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INCIDENCE EFFECTS OF PROPOSED REFORMS FOR THE PAYROLL TAX IN FINNISH MANUFACTURING*

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The main proposals for the reform of payroll-based employers' social security contributions have been the (partial) replacement of the contribution by increased sales tax and the so-called SII-contribution, in which the base would consist of the wage bill and the operating margin of the firm. In this study models for the determination of wages, employment and investment in Finnish industry are estimated. These models are then used to simulate the effects of the proposed reforms on the same variables.

The effects of both reform proposals are qualitatively similar. Both reforms would raise nominal wages and employment. They would also reduce capital formation. Real wages would probably remain roughly constant in the case of the SII-contribution, while they would fall in the shift to sales taxation. In percentage terms, the effects on the real variables would be small, less than one percentage point in magnitude. The effects on real wages depend on the degree of shifting of the increased sales tax or SII-contribution to output prices. Both reform proposals aim at moving away from a method of finance that is based entirely on a payroll tax towards a general tax on factors of production. (JEL H22, J38)

1. *Introduction*

In Finland the employer's social security contribution or the payroll tax, which is based on the wage bill of the firm, has been subject to a good deal of debate and discussion. While different kinds of reforms have been suggested, it seems fair to say that there have been two major proposals for changing the current payroll tax.[1] The first one, developed e.g. in a

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** *Academy of Finland.*

[1] *It should be noted that the Finnish old-age and disability pension system consists of two parts. All citizens are eventually entitled to a basic pension, which is approximately the same for everybody. This system is administered by the Social Insurance Institute and it is by and*

Committee report (1987) by the Ministry of Social Affairs, is a (partial) substitution of the payroll tax by increasing the sales tax. The extent of substitution was never made precise. The second main proposal, developed in a Committee Report (1987) of the Social Insurance Institute is an alteration of the current base for the contribution, so that the new base would consist of the sum of the wage bill and the operating margin of the firm. This suggested contribution was named the SII contribution.

The economic effects of these suggested reforms have so far been studied with the aid of the Bank of Finland macroeconometric model (BOF4 model). The study using a computable general equilibrium model for Finland, done by Honkapohja & Törmä (1988), was a tentative experiment, since the GEMFIN model was at a preliminary stage or development.[2] While such models give an overall view of the economy-wide effects of the proposals, the results for individual sectors are typically quite imprecise. Moreover, the interpretation and significance testing for results of this kind is difficult, so there remains considerable uncertainty about their reliability. There is, therefore, a need for further studies of economic effects at industry level.

In this paper we look at the incidence of these two reform proposals in Finnish manufacturing with the aid of a partial equilibrium framework. With it we hope to produce more precise results about the effects of the proposed reforms on this central sector of the Finnish economy. Moreover, we can assess the reliability of the attained results by computing approximate confidence intervals for the simulated results of reforms. This paper is partly based on and extends the earlier study by Honkapohja and Koskela (1990).[3]

The computation of the effects of the proposed reforms is done by solving numerically a system of three equations describing the partial equilibrium of the capital stock, employment and wages in the long run.[4] A necessary first step for such an exercise is the construction and estimation of econometric models for nominal wages, hours of work, and investment in fixed capital. Though in Finland there already exist a number of studies of these relations,[5] they have typically been carried out using formulations that are not easily adapted for a study of incidence effects. For this reason, we experimented with a variety of different specifications using annual data over the period 1960–1987.

The policy proposals are formulated as two scenarios for the simulations. In the first (scenario A, the SII alternative) the current system of payroll tax (to finance basic pensions, see fn. 1) is abolished, and the new SII contribution is substituted its place. The rate for the SII contribution is taken to be such that for the whole Finnish economy the revenue from the contribution is roughly equal to the revenue from the current payroll tax. In the second (scenario B, the sales tax alternative) the current payroll tax (to finance basic pensions, see fn. 1) is again abolished, and the rate of the sales tax is increased again in such a way that the resulting new tax revenue approximately equals the yield from the payroll tax. The reliability of the simulation results is considered by computing the confidence intervals of the results in the two scenarios.

The structure of this paper is the following. Since it was necessary to start the analysis by experimenting with alternative models for wage determination, employment, and capital formation we report these exercises first in section 2. The experiments provide a basis for the selection of the model for the policy analysis. This is done in section 3. Section 4 is the core of the paper. It contains a precise description of the simulations of the two policy scenarios and the policy results obtained. Section 5 contains concluding remarks.

large financed by employers' and employees' contributions. In addition, there exists a supplementary pension system, the benefits of which are based on earlier wage earnings. This system is administratively different from the basic pension system, and historically it has been financed entirely by contributions formally paid by the employer. The reform proposals analyzed and discussed here all concern only the basic pension system and its financing.

