A complete list of Working Papers on the last page

No 46, 1981

EFFECTS OF CHANGES IN PAYROLL TAXES - THEORY AND U.S./SWEDISH EXPERIENCES

by

Bertil Holmlund

June, 1981

Abstract

This paper includes theoretical and empirical analyses of some effects of changes in payroll taxes. First, the implications of the standard partial equilibrium analysis is explored in Section II. In particular, the relationships between statutory and economic incidence are clarified and the textbook neutrality conventionally taken for granted is shown to be subject to strong qualifications. It is demonstrated that the wage and employment effects of a one percentage point increase in the employers' contribution generally will differ from the effects of an increase by one percentage point of the employees' tax rate. Given the institutional features of the U.S. income and payroll tax systems, the theoretical results imply that a given increase in the employees' payroll tax rate will induce greater employment reductions (and greater increases in wage costs) than an increase in the employers' part of the tax. This non-neutrality, however, does not prevail when the incidence of incremental payroll tax changes is analyzed; labor's net income loss per tax dollar is exactly the same in the two policy alternatives.

Section III of the paper contains an empirical analysis of wage inflation and its relationship to changes in payroll (and income) taxes. The analyses explore U.S. and Swedish yearly data for three decades. One important conclusion is that the notion of complete backward shifting of the employers' tax has a very weak empirical foundation. The estimates for Sweden reveal that -- at most -- about 40 percent of the tax increases are shifted back onto labor as lower wage increases. There is also evidence showing some forward shifting of income tax increases; nominal wage growth generally tends to be higher when income tax rates are increased.

The analyses on U.S. data are facing more serious multicollinearity problems due to the presence of two payroll tax variables (the employers' as well as the employees' part). Reasonable estimates are only possible to get by imposing a few theoretical restrictions. The result from the constrained estimations is that about 30 percent of increases in the employers' tax are shifted back onto labor within one year. The estimates are also consistent with a forward shifting hypothesis; about 30 percent of increases in the employees' income and payroll tax rates appear to be shifted forward as higher nominal wage growth.

labor earnings exclusive of the employer's tax but inclusive of the employee's income and payroll taxes. A given increase of the employee's payroll tax rate may therefore imply a "large" relative after-tax wage reduction; a corresponding increase of the employer's part will amount to a smaller change of the worker's after-tax wage.

The differences regarding employment and wage effects are likely to be non-trivial given the magnitude of the pre-existing income and payroll tax schemes. This non-neutrality, however, does not prevail when the incidence of incremental payroll tax changes is analyzed; labor's net income loss per dollar of taxes raised appears to be exactly the same in the two policy alternatives. Labor's net income loss in absolute terms, however, is greater for a percentage point increase in the employee's tax.

Section III of the paper addresses one of the empirical issues involved, namely the relationships between nominal wages and payroll tax changes. The evidence indicates some backward shifting of the employers' payroll tax, but the shifting appears to be much less than complete.

II. A partial equilibrium analysis

A simple partial equilibrium framework is sufficient for our purposes. An application of the analysis to a two-factor model,[1] seems to be straightforward, although of questionable value in this context.

Consider an individual who is maximizing a quasi-concave and twice continuously differentiable utility function

$$U = U(Y_n, N_0 - N) \tag{1}$$

1. See Feldstein (1974).

Total differentiation of (4) and (5) results in the system

$$\begin{bmatrix} Q_{NN} & -(1+s) \\ A & (1-p-t)\cdot B \end{bmatrix} \begin{bmatrix} dN \\ dw \end{bmatrix} = \begin{bmatrix} w\cdot ds \\ wB\cdot dp \end{bmatrix} \tag{6}$$

where $A = [2w(1 - p - t)U_{21} - U_{22} - w^2(1 - p - t)^2U_{11}]$ is positive by virtue of the second-order condition, and where B already has been defined. Solving (6) gives

$$\frac{\partial N}{\partial s} = \frac{w(1 - p - t)B}{D} < 0 \tag{7a}$$

$$\frac{\partial N}{\partial p} = \frac{w(1 + s)B}{D} < 0 \tag{7b}$$

$$\frac{\partial w}{\partial s} = \frac{-wA}{D} < 0 \tag{7c}$$

$$\frac{\partial w}{\partial p} = \frac{wBQ_{NN}}{D} > 0 \tag{7d}$$

where D is the (positive) determinant associated with (6). Since w is the worker's gross wage, the different signs of (7c) and (7d) should be of no surprise. The change in labor's net wage due to an increase in the employee payroll tax rate is of course negative.

