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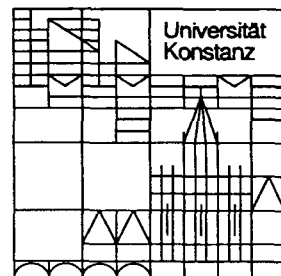
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**Sonderforschungsbereich 178
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Diskussionsbeiträge

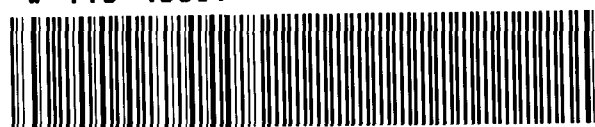
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Taxes in an Efficiency Wage Economy

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Abstract:

Various taxes influence wage and employment outcomes in efficiency wage models. These findings are extended by incorporating more comprehensive tax functions, additional tax parameters, union-firm wage bargaining, and balanced budget restrictions. Moreover, the importance of different effort functions is evaluated. It is shown that higher marginal tax rates, holding constant the level of taxes, reduce wages and increase employment. Higher level of taxes on income, labour cost and value-added can raise unemployment.

Keywords: efficiency wages, effort function, taxes, unemployment, wage bargaining

JEL-Classification: E 24, H24, H25, J41

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1. Introduction

Economic policy in many countries has suffered a loss of instruments over the last decades. Monetary policy is increasingly handed over to independent central banks which are made responsible primarily for price stability. The provisions of the Maastricht Treaty of the European Union can serve as an outstanding example. Demand management is often impeded by sizeable budget deficits which do not allow for expansionary policies, even when appropriate. One of the instruments governments have retained for purposes of economic policy, especially for tackling the major failure of modern market economies, the persistent high level of unemployment, is tax policy. Accordingly, changes in tax rates have been advocated as means of improving the functioning of the labour market. Examples of such proposals include a shift from direct to indirect taxes. As the latter are more difficult to evade than the former such a shift towards value-added tax, for example, can help to counteract the increased activity of the black economy. Labour demand can be boosted by a reduction in labour cost, such as payroll taxes or social security contributions. Finally, reductions in marginal income tax rates can be used to promote employment in unionised settings where the firm determines the number of jobs, as higher tax deductions tilt the union's optimal wage-employment combination towards more jobs.¹

The list of proposals for tax reforms to improve the employment performance of market economies is by no means complete but demonstrates some of the alternative routes suggested. The success of tax policy in achieving this aim depends to a large degree on the reasons why labour markets do not clear. Among the explanations put forward which seek the cause for high unemployment on the labour markets themselves efficiency wages and the influence of trade unions are the most prominent ones suggested especially for the European context. The impact of tax changes in the context of co-operative bargaining between unions and firms has been investigated in depth, both theoretically and empirically. The influence of alterations in tax rates in efficiency wage settings has found considerably less attention. This paper aims to rectify the imbalance for a number of reasons: Firstly, there exists substantial empirical evidence for the importance of efficiency wages.² Secondly, the specific assumptions about effort functions on which much of the previous research on taxes in efficiency wage models rests, might lead to incomplete if not wrong policy advice. And thirdly, it has to be ensured that the predictions regarding the impact of tax changes based on the analysis of one type of imperfect labour market - such as a unionised one - do not run counter to consequences which might arise if another explanation of unemployment were appropriate, such as the efficiency wage hypothesis. Only then can policy advice be provided with a fair amount of confidence.

¹ See OECD (1995) and EU (1993, chap.9) for recent examples of such policy proposals.

² Drago/Heywood (1992) present evidence for a comprehensive sample of "job holders" in the United States, Rebitzer/Taylor (1995) have looked at American law firms, Gerlach/Stephan (1994) investigate German data, Gera/Grenier (1994) report estimates for Canada, and Fehr et al. (1996) contain experimental evidence, to name but a few examples.

In order to determine the effects of tax changes in an efficiency wage context, two types of relation between work effort and its determinants will be investigated. This allows to incorporate different explanations of efficiency wages. More specifically, in section 3 the existence of an exogenously given effort function of the form $e = e(w^n)$ will be presumed, where e refers to worker's effort and w^n to the net wage. Apart from a non-linear income tax, taxes on value-added, labour cost and profits will be taken into account. Contrasting the wage and employment effects of tax changes in a simple model with an exogenously given effort function with those obtained for a specific shirking model, to be analysed in section 4, provides an insight into the generality of results. In addition, it will be investigated whether tax effects which are true for individual firms also hold in an efficiency wage economy. Moreover, a wide set of tax function will be considered to evaluate the robustness of previous findings and to ensure comparability with research on unionised labour markets. In addition, the basic models will be extended by imposing the requirement of budget-neutral tax changes (section 5.1) and by allowing for the combined existence of efficiency wages and trade unions (section 5.2). In general, increases in the level of taxes on income, labour cost or value added have ambiguous employment consequences. Higher marginal tax rates reduce wages and raise employment.

2. Taxes in Efficiency Wage Models

The main results emanating from the investigation of tax changes in efficiency wage models so far, relate to variations in taxes on labour (cost). Wage and employment effects of changes in an ad valorem or a specific employment tax in a shirking framework depend crucially on the features of the effort function (Pisauro 1991). The focus will be on two aspects here; the inclusion of alternative income and the degree of homogeneity of the effort function in wage and alternative income.³ If effort depends on the own wage only an increase in an ad valorem (specific employment) tax will not affect (reduce) wages and increase unemployment. If the alternative income is included as determinant of effort and if effort is homogeneous of degree zero in wages and alternative income, an ad valorem (specific employment) tax will reduce (have ambiguous consequences on) wages and will not change (decrease) employment. If the effort function contains the own wage, the alternative income and unemployment as arguments, an increase in an ad valorem (specific employment) tax will lower (raise) wages but increase unemployment.⁴

³ Pisauro (1991) also includes the curvature of the effort function as third relevant aspect. If risk-aversion on the employees' side is assumed, however, this issue can be neglected. The restriction implies that the Shapiro/Stiglitz (1984) model, in which effort e is a dichotomous variable, will not be discussed.