[2] *See Honkapohja (1988) for a summary and discussion of the results of these experiments. For a general review of various studies of social security financing reforms in different countries see e.g. Schmäl (1987).*

[3] *That study is published only in Finnish.*

[4] *In fact, we solve the Taylor approximation of the nonlinear system.*

[5] *See e.g. Suomen Pankin Neljännesvuosimalli BOF4 (1987) and Eriksson et al. (1990) for examples and further references.*

2. Wages, Hours of Work and the Capital Stock: Experiments with Alternative Specifications

As a necessary first step for the evaluation of the effects of the proposed tax reforms we have to construct and estimate econometric models for nominal wages, hours of work and investment in fixed capital in the Finnish manufacturing. This section reports experiments with alternative specifications. Since the core of the paper lies in the applied policy analysis, and not in testing theories, the equations to be estimated have not been derived from the common theoretical framework.[6] In that sense the equations to be estimated are ad hoc, though they can be qualitatively justified in terms of conventional theories of wage determination and in terms of the theory of the demand for factors of production. In what follows we use annual data over the period 1960–1987. The data comes from the BOF4 Quarterly model of Finnish Economy of the Bank of Finland. In section 2.1, we report experiments with alternative models for nominal wage and hours of work determination, while section 2.2 deals with investments in fixed capital.

2.1 Nominal wages, hours of work and taxation

There are several approaches to study the labour market effects of taxation. Simplifying a bit, one can distinguish between the approach, according to which wages and employment are determined by the demand and supply of labour in the competitive labour market, and the union bargaining approach, according to which wages are negotiated between the representatives of the labour union and employers and employment is demand-determined [see e.g. Holmlund (1983) and Farber (1986)].

Even though the latter approach would seem to be more realistic under the Finnish institutional circumstances, the choice between them is not, however, totally straightforward. First, the existence of wage drifts suggests that contract wages are not the only determinants of actual wages. Moreover, it is worth pointing out that both approaches lead to qualitatively rather similar hypotheses about the determination of nominal wages and employment; in the competitive labour market the behaviour of employees is to be seen via labour supply, while in the bargaining approach via the objective function of the labour union. Because alternative approaches gave rather similar results, we decided to rely on the competitive labour market approach in subsequent analyses.[7]

We assume that the demand for labour L^d depends on the wage rate w, the payroll tax s, the 'price' of the capital stock c, the producer price q, the proxy for aggregate demand, and the time trend factor T reflecting technical progress. The appropriate definition of the price of the capital stock – the user cost of capital – is a complex issue [see e.g. Nickell (1978, chapter 9) or Koskenkylä (1985) for a discussion of the issues involved]. In what follows we have used the following formula for the user cost of capital

$$(1) \quad c_t = g_t(r_t + \delta_t - \pi_t^e)(1 - u_t z_t)/(1 - u_t).$$

In (1) g is the price of investment goods, r is the nominal interest rate, δ is the capital depreciation coefficient, π^e is the expected rate of change in g, u is corporation tax rate, and $z_t = \xi_t/(\xi_t + r_t)$ describes the present value of the tax depreciation associated with one unit of capital stock. ξ is the tax depreciation coefficient of the capital stock (for a derivation of c_t and an estimation of π_t^e, see section 2.2 below).

The labour supply L^s is in turn assumed to depend on the wage rate w, the marginal tax rate t, the consumer price p and the trend factor T reflecting other potential determinants of the labour supply. Finally, assuming that the nominal wage rate is determined by the equality of demand and supply and assuming the log-linear functional forms gives the nominal wage equation, which depends positively on

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[6] *This kind of study with a different focus has been reported in Holm & Honkapohja & Koskela (1992).*

[7] *Drawing from Holmlund and Skeringer (1988) we estimated the wage drift equation by using the so-called »right-to-manage» model, according to which wages are negotiated between representatives of employees and employers and hours of work are demand-determined. Though it is difficult to make direct comparisons with the results reported in section 2.1, the wage drift equations do seem to lie in conformity with the incidence effects obtained using the competitive labour market approach. See Honkapohja and Koskela (1990) for details.*

factors which increase labour demand and negatively on factors which increase labour supply. It is natural to assume that the higher is production, the higher are the wages, ceteris paribus. We proxied the 'tightness' of the labour market (a proxy for aggregate demand) by the logarithmic trend deviation of output, $\log(\hat{Q}/Q)$. Log $(\hat{Q})$ denotes the OLS estimate from $\log(Q_t) = \alpha + \beta T + \varepsilon_t$, with ε_t as the error term. The resulting nominal wage equation in an unrestricted form was written after some experimentation as

$$(2)\ D\log(w)_t = \alpha_0 + \alpha_1 D\log(1+s)_t + \alpha_2 D\log(1-t)_t + \alpha_3 D\log(p)_t + \alpha_4 D\log(q)_{t-1} + \alpha_5 \log(\hat{Q}/Q)_t + \alpha_6 D\log(c)_{t-1} + v_t$$

where $Dx_t = x_t - x_{t-1}$ and where the subscript t refers to the time period and v_t is the error term.