The partial derivatives are more conveniently interpreted after a reformulation in terms of elasticities, i.e.

$$\frac{1}{N}\cdot\frac{\partial N}{\partial s} = \frac{\varepsilon_D\varepsilon_S}{(1+s)(\varepsilon_S-\varepsilon_D)} \tag{8a}$$

$$\frac{1}{N}\cdot\frac{\partial N}{\partial p} = \frac{\varepsilon_D\varepsilon_S}{(1-p-t)(\varepsilon_S-\varepsilon_D)} \tag{8b}$$

employer's tax; wage costs will -- given reasonable tax parameter values -- increase approximately twice as much in the former case.

Note that we have applied the two payroll tax parameters to the same base, i.e. workers gross earnings wN. This appears to be in conformity with actual practice, but implies nevertheless an asymmetry with non-negligible consequences. The worker's gross earnings wN exclude the employer's tax but include the employee's portion. Defining p' as the employee's payroll tax rate applicable to wage income net of payroll tax payments, and noting that $p = p'/(1-p')$, we can rewrite (7a) and (7b) as

$$\frac{\partial N}{\partial s} = \frac{w[(1+p') - t(1+p')^2] \cdot B}{(1+p')^2 \cdot D} \qquad (7a)'$$

$$\frac{\partial N}{\partial p'} = \frac{w(1+s)B}{(1+p')^2 \cdot D} \qquad (7b)'$$

Hence the textbook neutrality, $\partial N/\partial s = \partial N/\partial p'$, is obtained as a special case for which sufficient conditions are $p' = s$ and $t = 0$. The standard partial equilibrium analysis should obviously be made explicitly contingent on its underlying premises, which appear to be zero taxes initially. The conventional incidence analysis of new taxes is valid only with strong qualifications when actual tax changes are considered.

the same for the two considered policy changes.[1] In other words, net income is reduced more when the employee's tax rate is increased, but tax receipts are simultaneously increased more (compared to a policy of increasing the employer's payroll tax). The net income loss per tax dollar is independent of the chosen policy. In that sense the standard partial equilibrium incidence result remains valid. However, from the viewpoint of raising taxes or affecting employment or wages, it clearly does matter which part of the payroll tax that is increased.

III. Empirical analysis

This section includes an attempt to shed some empirical light on the relationship between wage inflation and payroll taxation in Sweden and the U.S. The Swedish experiences are of special interest here, given the fact that payroll taxes in this country have increased rapidly during the recent decade. Table 1 sets out some basic facts about taxes and inflation in Sweden and the U.S., respectively.[1]

The payroll taxes -- levied on employers only -- have increased from 4 percent in 1950 to nearly 40 percent in the late 70s. The development has been especially dramatic during the 70s, with payroll tax rates increasing from 14 percent in 1970 to 39 percent in 1978. To some extent these tax increases were elements in "soft" government income policies, intended to guarantee real wage increases without "excessive" increases in wage costs. The presumption was that reduced income taxes would result

---

1. A more detailed description is given in Appendix C.

in lower wage demands, and the difference between the "room for wage increases" and actual wage growth could be absorbed by higher payroll taxes.[1]

The increases in U.S. payroll taxes have apparently been much more modest, as revealed by the table. The employer's portion reached an effective rate of 8 percent in 1978, and the total effective payroll tax rate (the employer's plus the employee's portion) was 15 percent in 1980.

Among other details set out in the table it can be noted that Swedish income taxes have been growing much more rapidly than the corresponding U.S. taxes, that prices as well as nominal wages have been increasing faster in Sweden and that real wage growth -- before as well as after taxes -- have been higher in Sweden.

A natural procedure for investigating the shifting patterns of payroll tax changes is to specify and estimate wage equations. This is exactly the approach taken in this paper -- as well as in various other studies. The specification of the wage equation is derived from a simple but informative framework, previously utilized (partly in a slightly different form) by Parkin et al., (1976). The basic elements are as follows: The firms' desired demand for labor depends on the real product

---

1. The concept "room for wage increases" plays a crucial role in the so-called Scandinavian Model of Inflation. See Edgren et al. (1973). The room is defined as the sum of price increases and productivity increases in the sector exposed to foreign competition. Wage increases equal to the room imply of course a constant wage share.