⁴ See Johnson/Layard (1986), Schmidt-Sørensen (1990, 1991b), Pisauro (1991, 1994), Carter (1992, 1995), Agell/Lundborg (1992), Chang (1995) and Artis/Sinclair (1996). Zoega (1994) considers a higher ad valorem (consumption) tax to finance an expansion of the public sector. In this framework an increase in the labour (consumption) tax raises (has ambiguous consequences on) unemployment. Lastly, Petrucci (1994) investigates a turnover model, but derives basically the same results as can be found for the most general case of the shirking model.

In addition to labour taxes, changes in personal income tax rates have been investigated (Hoel 1989, 1990). An increase in the marginal income tax rate, while the average rate is held constant, lowers wages and unemployment. A rise in the average rate, while the degree of progressivity is held constant,⁵ will have no impact on wages and employment, if the effort function is homogeneous of degree zero in the net wage and the net alternative income. If, however, the ratio (difference) of net wage and the measure of net alternative income falls (does not increase) a rise in the average tax rate will not affect (reduce) the wage and will lower (have uncertain consequences for) unemployment. Allowing for wage bargaining while the firm determines the employment level has no impact on the outcome of a change in the marginal tax rate (Hoel 1989). If, for a given net alternative income, the level of income taxes is raised while the marginal rate or the degree of progressivity is held constant, wage and employment effects will be ambiguous. Assuming the net alternative income to vary less than the net wage, due to a given rise in the tax level, Hoel (1989) can show that an increase in unemployment becomes more likely than in the case in which the net alternative income is fixed. The theoretical predictions found so far in the literature are summed up in table 1.

Table 1: Summary of Wage and Employment Effects of Previous Studies

	Ad Valorem Tax		Employment Tax		Marginal Income Tax		Income Tax	
	w	u	w	u	w	u	w	u
$e(w^n)$	0	↑	↑	↑	↓	↓	n.a.	n.a.
$e(w^n/b^n)$	↓	0a)	?b)	↑	↓	↓	0a)	0a)
$e(w^n, b^n, u)$	↓	↑	↑	↑	↓d)	↓d)	↓c),d)	?c),d)

w = wage, w^n = net wage, b = alternative income, b^n = net alternative income, u = unemployment (rate).

a) Presumes a constant value of w^n/b^n . Unemployment will fall if this ratio declines.

b) If hours are included into the effort function the wage effect will become positive.

c) Assumes that $w^n - b^n$ does not increase.

d) Applies also for wage bargaining.

n.a. = No results are directly contained in studies cited. For sources see footnote 4 and text above.

In addition to the analysis of implications of tax changes in their own right, consequences for welfare and resource allocation of taxes have been investigated (Carter 1992, 1993, 1995, Agell/Lundborg 1992). Moreover, the question of optimal taxation and tariffs in a multi-sector economy with efficiency wages has been addressed.⁶ Finally, Lai/Chang (1993) determine the

⁵ Hoel (1989, 1990) defines the degree of progressivity of a tax function as the ratio of '1 minus the marginal tax rate' and '1 minus the average tax rate', where progressivity increases if this measure falls.

⁶ See Chang (1995) for the closed-economy, Brecher (1992) and Brecher/Choudhri (1994), and references therein, for the open-economy case.

effects of increases in a linear income tax on the aggregate price level and Chang/Lai (1996) investigate the impact of changes in tax evasion on output and revenue. This brief survey illustrates that the results derived so far either do not focus on labour market effects of tax changes, or that - if they do so - specific tax or effort functions are assumed.⁷

3. A Simple Effort Function

Effects of tax changes will be investigated in this section using a simple effort function $e = e(w^n)$. Four kinds of taxes will be considered, a profit-tax, a linear value-added tax V , an income tax T and a tax on labour cost Λ . T and Λ , in general, are assumed to be non-linear, wage-dependent tax functions, although linear versions of them emerge as special cases. Profit taxes are usually modelled as linear, but often certain activities are tax-free and there might exist a minimum level of gross profits Π^g which remains untaxed. These possibilities are captured by a linear profit tax P , with a non-negative level of exemption E , such that net profits Π are given by:

$$(1) \Pi = \Pi^g - (\Pi^g - E)P = \Pi^g(1 - P) + EP, \quad 0 \leq P < 1, \quad \Pi^g > E \geq 0.$$

Gross profits of the firm consist of net revenue less labour cost. Net revenue are comprised of output times its price p , which is assumed to be fixed, less that amount of a tax on revenue which cannot be shifted forward. The firm uses no other inputs than labour and sells all its production. A tax on revenue will thus be equivalent to a value-added tax. Such a value-added tax might, however, not only affect the firm's behaviour. If workers' effort depends on the real wage they receive, any change in the value-added tax that is not born entirely by the firms will give rise to the possibility of wage adjustments. These issues will be tackled in turn and it is first supposed that a value-added tax solely alters net revenue, in accordance with the possible extent of forward shifting. Subsequently, the notion will be included that changes in the value-added tax directly affect the workers' effort. The extent to which changes in the value-added tax can be shifted forward is assumed to be constant but a priori no specific value is presumed for it. Let s be the share of the value-added tax that can be passed on, where $0 \leq s$. If $s = 0$, prices will be fixed and no forward-shifting will occur. If $s = 1$, tax increases can be shifted forward completely. Values of $s < 1$ imply partial shifting, values of $s > 1$ entail overshifting. Let f be the strictly concave production function, $f' > 0$, $f'' < 0$. Net revenue R of a company is then given by:

$$(2) R = pf(1 + sV) - pfV = pf(1 - V(1 - s)), \quad \text{where } V < 1 \text{ by assumption.}$$

Apart from taxes on profits and revenue companies also have to pay taxes or contributions to social security funds which focus on labour cost. The total payroll PR of the company -

⁷ Taxes in dual economy models, in which the second sector absorbs all "unemployed" labour from the primary, efficiency wage sector are analysed by Bulow/Summers (1986), Copeland (1989) and Wilson (1990), for example. These models differ from the theories discussed in this paper at least insofar, as that every worker can be employed - in the secondary sector. Hence, unemployment need not exist (cf. Brecher 1992).

or its labour cost - is thus given by:

$$(3) PR = wN + N\Lambda(w) = N(w + \Lambda(w))$$

The tax on labour cost, or payroll tax Λ for short, is supposed to be non-decreasing in w , such that $\Lambda' \geq 0$. In addition, there might exist tax-like cost which vary solely with the number of employees but not with their pay. Workplace security arrangements, administrative cost of fulfilling informational requirements of social security or tax authorities, compulsory severance pay and the payroll tax that finances state unemployment insurance benefits in the US, which has a low contribution ceiling such that contributions do not vary with wage payments for incomes surpassing this ceiling, might constitute examples for such wage-independent, non-wage labour cost (cf. Hamermesh 1993, pp.44ff, Hart 1984, esp. chap.2). They can be integrated in this framework by assuming that Λ is fixed and given by $\Lambda(w) = t^*$.