Table 1. OLS estimation results of the nominal wage equation (2)

	coefficient estimates	t-ratio
constant	.060	(12.1)
Dlog(1+s)	–.176	(–4.1)
Dlog(1–t)	–.424	(–7.6)
Dlog(p)	.424	(7.6)
$D\log(q)_{-1}$	.176	(4.1)
$\log(\hat{Q}/Q)$	.203	(6.6)
$D\log(c)_{-1}$	–.004	(–2.9)
R^2	.957	
DW	1.69	
Chow	1.39	
B-P-G	7.65	
AR(1)	.070	(.4)
AR(2)	–.203	(–1.0)
AR(3)	–.121	(–.6)
AR(4)	–.046	(–.2)

R^2 is the adjusted multiple correlation coefficient. DW is the Durbin-Watson Statistic for the first-order serial correlation. Chow is the stability test statistic, its 5% critical value being 2.85 (with (5.16) degrees of freedom), B-P-G is the Breusch-Pagan-Godfrey heteroscedasticity test statistic, its critial 5% value being 9.5 (with 4 degrees of freedom). Finally, the statistics AR(i), where i refers to the degree of autocorrelation, are the LM-statistics for the i:th order autocorrelation. For more details on the test statistics, see e.g. Harvey (1981).

We started by testing for the following parameter restrictions associated with the basic equation (2): (i) $\alpha_1 = -\alpha_4$, (ii) $\alpha_2 = -\alpha_3$ and (iii) $\alpha_3 + \alpha_4 = 1$. The corresponding test ratios were –1.701, –.184, and –8.250 respectively with the 5 per cent critical value being $t_{.025}(19) = 2.09$.

Thus (i) and (ii) can be allowed for, but the restriction (iii) has to be rejected. The OLS estimation results of this partially restricted nominal wage equation are reported in Table 1. The following features of results merit attention: First, the diagnostics of the equation show neither autocorrelation, heteroscedasticity of the error term, nor signs of instability. Second, the parameter estimates are of the expected sign and rather precisely estimated. The payroll tax affects the nominal wages negatively, while the marginal tax rate seems to have a positive (and stronger) effect. Moreover, the consumer and producer prices affect wages positively. A rise in the user cost of capital tends to decrease labour demand and thereby the nominal wages. Finally, it should be mentioned that according to the estimation results 60% of the price changes have been reflected in the changes in nominal wages.[8, 9, 10]

[8] *These estimates are very close to those reported in Ingberg (1984) with somewhat shorter Finnish data and slightly different from those obtained by Holmlund (1983) with Swedish data.*

[9] *The estimation results here (as always) might be sensitive to seemingly minor changes in the specification. For instance in Sweden, it has been noticed that the precise role of the payroll taxes may depend on the measure of the tightness of labour markets to be used (see e.g. Bosworth and Lawrence (1987)). In order to check this we estimated the nominal wage equation (2) by using a direct labour market measure – the log difference of the job vacancy rate – as an alternative proxy for the labour market tightness. The estimation results both in terms of the size of the coefficient estimates as well as in terms of their statistical significance were very similar to those reported in Table 1. But using the job vacancy rate gave rise to a first-order autocorrelation of the error term. A complete set of results is available from the authors upon request. Finally, one might mention that the coefficient estimates of the tax variables reported in Table 1 are very close to those reported in Holm & Honkapohja & Koskela (1992) in which a rather different (game-theoretic) framework was used.*

[10] *Earlier we noted that the parameter restriction $\alpha_3 + \alpha_4 = 1$ had to be rejected. This implies that we cannot use the estimated nominal wage equation to solve the wage elasticities of the demand for labour on the one hand and the supply of labour on the other.*

As mentioned earlier we assumed that the demand for labour depends on the producer real wage, w/q, the payroll tax rate s, the user cost of capital (c), the amount of production Q as a proxy for aggregate demand and the trend factor T reflecting technical progress. We allowed for partial adjustment and on the basis of some preliminary estimations transformed the partial adjustment equation into the following unrestricted difference form

$$(3)\quad \mathrm{Dlog}(L)_t = \beta_0 + \beta_1 \mathrm{Dlog}(w/q)_{t-1} + \beta_1(1-\sigma)\mathrm{Dlog}(1+s)_{t-1} + \beta_2 \mathrm{Dlog}(Q)_t + \beta_3 \mathrm{Dlog}(c/q)_{t-1} + \beta_4 \mathrm{Dlog}(L)_{t-1} + \varepsilon_t$$

where the potentially different effects of the real producer price and the payroll tax has been taken into account, and where ε_t refers to the error term.

We started by estimating the demand for hours of work equation (3) in a non-linear form in order to get the parameter estimate for σ. We could not, however, reject the hypothesis that $\sigma = 0$. The test statistics of the restriction $\beta_1 = -\beta_3$ is –2.104 with the 5 per cent critical value being 2.07. Thus the restriction that the costs of factors of production affect in a ratio form was rejected. The OLS estimation results of the partially restricted demand for hours of work equation are reported in Table 2.

The estimation results can be briefly summarized as follows. First, while diagnostics indicate neither autocorrelation nor instability of the specification, there are signs of heteroscedasticity of error term. Therefore the standard errors have been corrected by using White's (1980) procedure. Second, the parameter estimates are of the expected sign and reasonably precisely estimated. The gross producer real wages affects the demand for hours of work negatively, and the production as a proxy for aggregate demand positively. A rise in the user cost of capital will decrease the demand for hours of work.