Substitution of (17) and (18) into Eq. (16) and solving for the rate of wage change yield the wage equation:

$$\frac{\Delta w}{w} = \pi_1 \; ED_{-1} + \pi_2 \frac{\Delta P_e}{P_e} + \pi_3 \frac{\Delta s}{1+s} + \pi_4 \frac{\Delta P_c}{P_c} + \pi_5 \frac{\Delta t'}{1-t'} \qquad (19)$$

where

$$\pi_1 = \frac{-\lambda}{\alpha_1 - \beta_1} \qquad (i)$$

$$\pi_2 = \frac{\alpha_1}{\alpha_1 - \beta_1} \qquad (ii)$$

$$\pi_3 = \frac{-\alpha_1}{\alpha_1 - \beta_1} \qquad (iii)$$

$$\pi_4 = \frac{-\beta_1}{\alpha_1 - \beta_1} \qquad (iv)$$

$$\pi_5 = \frac{-\beta_1}{\alpha_1 - \beta_1} \qquad (v)$$

implying the restrictions $\pi_2 + \pi_3 = 0$, $\pi_4 - \pi_5 = 0$ and $\pi_2 + \pi_4 = 1$. The interpretation of these restrictions are:

(i) An increase in the rate of expected product price inflation by one percentage point will have the same effect on wage inflation as a reduction of the employers' payroll tax rate by one percentage point.

(ii) An increase in the expected rate of consumer price inflation by one percentage point will increase wage inflation to the same extent as an increase of the income tax rate (or the employees' payroll tax rate) by one percentage point.

(iii) A simultaneous increase of expected product and consumer price inflation by one percentage point will increase wage inflation by one

Estimation results -- Sweden

The basic model given by Eq. (19) has been estimated on data pertaining to Swedish industry. Price expectations have been captured by current and lagged values of changes in value added prices (P_e) and in the private consumption deflator (P_c). Lagged values of detrended output, $(Q/\hat{Q})_{-1}$, are used to represent excess demand in the labor market.[1] It is by now well known that Swedish unemployment figures are unsatisfactory indicators of the demand pressure in the labor market.[2] The most important reason here is the unemployment preventing role played by Swedish labor market policy; the links between labor market slack and open unemployment have been gradually weakened due to, inter alia, extensive programs of temporary jobs, manpower training and employment subsidies.

A final modification of the basic model takes account of the mechanical wage feedbacks associated with two-year (or three-year) wage contracts. A dummy variable, D, is set equal to one for the second years of two or three year wage agreements between LO and SAF.[3] The dummy variable was multiplied by the lagged dependent variable, $D\cdot(\Delta w/w)_{-1}$, in

---

1. $\hat{Q}$ is obtained as predicted value from the regression $Q = \gamma_0 \exp[\gamma_1 TIME]$. The fluctuations in this "output gap" seem reasonable given other estimates of capacity utilization. The three boom years 1965, 1970 and 1974 have e.g. $Q/\hat{Q}$ as 1.09, 1.10 and 1.08, respectively; these values imply a "ranking" of these years that appear consistent with common notions. For details, see Appendix C.

2. See e.g. the discussion in Björklund-Holmlund (1980) or Schager (1981).

3. Contracts covering more than one year were agreed upon for the years 1957-58, 1960-61, 1962-63, 1964-65, 1966-68, 1969-70, 1971-73, and 1975-76.

LO = Landsorganisationen (The Swedish Trade Union Confederation)

SAF = Svenska Arbetsgivareföreningen (The Swedish Employers Confederation)

Table 2. Tax changes and wage inflation in Sweden. Annual data 1952-78, OLS-estimates.

	(1)	(2)	(3)	(4)
Constant	-0.034 (-0.942)	-0.040 (-1.153)	-0.048 (-1.314)	-0.050 (-1.439)
$\frac{\Delta s}{1+s}$	-0.412 (-1.774)	-0.439 (-6.803)	-0.417 (-1.705)	-0.410 (-6.607)
$\frac{\Delta t}{1-t}$	0.391 (1.464)	0.088 (0.875)	0.313 (1.130)	0.167 (1.971)
$D\cdot(\frac{\Delta w}{w})_{-1}$	0.176 (2.775)	0.196 (3.322)	0.142 (2.237)	0.156 (2.993)
$(\frac{Q}{\hat{Q}})_{-1}$	0.099 (2.810)	0.104 (3.060)	0.109 (2.981)	0.111 (3.237)
$\frac{\Delta P_c}{P_c}$	0.210 (1.969)	0.214 (2.380)	0.162 (1.499)	0.167 (1.971)
$(\frac{\Delta P_c}{P_c})_{-1}$	-0.179 (-1.736)	-0.126 (-1.358)	---	---
$\frac{\Delta P_e}{P_e}$	0.099 (1.932)	0.102 (2.007)	0.112 (2.099)	0.111 (2.175)
$(\frac{\Delta P_e}{P_e})_{-1}$	0.343 (7.745)	0.337 (7.813)	0.293 (8.230)	0.298 (9.061)
$\bar{R}^2$	0.897	0.899	0.886	0.895
DW	2.20	2.32	2.17	2.22
F(rest.)	---	0.777	---	0.155
F-critical (5%)	---	3.55	---	3.52