Taxes are not only levied on firms but also on its workers. Therefore, a non-regressive income tax system will be included into the investigation. In line with previous research on income taxes in non-clearing labour markets there will be a distinction between variations in the marginal tax rate T' , which leave the overall level of income taxation T unchanged, and alterations in the level of taxes T , retaining the marginal rate T' . It is therefore possible to determine whether changes in these tax parameters have differential impacts on wages, effort and employment, as suggested by Hoel (1989, 1990) for efficiency wage models, in union-firm bargaining approaches and in equilibrium search frameworks.⁸ The net wage w^n is defined as:

$$(4) w^n = w - T(w), \text{ where } T' \geq 0 \text{ and } T'' \geq 0.$$

It is thus supposed that the income tax is non-decreasing in the wage at a non-decreasing rate. This requirement is fairly general as it incorporates flat rate income tax systems, progressive ones and also those with step-wise increases in the marginal tax rate. Effort e depends positively on the (net) wage, though at a decreasing rate, such that $e = e(w^n)$ and

$$(5) e_w = e'(1 - T') \text{ and } e_{ww} = e''(1 - T')^2 - e'T'' < 0, \text{ as } e'' \leq 0 \text{ and } T'' \geq 0,$$

where at least one of the inequalities is supposed to hold strictly.

Using the information assembled above, net profits of the company can be defined as:

$$(6) \Pi = (1 - P)[pf(e(w - T(w))N)(1 - V(1 - s)) - N(w + \Lambda(w))] + EP,$$

as all non-labour inputs are assumed to be fixed and thus normalised to zero. Working hours are also given exogenously, such that no substitution between hours and employment is feasible.⁹ The

⁸ See, for example, Creedy/McDonald (1991), Holmlund/Kolm (1995) and Lockwood/Manning (1993) for the union case and Hansen (1996), Pissarides (1990, 145ff) for search models.

⁹ For efficiency wage models in which hours of work are included as determinants of effort see, for example, Schmidt-Sørensen (1991a, b) for a general efficiency wage model, Hoel/Vale (1986) for a labour turnover approach or Booth/Ravallion (1993) for a model with collective bargaining.

company will choose the wage it pays and the number of workers it employs such that:¹⁰

$$(7) \frac{\partial \Pi}{\partial w} = (1 - P)(pf'(e(w^n)N)e'(1 - T')N(1 - V(1 - s)) - N(1 + \Lambda')) = 0$$

$$(8) \frac{\partial \Pi}{\partial N} = (1 - P)(pf'(e(w^n)N)e(1 - V(1 - s)) - (w + \Lambda)) = 0$$

As profits exceed the level of tax exemption E and as the firm has been supposed to be risk-neutral, the level of profit-taxation will have no impact on the optimal wage and employment choice. This result is consistent with the standard notion that a profit-maximising firm will not alter its employment decision if profits are taxed, as long as the tax base excludes costs of capital (Atkinson/Stiglitz 1987, p.132). Thus, the profit tax P will be omitted from subsequent considerations. Combining (7) and (8) yields a modified Solow-condition:

$$(9) (1 - T') \frac{e'}{e(w^n)} \frac{w + \Lambda}{1 + \Lambda'} = 1$$

Rewriting (9) one obtains an implicit function G which can be used for the determination of wage effects due to tax changes:

$$(10) G \equiv (1 - T')e'(w + \Lambda) - e(1 + \Lambda') = 0$$

Differentiating with respect to the gross wage, note that $G_w < 0$, as either of the three inequalities $T'' \geq 0$, $e'' \leq 0$ or $\Lambda'' \geq 0$ is assumed to hold strictly.

$$(11) G_w = -T''e'(w + \Lambda) + (1 - T')^2 e''(w + \Lambda) - e\Lambda'' < 0$$

A sufficient condition for a profit maximum requires $\Lambda'' \geq 0$. This requirement implies that the tax on labour cost must not be increasing in wages at a decreasing rate, i.e., be concave in w . If $G_w < 0$, as it is assumed subsequently, the sign of G_i will determine the wage effect of tax changes, where $i = T, T', V, \Lambda, \Lambda'$.

Income Tax

Note that:

$$(12) G_T = -(1 - T')e''(w + \Lambda) + e'(1 + \Lambda') > 0$$

An increase in the level of income taxes, while the marginal rate is held constant, raises the wage. As a rise in T reduces the effort of workers for a given wage, the overall impact on effort and employment is ambiguous. Using Cramer's rule it can be shown that employment declines, as

$$(13) \frac{\partial N}{\partial T} = \frac{-\Pi_{NT}\Pi_{ww} + \Pi_{wT}\Pi_{Nw}}{J},$$

where J is the value of the Jacobian determinant, $J > 0$, and $\Pi_{ww}, \Pi_{wN} < 0$ (see appendix I).

¹⁰ Second order conditions for a maximum hold, as shown in appendix I.

Moreover,

$$(14) \Pi_{NT} = -e'p(1 - V(1 - s))(f''eN + f'), \text{ from (7) and}$$

$$(15) \Pi_{wT} = -(1 - T')Np(1 - V(1 - s))\left[f''(e')^2N + f'e''\right] > 0, \text{ from (8), if } e'' \leq 0.$$

$\Pi_{NT} > 0$ will hold, for example, for a Cobb-Douglas production function. Hence, $\partial N/\partial T < 0$.¹¹ A positive sign for $(f''eN + f')$ will also be assumed for the subsequent investigations.