Table 2. OLS estimation results of the demand for hours of work equation (3)

	coefficient estimates	t-ratio
constant	–.022	(–3.1)
$\mathrm{Dlog}(w/q)_{-1}$	–.121	(–2.0)
$\mathrm{Dlog}(1+s)_{-1}$	–.121	(–2.0)
$\mathrm{Dlog}(c/q)_{-1}$	–.006	(–2.8)
Dlog(Q)	.583	(7.0)
$\mathrm{Dlog}(L)_{-1}$	.308	(6.2)
R^2	.865	
DW	1.65	
Chow	2.64	
B-P-G	10.15	
AR(1)	–.001	(–.0)
AR(2)	.039	(.2)
AR(3)	.095	(.5)
AR(4)	.249	(1.3)

t-ratios are White's heteroscedasticity adjusted t-ratios, R^2 is the adjusted multiple correlation coefficient, DW is the Durbin-Watson statistic for the first-order serial correlation, Chow is the stability test statistic (with (5.16) degrees of freedom), its 5% critical value being 2.85, B-P-G is the Breusch-Pagan-Godfrey heteroscedasticity test statistic, its critial 5% value being 9.49 (with 4 degrees of freedom). Finally, the statistics AR(i), where i refers to the degree of autocorrelation, are the LM-statistics for the i:th order autocorrelation. For more details on the test statistics, see e.g. Harvey (1981).

2.2. Investment in fixed capital, relative prices and taxation

In order to do policy analysis of tax reform proposals the information about the effects of taxes on the real investments in fixed capital was also needed. Therefore, we constructed and estimated econometric models for investments in fixed capital by using the annual data from the Finnish manufacturing industry over the period 1960–1987.

We used the neoclassical theory of investment as the theoretical framework. Its main elements can be described very briefly as follows. Denote the firm's net cash flow at the moment t so

$$(4)\quad Y_t = q_t Q_t - w_t(1+s_t)L_t - g_t I_t - R_t\,,$$

where I is the volume of gross investments and R is the taxes paid by the firm. The taxes are determined according to

$$(5)\quad R_t = u_t[q_t Q_t - w_t(1+s_t)L_t - G_t]$$

where u is the corporate tax rate and G refers to the tax depreciation factors. Assume that the production function Q=F(K,L), where K is real capital stock, is strictly concave and describe the change in the capital stock by

$$(6) \quad DK_t = I_t - \delta K_{t-1},$$

where δ is the capital depreciation coefficient. The firm is assumed to choose gross investment so as to maximise the present value of the net cash flow subject to (6). This gives the desired capital stock as a function of tax-adjusted relative prices as follows $K_t^* = K\{(c/q)_t, [w(1+s)/q]_t\}$, where the user cost of capital is defined as in the equation (1). This demand function for capital is based on the assumption of perfect competition in the goods market. If firms are subject to a binding demand constraint, then the relevant demand function is of the form

$$(7) \quad K_t^* = K\{[w(1+s)/c]_t, Q_t\}$$

where Q refers to the demand constraint [see e.g. Grossman (1972)]. Finally, if firms face a negatively sloped demand curve for their products, then under certain additional assumptions we get the following demand for capital function

$$(8) \quad K_t^* = K\{(c/q)_t,\ [w(1+s)/q]_t, Z_t\},$$

where Z_t describes the position of the demand curve [see Nickell (1978) and Koskenkylä (1985) for more details]. There are two major differences between the demand functions (7) and (8). In the cost minimization case (7) the tax-adjusted relative price of factors of production is relevant together with the demand constraint Q, while in the case of the downward-sloping demand curve (8) the real tax-adjusted prices of factors of production enter as separate arguments and Z is not the demand, but describes a position of the demand curve in the price-quality space.

As for the functional form we specified and tested for linear and log-linear forms for (7) and (8), respectively. Moreover, it is natural to allow for slow adjustment of the capital stock to its desired level: for the linear specification we postulated the following adjustment mechanism $DK_t = \zeta(K_t^* - K_{t-1})$ and for the log-linear specification $D\log(K_t) = \zeta \log(K_t^*/K_{t-1})$, where D is the difference operator. This gives four alternative specifications to be estimated and tested, namely the linear and log-linear specifications both for the cost minimization case (7) and for the downward-sloping demand case (8) respectively:

$$(9{:}i) \quad I_t = \kappa_0 + \kappa_1 Q_t + \kappa_2 [w(1+s)/c]_t + \kappa_3 K_{t-1}$$

$$(9{:}ii) \quad I_t = \kappa_0' + \kappa_1' Z_t + \kappa_2' [w(1+s)/q]_t + \kappa_3' (c/q)_t + \kappa_4' K_{t-1}$$

$$(10{:}i) \quad D\log(K_t) = \theta_0 + \theta_1 \log(Q_t) + \theta_2 \log[w(1+s)/c]_t + \theta_3 \log(K_{t-1})$$

$$(10{:}ii) \quad D\log(K_t) = \varphi_0' + \varphi_1' \log(Z_t) + \varphi_2' \log[w(1+s)/q]_t + \varphi_3' \log(c/q)_t + \varphi_4' \log(K_{t-1})$$

In the capital stock equations the expected rate of change of the price of investment goods is unobservable. We assumed that the expectations are formed according to the error-learing formula

$$(11) \quad \pi_t^e = (1-\tau)\pi_{t-1}^e + \tau\pi_{t-1},$$

where τ is the adaptation parameter to be estimated. We estimated the specifications (9:i and 9:ii) and (10:i and 10:ii) for alternative values of τ and chose the value $\tau = .4$, which gave the highest value for the log-likelihood function.[11] This value was used in all subsequent analyses.

