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TAXES AND BENEFITS IN A NON-LINEAR WAGE EQUATION

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Summary

TAXES AND BENEFITS IN A NON-LINEAR WAGE EQUATION

This paper estimates a structural non-linear wage bargaining model for the Netherlands. The estimation results show a significant positive long-term impact of the average tax rate on wages. The marginal tax rate exerts a small negative impact on wages. The impact of benefits rises with the unemployment rate.

Key words: wage equation, bargaining model.

1 INTRODUCTION

The wage equation is of crucial importance in every macroeconometric model. Indeed, the wage equation largerly determines the macroeconomic impact of taxes and benefits. Unfortunately, the implications of theoretical notions and the results of empirical studies are at variance with each other. Theoretical models of wage setting suggest that taxes paid by employers, taxes paid by employees and VAT rates should all exert the same impact on wages, since they enter the wage equation as a single variable. Layard, Nickell, and Jackman (1991, 1994) suggest that these taxes do not exert long-term influence on wage costs whatsoever: ultimately, all taxes are completely born by labour. This contrasts with the findings of many empirical studies. For example, in testing a macro-wage equation for ten OECD countries, Knoester and Van der Windt (1987) find that the employers' and employees' tax rates have a significant impact on wage costs in the case of Australia, Canada, Germany, Italy, Japan, the Netherlands, Sweden, and the Unites Kingdom. For the United Kingdom, Layard and Nickell (1986) find that only the rate of social security contributions paid by employers affects wages.

Theoretical and empirical studies also come to different conclusions on how the replacement rate affects wages. Theoretical studies provide abundant support for such an influence. However, the empirical evidence is scarce and mixed. Most empirical studies do not detect any significant effect. Some studies, however, do find a rather large impact. Table 1 provides an overview of estimates of the coefficients for the VAT rate, the employers' social security contributions rate, the

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TABLE 1 – ESTIMATES OF TAX AND REPLACEMENT RATE ELASTICITIES IN WAGE EQUATIONS

Study	Country	VAT	Employers' ssc rate	Employees' tax/ssc rate	Replacement rate
Minford (1983)	UK	–	0.5	0.5	0.6
Layard and Nickell (1986)	UK	–	0.18	–	0.18
Nickell (1987)	UK	–	0.6	–	0.15 to 0.35
Manning (1993)	UK	1	–	–	0.18 to 0.21
Central Planning Bureau (1992)	Netherl.	0.5	0.8	0.36	0.15
Lever (1991)	Netherl.	0.22	0.76	0.5	0.17
Graafland (1992a, 1992b)	Netherl.	0.48	1	0.57	0.31
Calmfors (1990)	Norway	1	1	0	0
	Sweden	0.5	0.5	−0.5	0
	Denmark	0.6	1	0.34	0 to 0.28
	Finland	0.93	0	0	0.18
Christensen and Knudsen (1992)	Denmark	0.41	0	0	0.05
Dolado et al. (1986)	Spain	1	1	1	0.45
Adams and Coe (1990)	USA	0.8	0.8	–	0.05

employees' tax and social security contributions rate, and the replacement rate in empirical wage equations for several countries. The coefficients for the VAT rate in Table 1 generally are the coefficients for the consumer price in the corresponding study.

This paper develops a theoretical wage bargaining model, which yields a non-linear wage equation with a positive long-term impact of taxes on wages as a special case. The elasticity of the replacement rate depends on the unemployment rate. The wage equation is estimated on time-series data for the Netherlands. By distinguishing between short-term and long-term coefficients, we reconcile the divergence between theoretical predictions and empirical estimates of the effect of taxes on wage costs. The last section summarizes the main findings and reviews some policy implications.

2 DERIVATION OF THE WAGE EQUATION

The wage equation is derived from a wage bargaining model for a representative employer and employee. The outcome of the wage bargain is described by the maximization of the following Nash function:

$$\max arg(W)\colon \Omega = \Pi^{\alpha} V^{1-\alpha} \quad 0 < \alpha < 1\,, \tag{1}$$

where W denotes wage costs per employee, Π and V the employer's and employee's utility, respectively, and α represents the relative bargaining power of the employer. The employer's utility equals the operating profits generated by the employee. These operating profits are given by the value added price (P) times labour productivity (q) minus wage costs per employee (W):[1]