Restrictions: $\frac{\Delta s}{1+s} + \frac{\Delta P_c}{P_c} + (\frac{\Delta P_e}{P_e})_{-1} = 0$ [(2) and (4)]

$$\frac{\Delta t}{1-t} - \frac{\Delta P_c}{P_c} - (\frac{\Delta P_c}{P_c})_{-1} = 0 \quad (2)$$

$$\frac{\Delta t}{1-t} - \frac{\Delta P_c}{P_c} = 0 \quad (4)$$

Another interpretation of interest is obtained by focusing on wage costs. Since

$$\frac{\Delta w_c}{w_c} = \frac{\Delta w}{w} + \frac{\Delta s}{1+s} \tag{21}$$

it follows that

$$\frac{1}{w_c} \cdot \frac{\Delta w_c}{\Delta s} = \frac{0.6}{1+s} \tag{22}$$

implying that an increase of the payroll tax rate by one percentage point will increase the firms' wage costs about 0.4 percent (for s = 0.4). In the middle of the 60s -- with payroll tax rates around 0.10 -- the corresponding wage cost effects would have been slightly above 0.5 percent.

The estimates clearly indicate that only a fraction of the tax increases are shifted back onto labor (in the form of lower wage increases). How sensitive is this conclusion with respect to changes in specifications, sample periods and variables used? A number of regressions have been run to elucidate these issues. From Table 2 and Table 3 it is clear that the restrictions imposed on the tax and price coefficients are accepted by the F-test; the imposition of the restrictions produces also substantial increases in the t-ratios of the payroll tax coefficients.[1] Other estimations are shown in Appendix A. Table A1 shows results for equations with a different wage variable, pertaining to the whole competitive sector and including wages and salaries for all kinds of employees as well as imputed wage income for the self-employed. It seems clear that

1. Note that the "natural rate restriction" has not been imposed.

The result is not encouraging; all significance is placed on the current payroll tax change variable.

Taking account of the possibility of lags in labor supply and labor demand behavior requires more substantial respecifications of the estimating equations. The procedure is described in Appendix B for a case in which demand and supply adjust within two years. The estimations now imply a tax shifting coefficient of about -0.4 after two years, with the significance falling on the lagged tax change variable. This, however, mainly appears to be the result of the particular constraints imposed, forcing lagged payroll tax changes to equal lagged output price changes. The performance of these equations are generally inferior to the specifications implying factor adjustments within one year.

The basic conclusion of these various exercises is that only a minor part of the Swedish payroll tax is shifted back onto labor as lower nominal wage growth. The "preferred estimate" of the shifting coefficient implies a reduction in nominal wage growth during the first year by 0.3 to 0.4 percentage points for every percentage point increase in the payroll tax rate. No evidence indicates that additional backward shifting takes place with longer lags.[1] The estimated shifting coefficients appear, in fact, to be <u>upper limits</u> of the portion of the tax borne by labor; as shown above it has not always been possible to obtain significant tax-shifting coefficients without forcing the payroll tax coefficient to equal the negative of the output price coefficients.

---

1. Note, however, that the feedback variable $D\cdot(\Delta w/w)_{-1}$ implies a distributed lag when D=1, (i.e. when there are wage contracts covering more than one year).

with results that are ambiguous to an embarrassing degree. Some researchers claim that the employers' payroll tax is completely shifted back within a fairly short period of time; others find no evidence of backward shifting at all.[1] Estimates between the extremes are produced by Hamermesh (1979), who is utilizing longitudinal microdata and arrives at a shifting coefficient around -0.4.

A common problem in these studies of money wage behavior is the presence of correlation between two crucial explanatory variables, namely changes in the employers' payroll taxes and changes in the employees' payroll taxes. The theoretical prediction -- assuming some wage elasticity of labor supply -- is that the former type of change will reduce money wage growth whereas the latter will increase wage inflation. The frequently used procedure of including only changes in one of the two payroll tax variables (most often the employers' part) may result in seriously biased estimates, since the correlation between the excluded and included tax change variables is non-negligible.

The estimations of U.S. wage equations set out in Table 4 are focusing on manufacturing industry. The wage and price variables are those displayed in Table 1. The lagged layoff rate (yearly averages of monthly rates in percent) is applied as excess demand variable and a lagged dependent variable is used throughout to capture positive wage feedbacks.