For the linear specifications we first allowed for the separate effects of the wage rate and payroll tax rate and specified the following unrestricted form

$$(12) \quad I_t = \kappa_0 + \kappa_1 Z_t + \kappa_2 (w/q)_t + \kappa_3 [(1+s)/q]_t + \kappa_4 (c/q)_t + \kappa_5 K_{t-1}$$

We tested for the following parameter restrictions for this specification: (i) $\alpha_2 = -\alpha_4$ and its elasticity equivalence. $\alpha_4 = -\alpha_2 (w/c)$, (ii) $\alpha_2 = \alpha_3$ and its elasticity equivalent $\alpha_3 = \alpha_2 [w/(1+s)]$. These restrictions were tested under the following alternative proxies for Z: the real private consumption expenditure, the

11 In these estimations production was used as a proxy for the position of the demand curve. A complete set of results is available from the authors upon request.

sum of the real private consumption and investment expenditures, the real gross national product, and the lagged values of these variables.

The parameter restrictions (i) and (ii), when tested separately, were rejected, but with the wage variable of the form [w(1+s)/q] we could not reject the restriction (i) particularly in its elasticity form. Test results are thus partly ambiguous. In estimations the signs of the wage and payroll variables were sensitive to the choice of proxy (Z), but the gross wage variable turned out to fit the data best in the hours of work and the log-linear investment equations. For these reasons and in order to facilitate comparisons between various functional forms the wage and the payroll tax variables are combined in the estimations below. The OLS estimation results for the specification (9:i), which describes the gross investment equation under a binding demand constraint, are reported in Table 3a.

Diagnostics are reasonably good: the only problem seems to be instability of the equation according to the Chow-test. The coefficient estimate are of 'right' sign and rather precisely estimated: the gross wage rate and demand will have a positive, while the user cost of capital and lagged capital stock a negative effect on the gross investment.

For the log-linear specification we proceeded in the similar way. We could not reject the parameter restrictions analogous to (i) and (ii) in the linear case.[12] The OLS estimation results for the specification (10:i) are reported in Table 3b.

There are no signs of either heteroscedasticity or instability, but some autocorrelation according to LM-statistics. This suggests that the dynamics of the log-linear net investment equation may be misspecified and that the t-ratios may be biased. The coefficient estimates, however, are of 'right' sign.

In order to make the linear and the log-linear specifications comparable, we calculated the elasticities of the desired real capital stock with respect to the explanatory variables. Both the adjustment parameter and the demand and the relative price elasticities, E(Q) and E[w(1+s)/c], have been calculated at the average values of the variables. In the linear (respectively log-linear) case the following values were obtained ζ = .202 (.206), E(Q) = .87 (.62) and E[w(1+s)/c] = .025 (.064).[13] The elasticities are rather similar with the exception of the relative price elasticity, which is much higher in the log-linear case.

Table 3a. OLS estimation results of the linear investment function (9:i)

	coefficient estimates	t-ratio
constant	4781.1	(7.4)
w(1+s)/c	80.912	(7.8)
Q	.320	(4.2)
K_{-1}	–.125	(–2.5)
R^2	.830	
DW	1.72	
Chow	4.78	
B-P-G	2.80	
AR(1)	.120	(.6)
AR(2)	–.170	(–.9)
AR(3)	–.160	(–.8)
AR(4)	–.070	(–.4)

For the diagnostics, see Tables 1 and 2. Here the 5% critical values of the Chow-stability test and the B-P-G heteroscedasticity test are 2.93 (with (4.18) degrees of freedom) and 7.81 (with 3 degrees of freedom) respectively.

Table 3b. OLS estimation results of the log-linear investment function (10:i)

	coefficient estimates	t-ratio
constant	.982	(9.2)
log[w(1+s)/c]	.013	(7.4)
log (Q)	.128	(3.7)
$\log(K_{-1})$	–.206	(–2.5)
R^2	.750	
DW	1.41	
Chow	1.88	
B-P-G	1.39	
AR(1)	.230	(1.2)
AR(2)	–.470	(–2.4)
AR(3)	–.440	(–2.3)
AR(4)	.030	(.1)

For the diagnostics, see Tables 1 and 2. Here the 5% critical values of the Chow-stability test and the B-P-G heteroscedasticity test are 2.93 (with (4.18) degrees of freedom) and 7.81 (with 3 degrees of freedom) respectively.

[12] *A complete set of results is available from the authors upon request.*

[13] *These results are rather close to those reported in Koskenkylä (1985) by using the annual data from the Finnish manufacturing industry over the period (1960–1981).*

3. *Selection of an Empirical Model for Payroll Tax Reform Analysis*

After reporting various tests and estimation results for the nominal wage, the hours of work and the capital stock determination we now bring those elements together into a system of equations to be used in the policy analyses.