$$\Pi = Pq - W \tag{2}$$

The employee's utility corresponds to the surplus from working, which is the net wage offered by the employer minus the opportunity costs of taking the job (i.e. the reservarion wage). Let S, T_l, and T denote the employer's social security contributions per employee, the employee's tax and social security contributions per employee, and the total taxes and social security contributions per employee, so that $T = S + T_l$. Let $s = S/W$, $t_l = T_l/(W - S)$ and $t = T/W$, so that $(1 - t) = (1 - s)(1 - t_l)$. So, s is the employer's social security contributions rate (as a rate of wage costs), t_l is the employee's tax and social security contributions rate (as a rate of gross wages) and t is the total tax and social security contributions rate (as a rate of wage costs). The employee's utility is then:

$$V = W(1 - t) - \hat{W}\,, \tag{3}$$

where $\hat{W}$ stands for the reservation wage. The reservation wage is a weighted average of the opportunity wage in the official labour market ($\hat{W}_o$) and the wage in the informal sector ($\hat{W}_b$):

$$\hat{W} = \beta\hat{W}_o + (1 - \beta)\hat{W}_b\,. \tag{4}$$

The opportunity wage in the official labour market depends on the expected wage of other jobs and on the unemployment benefit. The reason is that the employee generally spends some time in unemployment before finding an alternative job. Income during unemployment equals the replacement rate (R) times the macro wage.[2] The expected wage of other jobs equals the macro wage rate ($\hat{W}$). The proportion of time spent unemployed before finding an alternative job is assumed to be equal to the unemployment rate u. This gives:

$$\hat{W}_o = uR\overline{W}(1 - t) + (1 - u)\overline{W}(1 - t)\,. \tag{5}$$

1 Total profits are given by operating profits minus some unspecified sunk costs. These could, for example, be hiring costs or capital costs. These costs create quasi rents that make the bargaining necessary. They also generate unemployment as a necessary force to reduce the union wage claims to a level compatible with general equilibrium, that is a level such that the firm's operating profits are high enough to cover the sunk costs.

2 We distinguish between two replacement rates. R_{ui} is the ratio of average net unemployment insurance benefits to the average after-tax wage, and R_w is the ratio of the average after-tax welfare benefits to the average after-tax wage. R is the average of R_{ui} and R_w.

Instead of looking for another job in the official labour market, the employee can withdraw from the official labour market and seek work in the informal sector. The informal labour market consists of home production and the underground labour market. In both sectors no taxes are levied. The Social Cultural Planning Bureau (1995) reports that, on average, men spend 8 hours a week on home production and women 24 hours a week. Underground labour supply of men and women equals less than one hour a week. Hence, home production forms the largest share of informal labour supply. It makes sense that productivity in the informal sector is positively related to that of the formal sector, because technological progress in the official sector generally also improves labour productivity in the informal sector. For convenience, we assume that informal labour productivity is proportionally related to formal labour productivity (q). The informal output price is also related to the formal consumer price (P_c), because home production is often performed to save official consumer outlays.[3] This gives:

$$\hat{W}_b = \gamma q P_c \quad (\gamma < 1)\,, \tag{6}$$

γ is added to allow for the relatively low productivity in the informal labour market compared to the official labour market.[4]

After substituting equations (2) and (3) into equation (1) and deriving the first-order condition for the Nash solution, we arrive at the following wage equation:

$$W = \frac{\alpha \hat{W}/(1-t_m) + (1-\alpha)Pq}{\alpha(1-t)/(1-t_m) + (1-\alpha)}\,, \tag{7}$$

where t_m denotes the marginal tax rate, defined as dT/dw. Equation (7) shows that the wage outcome strikes a balance between the utility of both bargaining parties. If the employer dominates bargaining ($\alpha = 1$), the employee's utility is zero and the wage equals the reservation wage. If the employee dominates bargaining ($\alpha = 0$), the employer's utility is zero and the wage equals the producer price times labour productivity. Since a wage contract will be concluded only if the maximum wage offer (Pq) exceeds the minimum wage claim ($\hat{W}$), equation (7) implies that the marginal tax rate unambiguously reduces the wage. At a given average tax rate a rise in the marginal tax rate implies that the government ab-

3 Alternatively, one could set the output price of the informal sector at the value added price times 1 plus the indirect tax rate, or equivalently, the consumer price after deducting the terms of trade effect.
4 An alternative way of including the informal sector in the reservation wage of the employee is to assume that unemployed persons do not withdraw from the official labour market but earn some informal income in addition to the unemployment benefit they receive. Then, the reservation wage is specified as: $\hat{W} = u(R\overline{W}(1-t) + \gamma q P_c) + (1-u)\overline{W}(1-t)$. This alternative equation implies that the impact of the informal sector on the reservation wage of the employee depends on the unemployment rate. As is shown in Appendix 1, the wage effect of the tax wedge then also depends on the unemployment rate. Our empirical tests rejected this alternative hypothesis (see Appendix 1).