---

1. For a menue of different results, see e.g. papers by Perry (1970), Gordon (1971), Vroman (1974), Halpern and Munnel (1980), Hagens and Hambor (1979) and Bailey (1980).

Finally, a guidepost dummy, DGDP, takes on the value of one in the years 1962-66.[1]

The first two columns of the table exclude changes in the employees' tax rate, whereas the following two columns exclude the employers' tax. The fifth column includes both payroll tax variables. The variables in the first two equations are correctly signed, although with varying degree of precision.[1] Of special interest here are the tax variables. Eq. (2) indicates that increases in the employers' payroll tax rate are completely shifted back onto labor within two years; a standard test reveals that the sum of the coefficients is insignificantly different from minus one (F = 1.064).

Turning, next, to the employees' payroll taxes we observe estimates of a more surprising nature. Increases in the employee tax rate appear to decrease nominal wage growth, a result clearly at variance with common presumptions about non-negative labor supply elasticities. The final column in Table 5 displays the outcome of including both payroll tax variables in an unconstrained form. The sign of the employee tax variable remains negative, whereas the employers' tax now shows up with a positive sign. Indeed, the estimates are not especially robust and their signs are not totally intuitive!

The obvious candidate explanation of the strange results is, of course, multicollinearity problems. Changes in the employers' and the employees' effective payroll tax rates are highly, although not perfectly,

---

1. In order to reduce the high degree of multicollinearity among the price variables, only the current output price change and the lagged consumer price change were retained.

Table 5. Tax changes and wage inflation in U.S. manufacturing [(1) and (2)] and the U.S. non-farm business sector [(3) and (4)]. Constrained estimates. Annual data, 1949-80.

	1	2	3	4
Constant	0.039 (5.072)	0.039 (5.072)	0.032 (5.869)	0.032 (5.784)
$\frac{\Delta s}{1+s}$	-0.191 (-5.280)	---	-0.442 (-4.030)	---
$\frac{\Delta \hat{s}}{1+s}$	---	-0.192 (-5.301)	---	-0.429 (-3.840)
$\frac{\Delta p}{1-p-t}$	0.238 (2.394)	---	0.164 (1.941)	---
$\frac{\Delta \hat{p}}{1-p-t}$	---	0.243 (2.397)	---	0.178 (2.025)
$\frac{\Delta t}{1-p-t}$	0.238 (2.394)	0.243 (2.397)	0.164 (1.941)	0.178 (2.025)
$(\frac{\Delta w}{w})_{-1}$	0.245 (2.362)	0.236 (2.231)	0.189 (1.936)	0.185 (1.874)
$LAYOFF_{-1}$	-0.008 (-2.472)	-0.008 (-2.430)	---	---
URAM	---	---	-0.002 (-2.372)	-0.002 (-2.256)
$(\frac{\Delta P_c}{P_c})$	---	---	0.110 (1.941)	0.118 (2.025)
$(\frac{\Delta P_c}{P_c})_{-1}$	0.238 (2.394)	0.243 (2.397)	0.055 (1.941)	0.059 (2.025)
$(\frac{\Delta P_e}{P_e})$	0.191 (5.280)	0.192 (5.301)	0.294 (4.030)	0.286 (3.840)
$(\frac{\Delta P_e}{P_e})_{-1}$	---	---	0.147 (4.030)	0.143 (3.840)
DGDP	-0.009 (-2.078)	-0.009 (-2.099)	-0.005 (-1.352)	-0.005 (-1.359)
$\bar{R}^2$	0.900	0.900	0.904	0.901
DW	2.48	2.47	2.50	2.50
F(restr.)	3.882	2.346	1.636	1.302
F-critical (5%)	3.03	3.03	2.68	2.68

in consumer prices and in the private, non-farm, business deflator). The predicted tax rates, $\hat{s}$ and $\hat{p}$ respectively, were used to define the new, wage purged, regressors:

$$\frac{\Delta\hat{s}}{1+s} = \frac{\hat{s}-s_{-1}}{1+s} \qquad (24)$$

$$\frac{\Delta\hat{p}}{1-p-t} = \frac{\hat{p}-p_{-1}}{1-p_{-1}-t_{-1}} \qquad (25)$$

The constrained estimates are given for the manufacturing sector as well as for the whole non-farm business sector. The basic difference between regressions with endogenous and wage purged payroll tax changes is appearing in the F-statistic for the restrictions; the constraints are more likely to be accepted when the instrumental variable procedure is used.