As for the nominal wage and hours of work determination we chose the following specifications (see Tables 1 and 2 and related discussion)

$$(13) \quad \mathrm{Dlog}(w)_t = \mu_0 + \mu_1 \mathrm{Dlog}(1+s)_t + \mu_2 \mathrm{Dlog}(1-t)_t - \mu_2 \mathrm{Dlog}(p)_t - \mu_1 \mathrm{Dlog}(q)_{t-1} + \mu_3 \log(\hat{Q}/Q)_t + \mu_4 \mathrm{Dlog}(c)_{t-1} + v_t$$

and

$$(14) \quad \mathrm{Dlog}(L)_t = \beta_0 + \beta_1 \mathrm{Dlog}[w(1+s)/q]_{t-1} + \beta_2 \mathrm{Dlog}(Q)_t + \beta_3 \mathrm{Dlog}(c/q)_{t-1} + \beta_4 \mathrm{Dlog}(L)_{t-1} + \varepsilon_t$$

where the symbols are the same as in section 2.1.

In section 2.2 we reported various experiments and tests about the determination of investment in fixed capital under two assumptions about the nature of goods market; either the firms were assumed to be subject to a binding demand constraint or to face a downward sloping demand curve for their products. On the basis of tests reported in section 2.2, it seems that the demand constrained hypothesis is more consistent with the data. We also estimated the investment functions both in a linear and in a log-linear form. In the former the dependent variable was gross investment, and in the latter net investment. The choice between functional forms is difficult. Though one might marginally prefer the linear specification to the log-linear one because of the autocorrelation of residuals in the latter, the log-linear specification fits better with the log-linear nominal wage and hours of work equations (13) and (14). Therefore, we report policy analyses in the next section only for the log-linear specification, which can be written as

$$(15) \quad \mathrm{Dlog}K_t = \theta_0 + \theta_1 \log(Q_t) + \theta_2 \log[w(1+s)/c]_t + \theta_3 \log K_{t-1} + v_t$$

where the symbols are the same as in section 2.2.

This system of equations (13)–(15), though ad hoc, is a simplified version of the dynamic factor demand specifications for labour and capital under imperfect competition in the goods market complemented with a nominal wage equation, which accounts both for labour demand and supply factors.[14]

For the purpose of policy analyses to be reported in section 4 we estimated the nominal wage, the hours of work and the investment equations as a system by using Zellner's SUR estimation method, which accounts for contemporaneous correlation between error terms of various equations and thus increases the efficiency of parameter estimates. Moreover, and even more important, the system estimation makes it possible to calculate the confidence intervals for alternative reform scenarios.

The SUR estimation results were very similar to the OLS estimation results reported in section 2. Therefore, we report in Table 4 only the long-run elasticities.

Table 4. Estimates of long-run elasticities for the wages, the hours of work and the demand for capital stock

Wage equation					
(13):	μ_0	μ_1	μ_2	μ_3	μ_4
– elasticity	.062	–.178	–.409	.194	–.0039
Hours of					
work (14):	β'_0	β'_2	β'_1	β'_3	
– elasticity	–.032	.843	–.182	–.0086	
Demand for					
capital (15):	θ_0	θ_1	θ_2		
– elasticity	4.640	.632	.063		

The long-run elasticities has been calculated as $\beta'_i = \beta_i/(1-\beta_4)$.

[14] *For an analysis of dynamic factor demand for capital and labor, see e.g. Shapiro (1986) and for the role of monopolistic competition in the goods market in terms of the capital stock, see Schiantarelli & Georgoutsos (1990).*

All the elasticities are of the expected sign. The payroll tax rate and the user cost of capital have a negative effect, while the marginal tax rate, the consumer and the producer price and the logarithmic trend deviation of output has a positive effect on the nominal wages. The elasticity of the nominal wage with respect to the marginal tax rate is higher in absolute terms than with respect to the payroll tax rate. The gross real wage and the real user cost of capital have a negative, and output a positive effect on the hours of work, the respective elasticities being –.18, –.009 and .84. As for the demand for capital equations, the elasticities with respect to the output is .63 and with respect to the tax adjusted relative prices of factors of production .063.

4. *Policy Results for Payroll Tax Reform Proposals*

For the computation of the policy effects we need to allow for the potential shifting of the relevant taxes and contributions in the markets for investment goods and output. Since the simulations concern long-run effects of the reforms, it is assumed that the supply of investment goods is perfectly elastic. This means that variations in investment demand do not affect their prices.

For the output market the incidence of the reforms on consumer and producer prices is not econometrically estimated, due to lack of appropriate studies of princing equations for Finnish manufacturing output.[15] Above in section 2.2 we estimated behavioural equations by assuming either that firms are subject to a binding demand constraint or face a downward sloping demand curve. While the former specification was chosen for simulations, the differences between them were relatively small (see section 2.2). If we interpret real output as a proxy describing a position of the demand curve, the incidence analysis of taxes becomes meaningful. (Forward shiftning cannot be analyzed at all with demand constraints). But the incidence depends on the slope of the demand curve and the marginal cost curve about which we have no information.[16] As basic cases it was hypothesized that the SII contribution is not shifted forward at all, or half of it is shifted equally to consumer and producer prices, while the sales tax is completely shifted. The incidence of the corporate tax is a complicated issue and depends partly on the structure of the tax. If the corporation tax is a tax on pure profits only, then it falls in the first instance on those who supply enterpreneurship to companies. To the extent that the corporate tax is not neutral, it is at least partly shifted forward. Empirical evidence on the corporate tax is very conflicting [see e.g. Stiglitz (1988) pp. 564–574 for a survey]. However, different possibilities were accounted for by computing the results for various degrees of forward shifting in the output market.