sorbs a larger share of a wage increase. Hence, increasing wages becomes less attractive for the employee (Hersoug (1984), Hersoug et al. (1986), Hansen (1996)).[5]

To derive the wage equation to be estimated, we use the equilibrium condition $W = \overline{W}$. After substitution of equations (4) to (6) into equation (7) and some rewriting, we arrive at:

$$\log W = \log q + \log P + \log \left[1 + \left(\frac{\delta}{1 - \alpha + \delta} \right) \left(\frac{P_c}{P(1 - t_m)} - 1 \right) \right] - \log \left[1 + \frac{\alpha}{1 - \alpha} \frac{1 - t}{1 - t_m} [1 - \beta(1 - u(1 - R))] \right] + \epsilon \qquad (8)$$

with $\delta = \alpha(1 - \beta)\gamma$

$$\epsilon = \log \left[1 + \frac{\delta}{1 - \alpha} \right].$$

Equation (8) implies that, at a given marginal tax rate (t_m), an increase in the average tax rate (t) unambiguously raises the wage. Intuitively, taxes raise the relative attractiveness of working in the informal sector, thereby improving the bargaining position of the employee. In addition, equation (8) implies that the employers' rate of social security contributions (s) and the employees' tax and social security contributions rate (t_l) exert the same effect on wages in the long run. What matters is the total difference between wage costs and net wage as measured by t.

Furthermore, call the term $P_c/(P(1 - t))$ the average total wedge and $P_c/(P(1 - t_m))$ the marginal total wedge. This total wedge is the ratio of the real product wage (W/P) to the real after-tax consumer wage $W(1 - t)/P_c$. The total wedge can be seen as a generalization of the regular tax wedge, which is the ratio of the nominal wage cost W to the nominal after-tax wage $W(1 - t)$, and therefore equals $1/(1 - t)$. Equation (8) implies that the ratio of the consumer price to the value added price (consisting of the indirect tax rate and terms of trade effects), the direct tax rate and the employer's and employee's social security contributions rates all effect wage costs only through these average and marginal to-

5 In this respect the wage bargaining model differs from the demand-supply equilibrium model, in which wages generate equilibrium between labour demand and labour supply. In this type of model, the marginal tax rate raises wage costs, because it decreases labour supply (see Graafland (1991)).

tal wedge variables.[6] In our presentation, however, we will focus on the more traditional tax wedge rather than this total wedge.

Another implication of equation (8) is that wage effects of the replacement rate and the unemployment rate are interrelated: the effect of the replacement rate on wage costs depends on the unemployment rate and *vice versa*. In particular, changes in the replacement rate affect wage costs more when unemployment is high than when it is low. The intuition is that the higher is unemployment, the more likely it is that workers will remain unemployed for a while when they lose their job and thus have to depend on unemployment benefits and/or welfare. These benefits therefore are more relevant to the wage bargaining process when unemployment is high than when it is low. The influence of the unemployment rate on wages falls when the replacement rate rises, becoming zero when the replacement rate equals one. The intuition is that the wage moderating effect of unemployment is lower, the less costly it is to be unemployed. And the cost of being unemployed falls when the replacement rate rises. If the replacement rate equals one, employed and unemployed workers have the same income and the cost of unemployment is zero. A final implication of equation (8) is that labour productivity affects wages with a unitary elasticity.

If the informal economy is irrelevant for the reservation wage of the employee ($\beta = 1$, and thus $\delta = 0$), the consumer price vanishes in equation (8), and taxes affect wage costs only insofar as the average tax rate differs from changes in the marginal tax rate. Accordingly, proportional taxes are fully born by the workers in the form of lower net wages.

3 ESTIMATION RESULTS

The data are based on the National Accounts by Statistics Netherlands and are given in Appendix 2. The estimation period is restricted to the period from 1967 to 1993, because data concerning the replacement rate are not available for the period before 1965, and we include two lags in the estimation. Data on the tax rate relate to the median worker in the income distribution.[7]

Equation (8) is estimated in two alternative ways. First, we used the NLS estimator for a direct estimation of the wage level equation as specified in equation (8). The advantage of this method is that the number of estimated coefficients is

6 Note that if we had corrected the consumer price for the terms of trade effect, as suggested in footnote 3, the terms of trade would also disappear from equation (8). The term P_c/P would then reduce to 1 plus the indirect tax rate, and the total wedge would only include indirect taxes, direct taxes, and social security contributions.