The performance of the constrained regressions is satisfactory by standard criteria. The restrictions are not rejected and the individual coefficients are generally significant, correctly signed and of reasonable magnitudes. The short run (i.e. one year) tax shifting coefficient for the employers' tax is on average about -0.3, indicating that a tax increase of one percentage point will reduce nominal wage rates by somewhat less than a third of a percent in one year. The coefficients for the employees' tax rates are located around 0.2, implying some forward shifting of taxes levied on workers; a tax increase by one percentage point would increase wages by about a quarter of a percent.[1]

---

1. Note that the income tax rate coefficient is fairly robust (although only bordering on significance) in the unconstrained regressions in Table 4.

The results of the paper have some implications for empirical research on the effects of payroll tax increases. The widely adopted Phillips curve approach has appended the wage equation with alternative measures of changes in payroll taxes. Eqs. (8) and (10) above give the "correct" definitions of these candidate arguments of wage equations (correct in the sense of being consistent with the neo-classical partial equilibrium framework). Given the presence of multicollinearity between changes in different tax rates suitable restrictions should be desirable, and the equations derived indicate ways of imposing such restrictions.

In fact, the restrictions used in the empirical section of the paper are essentially those indicated by the theoretical analysis. It appears that increases in the employers' payroll tax are only partly shifted back onto labor as a lower rate of wage growth. This result is more robust in the analyses on Swedish data, and an obvious implication is that Sweden's severe "cost crisis" in the middle of the 70s was partly due to the heavy increases in payroll taxes levied on employers.

The estimates obtained for the U.S. are crucially contingent on the validity of the imposed restrictions; those, however, are not rejected at conventional significance levels. Accepting the constraints it is found that about 30 percent of the employers' payroll tax is shifted back in one year.

Perry, G., "Changing Labor Markets and Inflation." Brookings Papers on Economic Activity, 1970:3, 411-48.

Schager, N-H., "The Duration of Vacancies as a Measure of the State of Demand in the Labor Market. The Swedish Wage Drift Equation Reconsidered." In G. Eliasson, B. Holmlund and F. P. Stafford: Studies on Labor Market Behavior: Sweden and the United States. IUI Conference Reports, Stockholm 1981.

Vroman, W., "Employer Payroll Taxes and Money Wage Behavior." Applied Economics, 1974, 189-204.

Table A2 Tax changes and wage inflation in Sweden. Annual data, various specifications and periods. Dependent variable: Wage changes for adult male industrial workers.

	1	2	3	4	5
CONSTANT	-0.014 (-2.240)	-0.036 (-0.645)	-0.027 (-0.511)	-0.038 (-1.029)	-0.042 (-1.038)
$\frac{\Delta s}{1+s}$	0.215 (0.465)	-0.464 (-5.887)	-0.448 (-6.023)	-0.494 (-1.950)	-0.494 (-1.899)
$(\frac{\Delta s}{1+s})_{-1}$	---	---	---	0.211 (0.848)	0.232 (0.874)
$\frac{\Delta t}{1-t}$	0.582 (1.639)	0.122 (0.697)	0.210 (1.696)	0.419 (1.545)	0.384 (1.261)
$(\frac{\Delta t}{1-t})_{-1}$	---	---	---	---	-0.097 (-0.293)
$D \cdot (\frac{\Delta w}{w})_{-1}$	0.107 (1.174)	0.169 (1.941)	0.134 (1.898)	0.181 (2.821)	0.185 (2.741)
$(\frac{Q}{\hat{Q}})_{-1}$	0.075 (1.238)	0.099 (1.676)	0.087 (1.574)	0.104 (2.891)	0.110 (2.662)
$\frac{\Delta P_c}{P_c}$	0.154 (1.245)	0.209 (1.661)	0.210 (1.696)	0.179 (1.580)	0.179 (1.539)
$(\frac{\Delta P_c}{P_c})_{-1}$	-0.122 (-0.932)	-0.085 (-0.707)	---	-0.211 (-1.909)	-0.218 (-1.878)
$(\frac{\Delta P_e}{P_e})$	0.230 (2.831)	0.150 (2.146)	0.164 (2.474)	0.100 (1.944)	0.089 (1.328)
$(\frac{\Delta P_e}{P_e})_{-1}$	0.328 (6.184)	0.314 (5.726)	0.284 (8.090)	0.353 (7.627)	0.364 (6.152)
$\bar{R}^2$	0.876	0.864	0.868	0.895	0.889
DW	2.04	2.18	2.07	2.20	2.23
F(rest.)	---	1.724	1.578	---	
Period	1952-73	1952-73	1952-73	1952-78	1952-78