The two reform proposals were made precise by the following definition of the scenarios:

Scenario A (SII altern.): The current payroll tax is reduced by three percentage points, and the corporate income tax is raised by four percentage points in a way that leaves the present value of tax depreciations of capital unchanged.

Scenario B (Sales tax altern.): The current payroll tax is reduced by seven percentage points, and the sales tax rate is increased by four percentage points.

These numbers were chosen to give approximate revenue-neutrality of the suggested reforms at the level of the aggregate economy (not for the manufacturing sector), and they were obtained from the simulation of the BOF4 macroeconometric model. In the simulations the data for the year 1987 was used as the reference point. Using Taylor approximations the two scenarios can be formally represented as follows:

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[15] *The main difficulty for such an evaluation for Finnish manufacturing is in the openness of the sector. A significant part of manufacturing output is exported.*

[16] *E.g. with the perfectly vertical marginal cost curve the sales tax is borne by firms, while with the horizontal marginal cost curve the extent to which firms or consumers bear the sales tax depends on the shape of the demand curve. With a linear demand curve, the price rises by exactly half the tax. With a constant elasticity demand curve there is more than 100% shifting onto consumers! Subsequent computation of the results with different degrees of shifting to producer and consumer prices thus allows output changes and is consistent with different possible values for demand and supply elasticitities in the output market.*

Table 5.1. Effects of reform scenario A on wages, employment, and the capital stock

	incidence		inflation			
variable	p(%)	q(%)	1	0		–1
W	0	0	.48	.20	(±.09)	–.09
	+1	–1	.60	.31	(±.06)	.02
W/P	0	0	–.0001	.0018	(±.0008)	.0037
	+1	–1	–.0035	–.0017	(±.0005)	.0002
L	0	0	3.28	2.57	(±2.55)	1.85
	+1	–1	1.30	.58	(±1.14)	–.13
K:	0	0	–781.5	–830.8	(±392.9)	–880.1
	+1	+1	–763.0	–812.3	(±384.3)	–861.6

Notation: W=nominal wages, P=price level, L=hours of work, K=capital stock. The base values are W=48.85 FIM/h, W/P=.4546 (index); L=854.755 (millions of hours); K=133698.6 million FIM (net at 1985 prices); P=107.41 (index).

(16) Scenario A: Ds=–.03;
Du=.04 (with D(1–uz)=0) in the system
$DK=(K_s)Ds+(K_u)Du+(K_p)Dp+(K_q)Dq$
$DW=(w_s)Ds+(w_u)Du+(w_p)Dp+(w_q)Dq$
$DL=(L_s)Ds+(L_u)Du+(L_p)Dp+(L_q)Dq.$

(17) Scenario B: Ds=–.07; Dlv=–.04 in the system
$DK=(K_s)Ds+(K_p)(p_{lv})Dlv+(K_q)(q_{lv})Dlv$
$+(K_p)Dp+(K_q)Dq$
$DW=(w_s)Ds+(w_p)(p_{lv})Dlv+(w_q)(q_{lv})Dlv$
$+(w_p)Dp+(w_q)Dq$
$DL=(L_s)Ds+(L_p)(p_{lv})Dlv+(L_q)(q_{lv})Dlv$
$+(Lp)Dp+(Lq)Dq.$

These systems describe the differential forms of the equations for the capital stock, wages, and employment, when the shifts in the policy parameters have taken place. The last two terms in each equations allow for the shifting of the reform to consumer and producer prices, compare the tables below. Operator D describes the change in the magnitude, and subscripts refer to partial derivatives. (For example, $p_{lv} = \partial p/\partial lv$, where lv is the sale tax.) The estimated values of derivatives are reported in the appendix.

The results for scenario A are given in table 5.1. In the table the different columns, referred to as inflation, correspond to alternative assumptions about the shifting of the reform to output prices. The approximate confidence intervals, at 95 per cent level, are given in parentheses.

The confidence intervals are based on the Wald test in the following way. In a model with only one nonlinear restriction the statistic W, defined e.g. in Harvey (1981), p. 167, has a Chi-square distribution, with one degree of freedom. In testing of the policy effects one can write them as equations (16) and (17), so that one can test the hypothesis that the effect on the variables is zero. (Note that the restriction must be centered, so its computed value is subtracted from it.) Denoting the centered restriction by r^*, one next finds the critical value ϕ for which the W statistic of $r^*+\phi$ is equal to 3.84, the 95 per cent critical value of the chi-square distribution at one degree of freedom. ϕ can be taken as an end point of the confidence interval.[17] The obtained confidence intervals must be considered approximate.[18] (For wages the formula is linear, so their confidence intervals are computed in the usual way using the t-distribution.)

It can be seen that the effects on wages and employment are sensitive to assumed forward shifting, while the effects on capital are less so. In the base of zero inflation nominal wages would increase about .20–.30 FIM. Real wages would slightly increase or decrease depending on the assumed shifting of corporate tax. The increase in employment would be about 2.6 million hours, and in spite of the width of the confidence interval this effect is just significantly different from zero at 95% level of significance. If the increased hours were done by new employees, this would increase employment by approximately 1500 men, assuming an average annual working time of 1750 hours. The effects on the capital stock can also be seen to be different from zero.