7 Empirical tests showed this definition to be more relevant than the average tax wedge of all employees. This might reflect that, at the time of wage bargaining, unions do not have full information on the average tax wedge of all workers and use the tax wedge of the median worker instead. Another explanation is that the tax wedge of the median worker better represents the tax wedge of the average union member if union members disproportionally consist of low-income workers.

relatively small. Because of the long-term character of equation (8), all variables are unlagged. In order to test for stationary of the residual, we use the LM test statistics.

Second, we used Two-Stage Least Squares to estimate the wage equation in an error-correction form, specified as:

$$\Delta \log W = \sum \phi_i \Delta \log X_i - \eta(\log W_{-1} - \log W^*_{-1}) \,. \tag{9}$$

The first terms consider the short-term effects (ϕ_i) of the explanatory variables (X_i). To deal with simultaneity between the growth in wage, producer price, consumer price, labour productivity, and unemployment, we employ one-year lagged values and import prices as instrumental variables. For the tax wedge we allow the short-term influence of the social security contributions rate paid by employers to differ from that of the rate of direct taxes and social security contributions paid by employees. The short-term effects of the replacement ratios based on unemployment insurance benefits (R_{ui}) and welfare benefits (R_w) are separately estimated as well. The last term in equation (9) captures the error-correction term defined as the difference between the previous years' wage level and the long-term wage level as specified by equation (8). The advantage of this second method is that it tends to reduce the finite sample bias in the estimated long-run coefficients (see e.g. Banerjee et al. (1993) pp. 214–223) and allows a simultaneous estimate of the long-term and short-term effects.

Table 2 presents the estimation results. The results in column (1) are from direct estimation of equation (8) without lags. The results in column (2) are from the estimation of the dynamic equation in error-correction form. The LM(2) test is an F-test on the joint significance and the once and twice lagged residuals. The LM(2) test does not reject the null-hypothesis of zero autocorrelation. The Arch(2) test gives no indication of heteroskedasticity. Commenting on the long-term coefficients, we do not find large differences between the estimated structural coefficients in the first and second columns. Wage bargaining seems to be almost fully dominated by the employer, as α equals 0.95. Furthermore, the reservation wage of the employee is almost fully related to the opportunity wage in the official labour market, as β is close to one. However, β differs significantly from 1. This implies that the reservation wage of the employee is also influenced by the opportunity wage in the informal sector. The estimates of α, β and δ further imply that the ratio between the productivity in the informal sector and the official sector (γ) varies from 0.43 (with *t*-value 1.9)[8] in the first column to 0.38 (with *t*-value 4.1) in the second column. These values concur with the relatively low productivity in the informal sector. The interpretation of ϵ is less straightforward because this coefficient also corrects for differences in scaling of the other explanatory variables.

8 This *t*-value is determined by the TSP command 'analyz'.

TABLE 2 – ESTIMATION RESULTS

	(1)		(2)	
Long-term coefficients [a]				
α	0.953	(66.9)	0.949	(126.9)
β	0.940	(48.9)	0.953	(118.6)
δ	0.025	(5.4)	0.017	(10.4)
ϵ	0.741	(2.2)	0.704	(4.9)
short-term coefficients [b]				
$\Delta \log P_c$			0.305	(3.2)
$\Delta \log (1 - s)$			−0.683	(3.6)
$\Delta \log (1 - t_l)$			−0.338	(5.3)
$\Delta \log (1 - t_m)$			0.193	(4.9)
$\Delta \log P$			0.436	(4.5)
$\Delta \log q$			0.213	(3.9)
$\Delta \log R_{ui}$			0.112	(3.6)
$\Delta \log R_w$ [b]			0.181	(4.3)
$\log W - \log W^*$			0.616	(9.2)
statistics				
$\bar{R}^2$	0.999		0.999	
Adjusted standard error (*100)	1.815		0.382	
LM(2)	2.210 [p = 0.13]		1.380 [p = 0.29]	
ARCH(2)	0.450 [p = 0.80]		0.990 [p = 0.61]	

Symbols

W wage cost
P_c consumer price
s employer's social security contributions rate (as a rate of wage costs)
t_l employees's tax and social security contributions rate (as a rate of gross wages)
t_m marginal tax and social security contributions rate
P value added price
q labour productivity
R_{ui} replacement ratio based on unemployment insurance benefits
R_w replacement ratio based on welfare benefits

[a] *t*-values in parentheses.
[b] One year lagged.