Note: Restrictions as in Table 2 in the text.

$$\hat{w} = \pi_1 \, ED_{-1} + \pi_2 \, \hat{w}_{-1} + \pi_3 \frac{\Delta s}{1+s} + \pi_4 \, \hat{P}_e + \pi_5 \left(\frac{\Delta s}{1+s}\right)_{-1}$$

$$+ \pi_6 \, \hat{P}_{e,-1} + \pi_7 \frac{\Delta t'}{1-t'} + \pi_8 \, \hat{P}_c + \pi_9 \left(\frac{\Delta t'}{1-t'}\right)_{-1} + \pi_{10} \, \hat{P}_{c,-1} \qquad \text{(B-6)}$$

where

$$\pi_1 = - \frac{\lambda}{\alpha_1 - \beta_1}$$

$$\pi_2 = - \frac{\alpha_2 - \beta_2}{\alpha_1 - \beta_1}$$

$$\pi_3 = - \frac{\alpha_1}{\alpha_1 - \beta_1}$$

$$\pi_4 = \frac{\alpha_1}{\alpha_1 - \beta_1}$$

$$\pi_5 = - \frac{\alpha_2}{\alpha_1 - \beta_1}$$

$$\pi_6 = \frac{\alpha_2}{\alpha_1 - \beta_1}$$

$$\pi_7 = - \frac{\beta_1}{\alpha_1 - \beta_1}$$

$$\pi_8 = - \frac{\beta_1}{\alpha_1 - \beta_1}$$

$$\pi_9 = - \frac{\beta_2}{\alpha_1 - \beta_1}$$

$$\pi_{10} = - \frac{\beta_2}{\alpha_1 - \beta_1}$$

(v) A simultaneous increase by one percentage point of past wage inflation, past output price inflation and past consumer price inflation will have no effect on current wage inflation. (The reason is that such changes will imply no changes in lagged real wages for firms and for households, and therefore no current period adjustments in labor demand or labor supply are required.)

(vi) An increase by one percentage point of output price inflation as well as of consumer price inflation will increase wage inflation by one percentage point. (This restriction, again, is the natural rate property.)

Estimation results are given in Table B1. The variable capturing effects of long-term wage contracts, $D(\Delta w/w)_{-1}$, was added to the wage equation given by (B-6).

APPENDIX C

DATA - SWEDEN

	w_1	w_2	s	t	P_e	P_c	$Q/\hat{Q}$
1950	2.720	2.6106	4.4910	12.988	.37684	.27800	1.0012
1951	3.290	3.1620	4.3951	15.577	.50440	.31700	1.0356
1952	3.920	3.7557	4.2134	16.650	.52109	.33900	.97700
1953	4.110	3.9072	4.2646	17.159	.47425	.34300	.93623
1954	4.290	4.1412	4.0903	17.027	.48372	.34700	.95359
1955	4.640	4.4521	4.4055	16.754	.49548	.35800	.95535
1956	5.040	4.7645	4.7201	16.697	.51401	.37500	.95655
1957	5.340	5.1072	4.7871	17.284	.51321	.38900	.97151
1958	5.670	5.4615	4.6775	17.246	.50169	.40600	.95291
1959	5.930	5.7342	4.7744	17.301	.50933	.40900	.93000
1960	6.320	6.3221	5.5602	17.890	.51768	.42500	.98365
1961	6.820	6.8916	6.1726	19.214	.52933	.43500	1.0040
1962	7.390	7.5291	7.6894	19.215	.53122	.45500	1.0266
1963	7.910	8.2248	9.5110	19.451	.52143	.46900	1.0259
1964	8.570	8.8714	10.714	19.077	.53940	.52700	1.0743
1965	9.450	9.7456	10.841	20.998	.56174	.55500	1.0909
1966	10.260	10.639	11.376	21.871	.56575	.59000	1.0656
1967	11.100	11.680	12.918	22.889	.56447	.61500	1.0561
1968	11.830	12.600	14.546	23.273	.56037	.62600	1.0612
1969	12.850	13.574	14.706	23.936	.56965	.64600	1.0890
1970	14.280	15.006	14.080	25.202	.61550	.68500	1.1006
1971	15.680	16.669	15.427	24.920	.61835	.73500	1.0857
1972	17.540	18.791	16.787	25.861	.64771	.77600	1.0541
1973	19.050	20.157	17.078	24.351	.71692	.82700	1.0730
1974	21.320	22.713	21.293	25.472	.88008	.90400	1.0834
1975	24.950	26.822	24.562	26.849	.97987	1.0000	.98761
1976	28.160	30.255	31.697	28.054	1.0614	1.1030	.93033
1977	30.400	32.849	35.634	27.318	1.1474	1.2240	.82646
1978	32.980	36.633	39.118	28.465	1.2301	1.3540	.79723