Moreover, differentiation of G with respect to T' yields:

$$(16) G_{T'} = -e'(w + \Lambda) < 0$$

An increase in the marginal income tax rate T' , while the level of taxation T remains unchanged, lowers the efficiency wage and thus effort. Note, that for a given level of employment the marginal product of labour $(f'e)$ increases with the wage for $(f''eN + f') > 0$. As the wage falls due to a rise in T' the marginal product of labour declines. But from $\Pi_{Nw} < 0$ it can be concluded that the marginal (value) product will decline by less than marginal cost if the wage falls. To equalise those two dimensions again, either wages or employment have to rise, given concavity of the production function. As has just been shown that wages will decline the company will employ more labour than before the tax increase. A rise in the marginal rate of income taxation, while holding constant the level, will therefore be beneficial for employment.

The differential results for increases in T' and T arise because changes in the marginal rate T' make wage increases less attractive to workers. A change in T , however, only affects the level of effort expanded but does not alter the marginal impact of wage payments on effort. In the case of a higher T it is beneficial for the company to compensate the workers for the tax hike by paying more, such that the reduction in effort is counteracted. In the case of a higher marginal tax rate the level of effort remains the same, for a given wage. A given gross wage increase, however, raises effort by less than before the tax was raised, while the cost of driving up wages remains the same. Hence, the company lowers its optimal wage.

Payroll Tax

Wage effects of changes in the tax on labour cost are determined by:

$$(17) G_{\Lambda} = (1 - T')e' > 0$$

$$(18) G_{\Lambda'} = -e < 0$$

An increase in the level of labour taxation Λ , while holding constant the marginal rate Λ' , raises

¹¹ More generally, $f''eN + f' > 0$ implies in a model in which capital is determined endogenously as well, that the elasticity of substitution between labour and capital is not too low. Assuming a CES production function Pisauro (1991, p.338 FN 15) demonstrates that an equivalent requirement is that the elasticity of substitution between labour and capital is greater than 1 minus labour's share of output or income.

wages, thus increasing effort as well, whereas an increase in the marginal rate Λ' , while retaining the original level Λ , reduces wages and effort. If the marginal rate of the tax on labour cost rises, any wage increase (decrease) will become more expensive (profitable) for the firm. Hence, the rise in Λ' extends the incentives to reduce the wage. An increase in Λ' raises the marginal (value) product of labour relative to marginal cost. The company can only warrant the first order condition with respect to employment if it expands employment, such that a higher marginal payroll tax is beneficial for employment. An increase in the level of taxes on labour cost, however, raises wages. This counterintuitive result comes about because the company will react to the increase in labour cost by inducing its employees to work harder. This will only be possible if it increases its wage payments. Higher wages raise the marginal value product of labour by less than they increase labour cost. Hence, the company needs to reduce employment. Thus, not only wage but also employment effects of alterations in the level and the marginal rate of the tax on labour cost, holding constant the other tax parameter respectively, differ.

Suppose now that the tax on labour cost can be represented by a linear ad valorem tax on wages, such that $\Lambda(w) = wt^*$. Substituting in (10) the payroll tax can be omitted from that expression. An ad valorem tax on labour does not have a wage effect, because the (potentially) opposite effects via the marginal rate and the level cancel out. If the wage remains unchanged, but the tax increases, the company will reduce its workforce. If, instead of an ad valorem tax, Λ depicts a specific linear tax on labour $\Lambda(w) = t^*$ will hold. In this case, $\Lambda' = 0$, such that the wage impact is determined by the level effect $G_{\Lambda} > 0$, implying that the efficiency wage will rise if t^* goes up. Furthermore, it can be shown that employment declines due to the rise in t^* .¹²

As pointed out by Pisauro (1991, 1994), an ad valorem tax and a specific (employment) tax will have differential wage effects if either workers are characterised by a non-linear utility function or if the effort function is continuous. If, instead, as in the model by Shapiro and Stiglitz (1984), e is dichotomous and the utility function is linear, changes in either type of taxes will have the same wage and employment consequences because tax variations do not affect the choice of effort by the employees at the margin.

Value-added Tax

The value-added tax will have no influence on the optimal wage, determined by the modified Solow-condition (9), if workers' effort depends solely on their nominal net wage, irrespective of the extent of shifting assumed. Hence, in this simple efficiency wage set-up wages do not respond to alterations in V , because the marginal gain from higher wages and employment is changed proportionately. If the increase in the value-added tax can be shifted forward completely ($s = 1$) employment will remain the same. If $s < 1$, the marginal gain from an additional employee will

¹² Assuming $\Lambda(w) = t^*$, it can be shown that $\partial \Pi_N / \partial t^* = -1$ and $\partial \Pi_W / \partial t^* = 0$. Thus, $\partial N / \partial t^* = \Pi_{WN} / J < 0$.

shrink while cost will be the same. Hence, the company employs fewer people. The opposite reasoning holds for the case of overshifting.

If, in contrast to the previous assumption, workers' effort depends on the net real wage w^{nr} changes in V will, in general, affect the efficiency wage. Define the net real wage w^{nr} as

$$(19) w^{nr} = \frac{w - T(w)}{1 + Vs},$$

where the initial price level has been normalised to unity. Assume for purposes of exposition that the only price alterations that can occur are due to variations in the value-added tax V . Substituting for w^n in (9) or (10) the sign of G_W is unchanged while G_V is found to be:

$$(20) G_V = -\frac{sw^{nr}}{1 + Vs} [(1 - T')(w + \Lambda)e'' - e'] > 0, \text{ if } s > 0.$$

A higher value-added tax that can be shifted forward at all, will raise the wage required to fulfil the Solow-condition, if workers' effort depends on their (net) real wage. As employment already declined for a given wage, if the value-added tax could not be shifted forward completely, the wage increase will aggravate the reduction in employment due to a higher V , if $s < 1$. For $s > 1$, the employment effect becomes ambiguous.

Given the absence of repercussions from the aggregate employment level on effort and assuming that all firms pay efficiency wages, results derived for individual companies can be generalised to the economy. Higher marginal income tax rates and higher tax rates on labour cost are therefore beneficial for employment in an efficiency wage economy in which the relationship between effort and net wage can be depicted by a simple function $e = e(w^n)$. The result for the marginal income tax rate is qualitatively the same as for a model of union-firm wage bargaining.