For the short-term coefficients in the second column, we find that the effect of the employers' rate of social security contributions on wage growth exceeds that of the consumer price of employees' tax and social security contributions rate (although the difference is not significant). This is consistent with other studies on Dutch wages (Fase et al. (1990), Central Planning Bureau (1992), Graafland (1991, 1992a), Graafland and Verbruggen (1993)). The relatively large influence of employers' social security contributions rates on wage costs can be explained by institutional aspects of wage bargaining. In the Netherlands, collective bargaining comprises contracts for the gross wage (e.g. wage costs excluding social security contributions paid by employers). If the gross wage is fixed, an unanticipated increase in the employers' tax rate will, in the short run, cause a similar change in wage costs. An unexpected increase in the employees' tax rate, in contrast, is absorbed by workers in terms of a lower net wage. In this way, unexpected changes in the employers' and employees' tax rate imply different short-run effects on wage costs. However, this difference in effects does not persist, because in the long run all components of the tax wedge have the same effect on wage costs.

Significant short-term effects on wage growth are also found for the producer price, labour productivity and the replacement ratios of unemployment insurance and welfare benefits. The latter two coefficients are more or less equal, although our estimation indicates that the influence of the latter takes some more time. We did not find any short-term effect of the unemployment rate and thus dropped it. However, the high value of the error-correction term implies that the wage level converges very quickly to its equilibrium level. Almost two thirds of the difference between the actual wage level and the equilibrium level disappears within a year, and 90% within three years.

From the estimation results, long-run (semi-)elasticities of the wage with respect to the explanatory variables in equation (8) may be calculated. For the producer and consumer prices and the replacement rate we calculate regular elasticities: $\partial \log w/\partial \log x$ for x being the three variables just mentioned. For the unemployment rate we calculated the more familiar semi-elasticity: $\partial \log w/\partial ur$. For the average tax rate we calculate $\partial \log w/\partial \log((1-t)^{-1})$, which is the elasticity of wage costs with respect to the tax wedge. Note that $\partial \log((1-t)^{-1}) = \partial t/(1-t)$, so $\partial \log w/\partial \log((1-t)^{-1})$ may also be interpreted as the semi-elasticity multiplied by one minus the average tax rate. Another interpretation which deals directly with the incidence of taxation is as follows. Taxes have to be born by either the workers or the employer. The division of the tax incidence is determined by how much wage costs and the after-tax wage move in response to tax changes. Letting wn denote the after-tax wage, we have by definition: $wn = w(1-t)$. Let $\partial \log w/\partial \log((1-t)^{-1})$ equal θ. Then $\partial \log(wn)/\partial \log((1-t)^{-1})$ equals $\theta - 1$. If θ equals zero, a rise in taxes is completely born by the workers with wage costs unaffected. This is the case Layard, Nickell, and Jackman (1991, 1994) suggest should be the case. If θ equals 1, employers fully bear the tax incidence, as workers are able to keep their after-tax wages constant. In general, θ lies between zero and one and measures the degree to which the employers bear the incidence of an increase in taxes through increases in wage costs. For the marginal tax rate, we calculated the corresponding formula $\partial \log w / \partial \log ((1 - t_m)^{-1})$.

Figure 1 presents these elasticities derived from the estimates in the second column of Table 2. For each elasticity three lines are drawn: the middle one is the calculated elasticity, and the top and bottom lines are the calculated elasticity plus and minus two standard errors.[9] The top and bottom lines therefore enclose a 95% confidence interval around the calculated elasticity.

For the producer and consumer prices, these elasticities show only little variation over the estimation period. The elasticity with respect to the average tax wedge is 0.55 on average and highly significant: the average standard error is 0.07. Hence, the incidence of a higher tax wedge (given marginal taxes) is split about evenly between employers and employees in terms of higher gross wage costs and lower after-tax wages, respectively. The elasticity with respect to the marginal tax wedge is significantly negative. The negative wage effect of the marginal tax rate is supported by studies for the United Kingdom (Lockwood and Manning (1993)), Italy (Malcomcon and Sartor (1987)), and other OECD countries (Tyrväinen (1994), Hansen et al. (1995), Lockwood et al. (1995),[10] and Wickström et al. (1996)). The intuition is that a higher marginal tax rate implies that increases in the wage rate only generate a small increase in after-tax wage incomes. As a result the marginal utility of wages for the employee is only small, and the bargain shifts towards a lower wage.