(continued on next page)

DATA - U.S.

	w_a	w_b	s	p	t	P_e^a	P_e^b	P_c	LAYOFF	URAM
1946	---	---	3.6400	1.8088	10.515	---	---	---	---	---
1947	43.856	426.00	3.0069	1.7473	11.256	71.889	51.250	52.875	1.1556	---
1948	47.400	460.00	2.3612	1.6049	10.055	77.642	54.800	55.975	1.3917	3.2
1949	50.158	482.00	2.7283	1.6518	8.9731	76.233	55.350	55.750	2.8000	5.4
1950	51.342	500.00	2.8231	1.9728	9.0709	76.817	56.275	56.900	1.4750	4.7
1951	55.392	537.00	2.9330	2.0137	11.351	86.625	60.000	60.625	1.3583	2.5
1952	58.325	564.00	2.7924	2.0370	12.533	85.350	61.100	62.00	1.5000	2.4
1953	61.583	596.00	2.5941	2.0023	12.338	84.792	62.425	63.200	1.2833	2.5
1954	63.892	617.00	2.7947	2.3501	11.215	85.592	63.375	63.750	2.4333	4.9
1955	65.600	637.00	2.9415	2.4808	11.412	86.200	64.775	64.375	1.5750	3.8
1956	68.942	670.00	3.1096	2.5512	11.923	89.333	66.875	65.600	1.7167	3.4
1957	72.600	703.00	3.4173	2.8112	12.061	92.533	69.250	67.775	1.8417	3.6
1958	75.725	732.00	3.4723	2.8485	11.671	93.633	69.900	69.225	2.7917	6.2
1959	78.250	758.00	3.8911	3.0607	11.965	94.550	71.500	70.550	1.9250	4.7
1960	80.733	784.00	4.3394	3.4017	12.514	94.675	72.600	71.900	2.2667	4.7
1961	83.133	808.00	4.3926	3.4532	12.458	94.442	73.050	72.625	2.3667	5.7
1962	85.325	835.00	4.6972	3.4558	12.815	94.433	74.100	73.700	1.9667	4.6
1963	87.458	859.00	4.9541	3.7575	12.934	94.292	75.050	74.850	1.8583	4.5
1964	89.783	882.00	4.7899	3.7412	11.739	94.700	75.875	75.875	1.6833	3.9
1965	92.025	912.00	4.6133	3.6809	12.000	95.958	77.075	77.175	1.4500	3.2
1966	94.992	953.00	5.2840	4.4682	12.667	98.667	79.150	79.425	1.2083	2.5
1967	99.175	1000.0	5.3340	4.8305	13.032	99.808	81.600	81.325	1.3750	2.3
1968	104.95	1062.0	5.3399	4.8661	14.075	102.12	84.700	84.625	1.2500	2.2
1969	111.30	1132.0	5.5752	5.0856	15.338	105.50	88.675	88.400	1.1167	2.1
1970	118.27	1207.0	5.5996	5.0802	14.277	109.70	92.875	92.525	1.7417	3.5
1971	126.13	1292.0	5.8378	5.2704	13.438	113.26	97.075	96.450	1.6417	4.4
1972	133.88	1375.0	6.2576	5.4272	14.826	117.12	100.0	100.00	1.2083	4.0
1973	141.97	1460.0	7.0918	6.0599	14.146	126.80	103.78	105.65	.90833	3.2
1974	153.36	1575.0	7.3736	6.2629	14.567	148.61	113.93	116.30	1.2417	3.8
1975	168.97	1706.0	7.4965	6.2564	13.352	169.76	125.13	125.12	2.2833	6.7
1976	182.24	1830.0	7.9248	6.2337	14.150	177.68	131.53	131.63	1.2917	5.9
1977	196.62	1968.0	8.0780	6.2128	14.723	188.17	139.15	139.50	1.1917	5.2
1978	212.95	2129.0	8.3320	6.3010	15.033	201.37	148.85	149.00	.9500	4.2
1979	231.47	2298.0	8.6111	6.5256	15.538	223.75	161.52	162.28	1.0667	4.1
1980	254.08	2506.0	8.6195	6.5395	15.675	256.54	177.08	178.90	1.8667	5.9

(continued on next page)