4. A Shirking Model

In this section an efficiency curve is utilised which results from maximisation of expected utility by a representative worker. The main difference in comparison to the previous approach is that effort e will also depend on net alternative income b^n and the unemployment rate u . This follows the tradition of viewing unemployment as worker discipline device (cf. Shapiro/Stiglitz 1984). To enable comparisons with previous work and in order to keep the analysis tractable, a framework by Pisauro (1991) is employed. Under Pisauro's assumption the (indirect) utility function of a worker is additively separable in utility from net income y and a measure of effort and defined as:

$$(21) U(y, e) = v(y) + \beta(1 - e),$$

where e is the time during which effort has been expended on the tasks demanded by the employer and β a parameter capturing the relative importance of effort relative to utility from income. The function U is strictly concave in income, such that $v' > 0$ and $v'' < 0$. Total working

time is fixed exogenously and normalised to unity, such that $e = 1$ implies no shirking. For simplicity, the term shirking will be used, if $e < 1$, i.e., although the degree of shirking, or the time spent at work not exerting effort, can vary substantially. This yields an effort function including the income tax parameters also used in section 3, as given by (see Pisauro 1991 for a derivation of the case without taxes):

$$(22) e = \frac{1}{2} \left[\frac{v(w - T(w)) - v(b - T(b))}{\beta} + 1 - \frac{1}{ud} \right],$$

where d is the dismissal probability for a shirker. From (22) note that:

$$(23a) \frac{\partial e}{\partial u} = 1 / 2u^2 d > 0$$

$$(23b) \frac{\partial e}{\partial T} = \frac{v'(b^n) - v'(w^n)}{2\beta} > 0$$

$$(23c) \frac{\partial e}{\partial T'} = 0$$

$$(23d) \frac{\partial e}{\partial w} = \frac{v'(1 - T')}{2\beta} > 0$$

Hence, effort increases in employment, for a given wage, will rise in the level of taxation, if the marginal tax rate is held constant and if the alternative income is taxed. If the alternative income is not subject to income taxation, $\partial e / \partial T$ will have a negative sign, that is, effort will decrease with T . Moreover, effort is independent of the marginal tax rate T' and increasing in the gross wage.

If all firms are identical and if the allocation of resources across them is efficient it is possible to aggregate across firms to obtain an aggregate condition determining the wage and also aggregate labour demand. Following Pisauro (1991) these two curves can be understood as the marginal cost curve of employment or as no-shirking constraint, and as the labour demand curve of the economy, the latter being the product of the number of firms and the level of employment N in each of them. Aggregate employment is then given by \tilde{N} . The intersection of the labour demand curve LD and the shirking constraint SC (or the modified Solow-condition) determines the wage and unemployment level. Let F be the aggregate production function. Using equation (23d) the following expressions can be obtained for LD and SC and their slopes:

$$(8a) LD = pF'[e(w^n, b^n, u)\tilde{N}]e(w^n, b^n, u)(1 - V(1 - s)) - (w + \Lambda) = 0$$

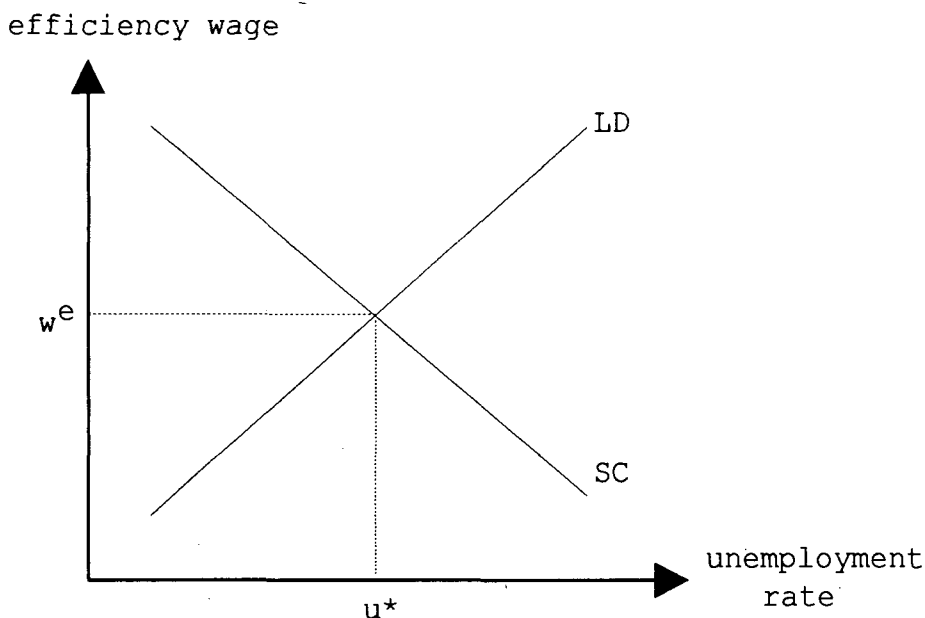
$$(9b) SC = \frac{(1 - T')(w + \Lambda)}{(1 + \Lambda')} \frac{v'}{2\beta} - e(w^n, b^n, u) = 0$$

$$(24) \frac{dw}{du} \Big|_{LD} = \frac{2\beta[F''(e - e_u(1 - u))e - F'e_u / L]}{F''ev'(1 - T')(1 - u)} > 0$$

$$(25) \frac{dw}{du} \Big|_{SC} = \frac{(1 + \Lambda') 2\beta e_u}{v''(1 - T')^2 (w + \Lambda) - v' T'' (w + \Lambda) - 2\beta e \Lambda''} < 0$$

The labour demand curve LD and the shirking constraint SC are depicted in figure 1 (cf. Pisauro 1991), where linearity has been assumed for simplicity.

Figure 1: Labour Market Equilibrium in the Shirking Model



Assuming a steady-state the slope of the labour demand curve LD can be determined because total employment \tilde{N} is equal to the labour force L , multiplied by the employment rate $(1 - u)$. Given $\tilde{N} = (1 - u)L$, $\partial(e\tilde{N})/\partial\tilde{N} = e - (1 - u)e_u$, which is assumed to be positive.¹³ Using the first-order condition with respect to the wage yields the positive sign for the slope of the labour demand curve.