As the previous paragraph already indicated, the wage effects of the replacement rate and the unemployment rate are interdependent. As a result, the elasticities with respect to the unemployment rate and replacement rate vary considerably over time. During the sixties, when unemployment was low, the replacement rate did not matter much for wage formation since it was so easy to get another job anyway. When unemployment rose during the seventies, it became more difficult to find another job and workers had to rely more on unemployment insurance or welfare benefits if they lost their jobs. As a result, the levels of these benefits therefore became more relevant to the wage bargaining process, and the elasticity of wages with respect to the replacement rate rose, reaching its peak during the recession in the beginning of the eighties. In the nineties, the impact of the replacement rate on wages diminished again, but it remained well above the level of the seventies.

9 The standard errors are again calculated with the TSP 'analyz' command and are conditional on the values of the exogenous variables.

10 Lockwood et al. (1995) find a negative impact of tax progressivity on wages of middle-income groups, but a positive impact for (male white collar) high-income earners and (female) low-income earners.

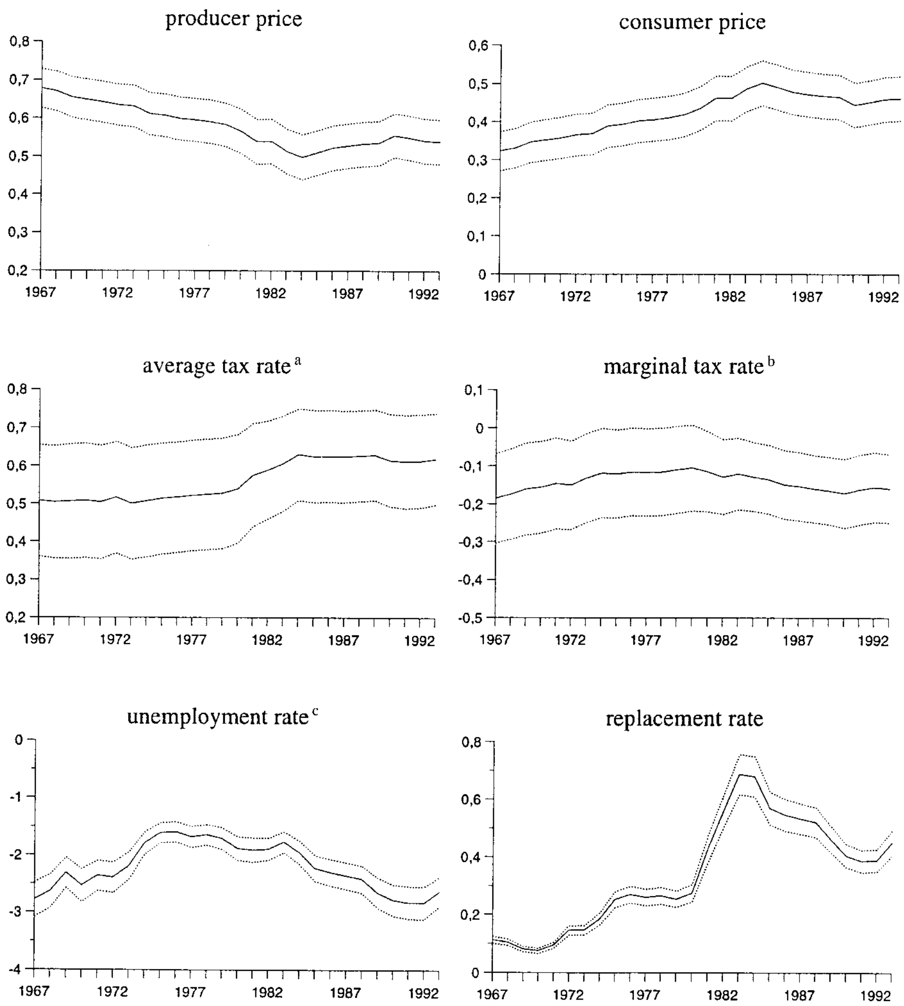

Figure 1 – Wage elasticities. [a] $(\partial W/W)/(\partial t/(1-t))$, [b] $(\partial W/W)/(\partial t_m/(1-t_m))$, and [c] semi-elasticity, defined as $(\partial W/W)/\partial u$.

