
 = deflator of gross production in the respective sector
- 5)  $P_c$  = consumer prices
- 6)  $P_h$  = prices of dwellings
- 7)  $P_m$  = input price of raw materials and semifinished products (incl. energy), proxied by the import price of raw materials and semifinished products
- 8)  $M$  = raw material input (incl. energy)
- 9)  $U$  = number of union members
- 10)  $N$  = number of persons employed
- 11)  $\text{UNION} = \text{unionization rate} = \frac{U}{N}$
- 12)  $H$  = hours worked
- 13)  $B$  = unemployment benefits  
 Source: Eriksson et al. (1990)
- 14)  $Q$  = gross output
- 15)  $YD$  = real disposable income of households

- 16)  $K$  = capital stock
- 17)  $\text{TIME}$  = time trend
- 18)  $K \ \& \ \text{TIME}$  = contribution of capital stock and technical progress to productivity growth  

$$= (K^h) * (e^{\xi * \text{TIME}}), \text{ where}$$

$$h = \text{income share of capital}$$

$$\xi = \text{rate of increase in overall productivity}$$

$h$  is calculated from the National Accounts as an average over the sample period s.t.

$$h_i = 1 - \frac{(\text{Wage sum} + \text{social security contributions})_i}{\text{value of GDP}_i}$$

where  $i$  refers to the respective sector.  
 $\xi$  is the average over the sample period

$$\Delta \log Q_i - h_i \Delta \log(K_i) - (1 - h_i) \Delta \log(H_i).$$

- 19)  $\text{DCONT}$  = "institutional" dummy which captures the differences in the quarterly timing of wage settlements in different years. The sum of the quarterly dummies is one in each year. If the only rise in the year becomes effective at the beginning of March, the contract raises wages in the first quarter with a weight of 1/3 while 2/3 of the effect is observed in the wage index only in the second quarter. Our contract dummy (DCONT) obtains the value 0.333 in the first quarter and 0.666 in the second (see also Tyrväinen (1988a)).
- 20)  $\text{DSTAB}$  = dummy for stabilization policy. It is 1 in 1968Q2–1970Q4 and otherwise nil.
- 21)  $\text{DN}$  = dummy for a change in private sector employment statistics. It is 1 before the change took place, that is 1965Q1–1975Q4, and otherwise nil.
- 22)  $\text{DISD}$  = dummy referring to an act improving workers' security against dismissals. It is 1 from 1984Q4 onwards and otherwise nil.

# Appendix 3

Table A1.

## Tests for the order of integration Results of an Augmented Dickey-Fuller (ADF)-test

W private sector	I(2)
manufacturing	I(2)
W/CPI private sector	I(2)
manufacturing	I(1)
N private sector	I(1)
manufacturing	I(1)
H private sector	I(1)
manufacturing	I(1)
CPI	I(2)
$P_m$	I(1)
$P$ private sector	I(2)
manufacturing	I(2)
$P_h$ /CPI	I(1)
CPI/ $P$ private sector	I(1)
manufacturing	I(1)
$P_x$	I(1)
$P_x/P_m$	I(1)
$P_m/P$ private sector	I(2)
manufacturing	I(2)
$1+\tau_1$ private sector	I(1)
manufacturing	I(1)
$1-\tau_2$	I(1)
Q private sector	I(2)
manufacturing	I(2)
YD	I(2)
B	I(2)
B/CPI	I(2)
K private sector	I(2)
manufacturing	I(2)
K&TIME private sector	I(2)
manufacturing	I(2)
U	I(2)

Table A2. The Second Stage of the Granger & Engle Two-Step Estimation Procedure: The Parsimonious Error Correction Equations

Estimation method: OLS

Estimation period: 1965Q2-1989Q4, except 1971Q2-1989Q4 in equation (27)