Value-added Tax

From inspection of (9^a) it can be noted that the SC is not affected by alterations in the value-added tax V . Hence, solely repercussions on the labour demand curve determine the consequences of changes in V . Differentiation of (8^a) yields:

$$(26) \frac{\partial w}{\partial V} \Big|_{LD} = \frac{2\beta(1-s)F'}{F''(1-V(1-s))v'(1-T')\tilde{N}} < (\geq) 0, \text{ if } s < (\geq) 1.$$

In the case of complete forward-shifting of the value-added tax ($s = 1$), marginal revenue will be

¹³ For the significance of this assumption, see Pisauro (1991).

unaffected by changes in V . Gross and net wage, effort and also unemployment remain the same. If the company cannot shift forward the increase in the value-added tax completely ($s < 1$) the labour demand curve will move downward and to the right. The gross and net wage fall, as does effort. Despite the fall in wages unemployment rises. If the company is able to overshift any value-added tax increase the labour demand curve will shift upward, implying exactly the opposite results in comparison to less than complete forward shifting.

Comparing the results for an increase in the value-added tax with the outcomes obtained for the simple efficiency wage model of section 3 it can be noted that both approaches predict a reduction in employment, while only the model based on the effort function $e(w^n, b^n, u)$, i.e., including unemployment, implies a negative wage impact because the increase in the number of jobless will induce the firm to lower the wage, as $e_{wu} = 0$ and $e_u > 0$ hold.

If it is assumed, as in the previous section, that workers' effort is determined not by net wages but net *real* wages instead, the impact of variations in V will change. Using expression (19) and also applying this concept to the alternative income, the condition determining labour demand and the shirking constraint can be rewritten. Moreover, from a modified expression for the effort function (22) one obtains:

$$(27a) \quad \frac{\partial e}{\partial w} = \frac{v'(1-T')}{2\beta(1+Vs)} > 0, \text{ such that}$$

$$(27b) \quad \frac{\partial^2 e}{\partial w \partial V} = -\frac{s[v''w^{nr} + v'](1-T')}{2\beta(1+Vs)^2}$$

$$(27c) \quad \frac{\partial e}{\partial V} = \frac{s}{2\beta(1+Vs)} \left[v'(b^{nr})b^{nr} - v'(w^{nr})w^{nr} \right]$$

Neither e_{wV} nor e_V can be signed unambiguously. Hence, the direction in which the labour demand curve shifts due to an increase in the value-added tax is uncertain:

$$(28) \quad \frac{\partial w}{\partial V}|_{LD} = -\frac{e_V(1-V(1-s))(F''e\tilde{N} + F') - F'e(1-s)}{F''(1-V(1-s))e_w\tilde{N}e}$$

The same applies to the shift in the shirking constraint:

$$(29) \quad \frac{\partial w}{\partial V}|_{SC} = \frac{e_wV(w+\Lambda) - (1+\Lambda')e_V}{-T''\frac{v'}{2\beta}\frac{w+\Lambda}{1+Vs} + \left(\frac{1-T'}{1+Vs}\right)^2\frac{v''}{2\beta}(w+\Lambda) - e\Lambda''}$$

Should the effort of a worker be determined by the difference in income between the (net) real wage and the (net) real alternative income, any alteration in the value-added tax, irrespective of the amount of shifting, will have ambiguous wage and employment consequences. This result differs from that derived for the simple effort function $e = e(w^{nr})$, because the increase in the value-added tax, on the one hand, reduces the utility from the net real wage w^{nr} but, on the other

hand, also lowers the utility from the net real alternative income. As effort depends crucially on the difference between the two it is not evident a priori which effect dominates.

In many countries there exist multiple value-added tax rates. Moreover, it is plausible to presume that the consumption bundle purchased with the alternative income is consisting, firstly, of a larger share of goods for which a reduced value-added tax rate applies and, secondly, of goods for which the price elasticity is relatively small such that shifting is feasible to a lesser extent than for goods a worker earning the 'regular' wage purchases. These considerations can be captured by defining the net real alternative income as

$$(30) \quad b^{nr} = \frac{b - T(b)}{1 + V_s \zeta},$$

where $0 < \zeta < 1$ measures the differential impact of alterations in value-added tax rates on w^{nr} and b^{nr} . The impact of alterations in V on effort e (cf. (27c)) will still be ambiguous if (30) holds. But an increase in the value-added tax for $0 < \zeta < 1$ is more likely to reduce effort than for $\zeta = 1$. Assuming e_V to be negative, the labour demand curve shifts downward and the shirking constraint upward in response to an increase in the value-added tax. This would increase unemployment but have ambiguous wage and therefore effort effects. Under plausible assumptions it can therefore be conjectured that an increase in the value-added tax shifted forward to less than 100% has detrimental employment effects in an efficiency wage framework which includes the (net) real alternative income and unemployment as determinants of effort.

Payroll Taxes

Consider first a change in the level of taxes on labour cost Λ :

$$(31) \quad \frac{\partial w}{\partial \Lambda} \Big|_{LD} = \frac{2\beta}{pF'' e(1 - V(1 - s)) \tilde{N}v'(1 - T')} < 0$$

$$(32) \quad \frac{\partial w}{\partial \Lambda} \Big|_{SC} = - \frac{(1 - T')v'}{v''(1 - T')^2 (w + \Lambda) - v'T''(w + \Lambda) - e2\beta\Lambda'} > 0$$

The labour demand curve shifts downward, while the shirking constraint moves upward. This implies less employment. Using Cramer's rule it can be shown that gross and therefore net wages and also effort will increase if Λ rises (see appendix II). Raising the level of the payroll tax, while holding constant its marginal rate thus increases wages and lowers employment. This result concurs with Pisau's (1991, 1994) case of a specific tax on labour, which implicitly assumes a marginal tax rate of zero.

Analysing changes the marginal rate of the tax Λ' , it can be noted that the labour demand curve is not affected by alterations in Λ' , while the shirking constraint shifts downward, such that gross and net wages, effort and unemployment fall.

$$(33) \frac{\partial w}{\partial \Lambda'} \Big|_{SC} = \frac{2\beta e}{v''(w + \Lambda)(1 - T')^2 - v'T''(w + \Lambda) - e2\beta\Lambda''} < 0$$

An ad valorem tax is defined by $\Lambda(w) = wt^*$, where t^* is the tax rate on labour cost. Substituting in (9^a) accordingly demonstrates that the shirking constraint is not affected by variations in t^* (as terms cancel out). The labour demand curve shifts downward, such that wages fall and unemployment increases. In case of a specific employment tax it can be shown that the labour demand curve will shift downward while the shirking constraint will move upward if the tax is raised. As the effect of the movement of the shirking constraint dominates, the wage will rise.