The wage moderating effect of the unemployment rate varies inversely with the replacement rate. When the replacement rate is high, being unemployed results in only limited financial loss, and therefore a rise in unemployment induces little wage moderation. The replacement rate increased from 0.73 in 1965 to 0.83 in 1976 and then fell back to 0.69 in 1993. Hence, the absolute value of the semi-elasticity of unemployment first falls and then rises again.

Finally, it is noted that, in terms of absolute values, the average value of the semi-elasticity of unemployment is rather high, namely 2.2. In most previous research for the Netherlands the absolute value of this elasticity varies from 0.7 in Gelauff and Graafland (1994) to 1.4 in Graafland and Verbruggen (1993). This difference is partly explained by the non-linear specification used in this paper. If we estimate a linearized specification of equation (8), the absolute value of the semi-elasticity of the unemployment rate falls from 2.2 to 1.5.

4 CONCLUSIONS AND POLICY IMPLICATIONS

This paper estimates a non-linear wage equation for the Netherlands. The long-term equation is derived from a wage bargaining model in which the reservation wage of employees takes account of the level of income earned in the untaxed informal sector. Wages also depends on the consumer price, the producer price, labour productivity, the unemployment rate, and the replacement rate. The ways in which the latter two variables affect wages are related. In particular, the wage pressures generated by the replacement rate rise with the unemployment rate. Furthermore, the moderating influence of unemployment on wages varies inversely with the level of the replacement rate.

Estimation results for the Netherlands show a highly significant long-term impact of the tax wedge on wages. The implied elasticity of the average tax wedge is about 0.5. The marginal tax wedge exerts a small negative impact on wages, with an elasticity of -0.1. Both elasticities are fairly stable over the estimation period (1967–1993). The elasticity of the replacement rate and the unemployment rate, in contrast, show large variations. The elasticity of the replacement ratio increases from 0.1 during the sixties to over 0.4 in the eighties. The semi-elasticity of the unemployment rate varies from -1.5 during the second half of the seventies to -2.5 during the first half of the nineties.

Estimation of the dynamic effects shows that the employers' social security contributions rate exerts a substantial impact on wage costs in the short run, twice as much as the short-term wage effect of the employees' tax and social security contributions rate. However, this strong impact is short-lived, because the estimated error-correction mechanism implies that the wage rapidly converges towards its long-term level.

The findings in this paper yield important policy implications. First, the significant long-term influence of the tax wedge on wage costs implies that tax policy affects equilibrium unemployment. This conclusion is in contrast with Layard, Nickell, and Jackman (1991, 1994), who argue that the tax wedge leaves equilibrium unemployment unaffected, but is in line with previous research for the Netherlands. The negative influence of the marginal tax rate implies that reducing marginal tax rates while leaving the average tax rate unaffected raises wage costs.[11] Furthermore, the dynamic estimates imply that, for the short run, a decrease in the employers' social security contributions rate seems to be the most effective instrument to moderate wages. For the long run, however, there is no difference in wage effect between a reduction in the employers' rate of social contributions or the employees' rate of social contributions. The estimation results further suggest that at high levels of unemployment a reduction in unemployment benefits is particularly effective in reducing wage costs.

APPENDIX 1
Test on alternative specification of reservation wage

Substitution of the alternative specification of the reservation wage as presented in footnote 4 into equation (7) and combining with the equilibrium condition $W = \overline{W}$ gives:

$$\log W = \log q + \log P + \log\left[1 + \alpha\left(\gamma u \frac{P_c}{P(1-t_m)} - 1\right)\right] - \log\left[1 + \frac{\alpha}{1-\alpha}\,\frac{1-t}{1-t_m}\,u(1-R)\right] - \log(1-\alpha)\,. \qquad (10)$$

This equation can be tested against equation (8) by adding two parameters:

$$\log W = \log q + \log P + \log\left[1 + \alpha\left[(\eta u + \kappa)\frac{P_c}{P(1-t_m)} - 1\right]\right] - \log\left[1 + \frac{\alpha}{1-\alpha}\,\frac{1-t}{1-t_m}\,[1-\beta(1-u(1-R))]\right] + constant\,. \qquad (11)$$

If $\eta = 0$, $\kappa > 0$ and $\beta < 1$, equation (8) results, with $\kappa = \delta/(\alpha(1-\alpha+\delta))$. If $\eta > 0$, $\kappa = 0$ and $\beta = 1$, equation (10) is obtained, with $\eta = \gamma$. So, equations (8) and (10) are both nested within equation (11). Estimation of equation (11) gives

11 This can be done in practice by, for instance, reducing marginal taxes financed by also lowering the zero tax bracket, so that the tax schedule becomes less steep but starts at a lower income level.