The results for scenario B, the sales tax al-

[17] *Note that the centered Wald test statistic is symmetric around zero and that the matrix of derivatives of the restriction remains constant.*

[18] *The Wald test is only asymptotically chi-squared, so the nonlinear Wald test can be quite sensitive to the form of the restriction (see Lafontaine & White (1986)).*

Table 5.2. Effects of reform scenario B on wages, employment, and the capital stock

	incidence		inflation			
variable	p(%)	q(%)	+1	0		–1
W	4	0	1.58	1.29	(±.20)	1.00
	3	–1	1.29	1.00	(±.16)	.72
	2	–2	1.00	.72	(±.12)	.43
W/P	4	0	–.0080	–.0062	(±.0019)	–.0043
	3	–1	–.0062	–.0043	(±.0015)	–.0024
	2	–2	–.0043	–.0024	(±.0011)	–.0005
L	4	0	5.40	4.69	(±3.9)	3.97
	3	–1	4.69	3.97	(±3.3)	3.25
	2	–2	3.97	3.25	(±2.8)	2.54
K:	4	0	–204.0	–253.3	(±118)	–302.6
	3	–1	–253.3	–302.6	(±141)	–351.9
	2	–2	–302.6	–351.9	(±164)	–401.2

Notation and reference values as in table 5.1.

ternative, are given in table 5.2. In this computation we permitted different incidences of the reform on producer and consumer prices (q and p, respectively). These results are given on different rows for each variable. Moreover, some allowance was made for general inflationary impact, and the results for the alternatives are in different columns.[19] Zero inflation was taken as the base case. The confidence intervals were computed only in the base case, and for each variable they are given in parentheses after the average value in the appropriate column.

In qualitative terms the effects in scenario B are like those of scenario A: nominal wages and employment increase, and the capital stock falls. The effects on real wages depend on the incidence of sales tax on consumer and producer prices and on potential effects on the general price level. If the sales tax is fully shifted into consumer prices, then real wages would slightly fall. In the base case of no general inflation nominal wages would rise about 1.3 FIM, and real wages fall about 1.3 per cent, the confidence interval being approximately .4 per cent. The increase in employment is bigger the more the reform is shifted into consumer prices. In the base case of full shifting and no general inflation employment would increase about 4.7 million hours, the confidence interval being ±3.9 million hours. This would mean about 2700 new employees under the same assumptions as before. The effects on the capital stock are also statistically significantly different from zero.

[19] *The selected cases are based on simulations with the BOF4 macroeconometric model, compare Honkapohja (1988).*

5. Concluding Remarks

In this study we have developed and utilized a partial equilibrium framework to analyze the incidence effects of the proposed reforms of the employers' payroll tax in Finland. The manufacturing industry was taken to be the object of study. The qualitative effects of the two suggested reforms turned out to be similar. Both of them would raise nominal wages and employment and decrease the capital stock. The two alternatives have somewhat different effects on real wages, due to the assumed different degrees of forward shifting into consumer and producer prices. All the effects are relatively small, being less than one percentage point in real variables. These results are broadly consistent with those obtained from a macroeconometric model [see Honkapohja (1988)].

The effects of the proposed reforms on nominal wages follow from the fact that lowering the current payroll tax leads in part to higher nominal wages to workers and in part to lower wage costs, thereby increasing the demand for labor. The effects on real wages depend on the nature of forward shifting. If in scenario A (the SII contribution) this effect is smaller than in scenario B (sales tax alternative) real wages would be lower in the latter case. Both proposals mean a shift from a tax on labor toward a general taxation of productive inputs, and this explains the negative effects on the capital stock. In scenario B the negative effect is smaller than in scenario A, since in it real wages change less than in scen. A thus leading to less substitution between capital and labor.

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Appendix

The Matrix of Estimated Values of Partial Derivatives

Scenario A: Ds = –.03; Du = .04 [with D (1–uz) = 0]

$$\begin{bmatrix} Dw \\ D(w/p) \\ DL \\ DK(\log-1) \end{bmatrix} = \begin{bmatrix} -7.04 & -0.373 & 19.9 & 8.70 \\ -0.066 & -0.0035 & -0.269 & 0.080 \\ -103.2 & -13.2 & -63.4 & 134.8 \\ 5555.4 & -16604.0 & 3389.0 & 1540.1 \end{bmatrix} * \begin{bmatrix} Ds \\ Du \\ Dp(\%/100) \\ Dq(\%/100) \end{bmatrix}$$

Scenario B: DS = –.07; Dlv = .04.

$$\begin{bmatrix} Dw \\ D(w/p) \\ DL \\ DK(\log-1) \end{bmatrix} = \begin{bmatrix} -7.04 & 19.9 & 8.70 \\ -0.066 & -0.269 & 0.080 \\ -103.2 & -63.4 & 134.8 \\ 5555.4 & 3389.0 & 1540.1 \end{bmatrix} * \begin{bmatrix} Ds \\ Dp(\%/100) \\ Dq(\%/100) \end{bmatrix}$$