Comparing the results with those obtained for the simple efficiency wage model of section 3 it can be noted that they are not affected by the alteration in the effort function. As unemployment changes already in the simple model, the repercussions via an extended effort function might mitigate the wage and effort effects. But they will not reverse the employment consequences of changes in Λ and Λ' , as the wage variations due to changes in unemployment are only of second order magnitude in comparison to the tax induced wage variations.

Level of Income Tax T

If only the level of income taxation is raised, while the marginal rate is held constant, the direction of the shift in the labour demand curve will depend on the tax liability of the alternative income and on the characteristics of the aggregate production function.

$$(34) \frac{\partial w}{\partial T} \Big|_{LD} = - \frac{2\beta [F'' e\tilde{N} + F'] (v'(b^n) - v'(w^n))}{F'' e\tilde{N} v'(1 - T')} > 0, \text{ if } F'' e\tilde{N} + F' > 0$$

Given concavity of the utility function the second term in the numerator of (34) is positive. For an (aggregate) Cobb-Douglas production function the term in square brackets is also positive, such that the labour demand function will shift upward if T is raised. Should, however, the alternative income be untaxed, such that $v'(b^n)$ drops out, the labour demand curve will shift downward. The impact on the shirking constraint is determined by:

$$(35) \frac{\partial w}{\partial T} \Big|_{SC} = \frac{(w + \Lambda)(1 - T')v'' + [v'(b^n) - v'(w^n)](1 + \Lambda')}{v''(1 - T')^2(w + \Lambda) - v'T''(w + \Lambda) - 2\beta e\Lambda''}$$

If the alternative income is subject to income taxation, the expression in the numerator cannot be signed unambiguously; the impact of alterations in T on the shirking constraint is unpredictable. The overall impact on wages and unemployment cannot be determined as the upward shift of the labour demand curve, implying lower unemployment and higher wages, can either be complemented by a downward shift of the shirking constraint, inducing again lower unemployment but also lower wages, or by an upward shift of the shirking constraint, such that wages rise further but implying a countervailing influence on unemployment.

If the alternative income is not subject to the income tax, the numerator of (35) will be negative, as will be the denominator. The shirking constraint shifts upward. Moreover, the labour demand curve moves downward. Both changes imply a reduction in employment but entail ambiguous consequences for the wage level and effort. While the use of the simple effort function, which does not contain the alternative income as a determinant of effort allows for unambiguous wage and employment predictions of variations in T , this is not possible for $e = e(w^n, b^n, u)$ because the marginal utility from a given wage is increased, inducing higher wages, while the difference in utility resulting from the net wage and the net alternative income increases, implying - on the contrary - the need for a lower wage. If the alternative income is not taxed the predictions of the two model will coincide.

Marginal Income Tax rate T'

Inspection of the labour demand curve shows that an alteration in the marginal tax rate T' has no impact on labour demand, as the effort of employees is not changed by variations in T' . But the shirking constraint shifts downward, thus implying lower gross and net wages and less unemployment. Both developments contribute to a reduction in effort, as $e_w, e_u > 0$.

$$(36) \quad \frac{\partial w}{\partial T'} \Big|_{SC} = \frac{v'(w + \Lambda)}{v''(1 - T')^2(w + \Lambda) - v'T''(w + \Lambda) - 2\beta e\Lambda''} < 0$$

The predictions regarding variations in the marginal income tax rate T' do not depend on the type of effort function used. They seem to represent a policy instrument which can potentially be used without precise knowledge of the relationship between effort and its determinants.

Alternative Tax Structure

Instead of a general tax function $T(w)$ it is also possible to presume a more specific relationship between gross and net income which, however, does not allow the distinction between changes in marginal tax rates, while the level is held constant, and changes in the level of income taxes, while the marginal rate remains unchanged. An obvious way of modelling such a tax system is to assume a positive level of exemption t^e and a linear rate t^l , such that $w^n = (w - t^e)(1 - t^l) + t^e = w(1 - t^l) + t^e t^l$. This definition of net income implies uncertain wage effects for changes in t^l while the wage will fall if t^e is increased, should the alternative income be subject to an income tax, too. Employment effects of changes in the level of tax exemption t^e and the linear rate t^l can, however, not be predicted, unless further simplifying assumptions are made. The ambiguous employment consequences are similar to results obtained in models of union-firm wage bargaining, as the income effect of a change in either t^e or t^l cannot be signed, such that the overall impact of variations in those tax parameters is indeterminate (cf. Oswald 1982, Malcomson/Sartor 1987).

5. Extensions

In the beginning it has been argued that tax policy represents one remaining economic policy instruments governments still have at their disposal while demand management, for example, cannot be employed any more, due to sizeable budget deficits. Implicitly this argument assumes that changes in tax rates are balanced by alterations in other taxes, such that the budgetary consequences cancel out. In section 5.1 revenue-neutral tax reforms will therefore be investigated. Moreover, it has been argued in the introduction that it would be desirable to establish wage and employment effects for various explanations of non-market clearing mechanisms of wage determination. So far, union-firm bargaining and efficiency wages have been treated as separate mechanisms. In section 5.2 these two theories of wage determination will be combined.