$\eta = -0.004$ with a standard error of 0.15, $\kappa = 0.030$ with a standard error of 0.013 and $\beta = 0.94$ with a standard error of 0.021. Hence, equation (10) is rejected and equation (8) is not.

APPENDIX 2
Data

	W	P_c	P	q	t	s	t_l	t_m	u	R_{ui}	R_w	R
1965	0.162	0.314	0.388	0.423	0.348	0.144	0.233	0.335	0.006	81.805	63.400	72.602
1966	0.180	0.331	0.402	0.435	0.363	0.158	0.238	0.352	0.008	82.398	63.680	73.129
1967	0.196	0.340	0.411	0.466	0.373	0.165	0.244	0.410	0.017	79.289	61.450	70.369
1968	0.213	0.349	0.419	0.500	0.390	0.178	0.252	0.427	0.015	81.340	63.040	72.190
1969	0.241	0.370	0.440	0.535	0.402	0.181	0.263	0.460	0.011	86.166	66.780	76.473
1970	0.272	0.386	0.454	0.569	0.408	0.183	0.270	0.468	0.010	83.637	64.820	74.228
1971	0.310	0.417	0.484	0.589	0.432	0.190	0.291	0.476	0.013	85.608	65.470	75.539
1972	0.348	0.451	0.524	0.619	0.444	0.193	0.305	0.494	0.020	84.146	65.620	74.883
1973	0.404	0.490	0.558	0.667	0.473	0.211	0.324	0.490	0.021	86.276	66.450	76.363
1974	0.467	0.537	0.596	0.702	0.488	0.216	0.340	0.520	0.023	91.813	70.090	80.951
1975	0.526	0.591	0.645	0.690	0.483	0.215	0.336	0.520	0.032	90.197	75.410	82.804
1976	0.584	0.644	0.693	0.739	0.490	0.217	0.343	0.531	0.035	89.393	76.640	83.017
1977	0.635	0.683	0.729	0.756	0.485	0.213	0.339	0.533	0.033	88.484	75.900	82.192
1978	0.680	0.714	0.763	0.778	0.486	0.211	0.342	0.542	0.034	88.609	76.920	82.765
1979	0.722	0.745	0.782	0.795	0.489	0.213	0.344	0.550	0.032	88.274	76.120	82.197
1980	0.767	0.797	0.808	0.801	0.493	0.216	0.345	0.564	0.036	84.686	76.080	80.383
1981	0.802	0.847	0.830	0.819	0.492	0.216	0.347	0.595	0.056	83.990	75.930	79.960
1982	0.855	0.892	0.880	0.844	0.511	0.215	0.368	0.598	0.079	82.090	75.480	78.785
1983	0.890	0.917	0.898	0.872	0.541	0.222	0.396	0.634	0.097	83.660	76.360	80.010
1984	0.898	0.936	0.905	0.915	0.528	0.221	0.382	0.651	0.097	82.206	74.240	78.223
1985	0.915	0.957	0.918	0.922	0.518	0.220	0.369	0.631	0.087	77.091	72.090	74.591
1986	0.939	0.959	0.949	0.934	0.507	0.220	0.359	0.624	0.084	76.923	70.680	73.801
1987	0.954	0.961	0.956	0.933	0.508	0.216	0.364	0.617	0.085	75.689	69.790	72.740
1988	0.964	0.967	0.973	0.952	0.504	0.215	0.360	0.614	0.084	74.842	68.960	71.901
1989	0.971	0.978	0.989	0.980	0.495	0.204	0.359	0.612	0.077	71.793	66.900	69.347
1990	1.000	1.000	1.000	1.000	0.471	0.205	0.327	0.574	0.070	70.100	64.960	67.530
1991	1.042	1.032	1.014	1.009	0.474	0.212	0.324	0.578	0.066	70.276	64.590	67.433
1992	1.091	1.063	1.031	1.009	0.483	0.214	0.332	0.586	0.067	70.127	64.510	67.318
1993	1.125	1.085	1.038	1.011	0.483	0.214	0.333	0.583	0.077	74.276	63.670	68.973

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