		Cointegrating equation with which the ECM concerned is connected						
		(1)	(5)	(10)	(11)	(15)	(18)	(21)
Explanatory variables	Lag	Dependent variables						
		$\Delta W$ priv. (25)	$\Delta W$ manuf. (26)	$\Delta W$ manuf. (27)	$\Delta N$ priv. (28)	$\Delta N$ manuf. (29)	$\Delta H$ priv. (30)	$\Delta H$ manuf. (31)
Lagged dependent	1	-	.381 (2.69)	.272 (2.45)	.161 (2.27)	-	-.186 (1.93)	.172 (1.35)
	2	-	.221 (2.09)	-	.161 (2.09)	.167 (2.02)	-.398 (5.20)	-
	3	-.091 (2.17)	-	-	-	.302 (3.42)	-.521 (7.40)	-
$\Delta \log(\text{CPI})$	0	.883 (5.99)	-	-	-	-	-	-
	2	-.261 (1.89)	-	-	-	-	-	-
$\Delta \log(\text{CPI}/P)$	0	-.119 (1.82)	.446 (1.78)	-	-.076 (2.84)	-.276 (3.65)	-.141 (1.74)	-.661 (2.37)
	1	-.114 (1.54)	-	-	.034 (1.29)	-	-	-
	3	-	-	-	-	-	-	.388 (2.15)
$\Delta \log(P_v/\text{CPI})$	0	-	-	.667 (2.05)	-	-	-	-
	2	-.138 (3.56)	-	-	-	-.094 (2.15)	-	-
	3	-	-	-.698 (3.15)	-	-	-	-
$\Delta \log(P_m/P)$	0	-	-	-	-	-.034 (1.52)	-	-.118 (1.26)
	2	-	.120 (1.47)	.178 (2.24)	-.024 (3.11)	-	-	-
	3	-	-	-	-.012 (1.55)	-	-	.152 (1.78)
$\Delta \log(1+\tau_1)$	1	-.461 (1.17)	-	-	-	-	-	-
$\Delta \log(1-\tau_2)$	0	-.115 (2.02)	-	-	-	-	-	-
	1	-	-	-.338 (2.88)	-	-	-	-
$\Delta \log(B/\text{CPI})$	2	.214 (1.93)	-	-	-	-	-	-
	3	-.173 (1.67)	-	-	-	-	-	-
$\Delta \log(\text{UNION})$	0	-	-	-	-	-	-.235 (4.02)	-
	1	-	.498 (2.36)	-	-	-	-	-
	2	-	-.550 (2.41)	-2.126 (2.02)	-	-	.102 (2.05)	-
	3	-	-	2.118 (2.47)	-	-	-	-
$\Delta \log(Q)$	0	-.203 (2.39)	-	-	.154 (6.00)	.179 (5.08)	.278 (4.16)	.389 (2.91)
	1	-.206 (2.31)	-	-	-	-	-	-
	2	-	-	-	-	-	.285 (3.13)	-
	3	-	-	-	-	-.113 (2.66)	.323 (3.34)	-
$\Delta \log(K \& \text{TIME})$	1	6.840 (5.26)	-	-	-	-	-.725 (3.37)	-6.405 (2.12)
	2	-	-	-	-	-1.555 (1.96)	-	6.026 (1.90)
	4	-5.707 (4.14)	-	-	-	1.634 (2.12)	-	-
DCONT		.0575 (9.32)	.049 (5.65)	.077 (7.44)	-	-	-	-
$\Delta(\text{DSTAB})$		-	-.057 (4.63)	-	-	-	-	-
$\Delta(\text{DISD})$		-	-	-	-.008 (8.35)	.006 (2.78)	-	-
$\Delta(\text{DN})$		-	-	-	.016 (10.25)	-	-	-
TARGET ERROR	1	-.305 (3.89)	-.926 (4.50)	-.752 (3.76)	-.373 (6.24)	-.310 (5.90)	-.867 (6.23)	-.909 (5.51)
R <sup>2</sup>		.863	.569	.645	.653	.524	.809	.550
R <sup>2</sup> C		.838	.530	.602	.617	.468	.786	.508
DW		1.959	1.916	2.050	1.946	2.017	1.795	2.138
SE		.010	.027	.028	.004	.010	.012	.028

Below the parameter estimates are shown the White's heteroscedasticity adjusted t-ratios. Degrees of freedom correction has been made according to McKinnon & White (1985).

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