5.1 Revenue-neutral Tax Reforms

Given current strains on the fiscal situation in many countries it might seem desirable to alter tax rates without any budgetary impact. Hence, the question arises as to whether the wage and employment effects of tax alterations described above will also hold if a requirement of budget neutrality is imposed. Such a budget- or revenue-neutral change in the tax structure can be realised by variations in the tax levels T , V and Λ ,¹⁴ as changes in the marginal rates - per definition - leave revenue unaltered. All companies are identical and face a simple effort function $e = e(w^\Pi)$ as constraint. The only sources of income for the government are the taxes on income, labour cost and value-added. Its revenue B is then given by:

$$(37) B = \tilde{N} T(w) + \tilde{N} \Lambda(w) + F V,$$

where the initial price level p has been normalised to unity, \tilde{N} is the total number of employed and F is aggregate output. Using the notion of ex-ante budget neutrality, a change in the tax structure will be revenue-neutral if:

$$(38) dB = B_T dT + B_\Lambda d\Lambda + B_V dV = 0$$

Substituting from (37) into (38) yields the following relations between two tax rate alterations, where changes in the third have been assumed to be zero.

$$(39) \frac{dT}{d\Lambda} = -1, \quad \frac{dT}{dV} = -\frac{F}{\tilde{N}}, \quad \frac{d\Lambda}{dV} = -\frac{F}{\tilde{N}}$$

Suppose, the government raises the income tax level T but lowers the tax on labour cost Λ in such a way as to guarantee (38). Using (12) and (17) the wage effect can be written as:

$$(40) \frac{\partial w}{\partial \Lambda} \Big|_{dB=0} = w_T \frac{dT}{d\Lambda} + w_\Lambda = \frac{G_T - G_\Lambda}{G_w} = -\frac{(1-T')e''(w+\Lambda) - e'(\Lambda'+T')}{G_w} < 0$$

¹⁴ Alterations in the profit tax are not considered.

A balanced budget increase in the payroll tax Λ compensated by a decrease in the income tax T therefore lowers wages. As the impact on effort is ambiguous (T and w fall, such that w^n might change in either direction), the employment effect cannot be signed. The wage reduction comes about because a decrease in T on the one hand raises effort directly. On the other hand, the marginal increase in effort from a higher wage rises with T , as $e_{wT} = -e''(1-T) > 0$. Hence, the marginal loss of effort due to a reduction in w will fall if T is reduced. It is more beneficial for the company also at the margin to lower the wage. The two effects of a lower T on effort more than compensate the cost effect of a higher tax on labour cost Λ .

If the government raises the value-added tax V but lowers the income tax level T , the overall wage effect will be given by - using (11) and (20):

$$(41) \quad \frac{\partial w}{\partial V} \Big|_{dB=0} = \frac{\frac{F}{\tilde{N}} G_T - G_V}{G_w} \\ = -\frac{1}{G_w} \left(e''(w + \Lambda)(1 - T') \left[\frac{F}{\tilde{N}} - sw^{nr} \right] - e' \left\{ \frac{F(1 + \Lambda')}{\tilde{N}} - \frac{sw^{nr}}{1 + V_s} \right\} \right)$$

A profitable company is characterised by $f(1 - V(1 - s)) - N(w + \Lambda) > 0$, for $p = 1$. If companies on the whole make profits, the above inequality can be rewritten and manipulated to obtain:

$$(42) \quad \frac{F}{\tilde{N}}(1 + V_s) - \frac{F}{\tilde{N}}V > w + \Lambda \quad \Leftrightarrow \quad \frac{F}{\tilde{N}} > \frac{w + \Lambda + V(F/\tilde{N})}{1 + V_s} \\ \Leftrightarrow \frac{F}{\tilde{N}} - sw^{nr} > \frac{w + \Lambda + V(F/\tilde{N}) - s(w - T(w))}{1 + V_s} = \frac{w(1 - s) + \Lambda + sT(w) + V\frac{F}{\tilde{N}}}{1 + V_s} > 0, \text{ if } s \leq 1.$$

Given a positive level of profits the expression in square brackets in (41) is positive, too. This being the case, the term in curly brackets will also be positive. The efficiency wage will decline if the value-added tax is raised and the level of income taxation lowered, provided there is no overshifting of the value-added tax. Although changes in T and V both affect effort and marginal effort, the requirement $s \leq 1$ ensures that the income tax effects dominates the value-added tax effect. The impact of such a tax reform on employment is ambiguous.

Finally, it is possible to consider the case of a higher tax on labour cost Λ , the budgetary effects of which are balanced by a lower value-added tax V . If effort depends solely on the net wage w^n , any change in V will leave the efficiency wage unaffected. Hence, the combined tax changes will result in higher wages. The employment effect is given by:

$$(43) \quad \frac{\partial \tilde{N}}{\partial \Lambda} \Big|_{dB=0} = \tilde{N} \Lambda - \frac{\tilde{N}}{F} \tilde{N} V,$$

where

$$(44) \tilde{N}_\Lambda = \frac{-\Pi_{\tilde{N}\Lambda}\Pi_{ww} + \Pi_{w\Lambda}\Pi_{\tilde{N}w}}{J} = \frac{\Pi_{ww}}{J} < 0, \text{ as } \Pi_{w\Lambda} = 0 \text{ and } \Pi_{\tilde{N}\Lambda} = -1 \text{ and}$$

$$(45) \tilde{N}_V = \frac{-\Pi_{\tilde{N}V}\Pi_{ww} + \Pi_{wV}\Pi_{\tilde{N}w}}{J},$$

where $J > 0$ is the value of the Jacobian determinant. Substituting in equation (43) yields:

$$(46) \frac{\partial \tilde{N}}{\partial V} \Big|_{dB=0} = \frac{1}{J} \left[\Pi_{ww} \left\{ 1 + \frac{\tilde{N}}{F} \Pi_{\tilde{N}V} \right\} - \Pi_{wV} \Pi_{\tilde{N}w} \right]$$

The term in curly brackets will be positive if firms on the whole make profits.

$$(47) \left\{ 1 + \frac{\tilde{N}}{F} \Pi_{\tilde{N}V} \right\} = \frac{1}{F} \{ F - \tilde{N}F'e(1-s) \} = \frac{1}{F} \left\{ F - \tilde{N} \frac{w + \Lambda}{(1 - V(1-s))} (1-s) \right\}$$

$$= \frac{(1 - V(1-s))F - \tilde{N}(w + \Lambda) + \tilde{N}s(w + \Lambda)}{F(1 - V(1-s))} = \frac{\tilde{\Pi} + \tilde{N}s(w + \Lambda)}{F(1 - V(1-s))}$$

using the first order condition (8) for $e = e(w^n)$ and setting $p = 1$, where $\tilde{\Pi}$ describes aggregate profits. As all other terms contained in the square brackets of (46) are negative, but $J > 0$, employment declines for the balanced budget tax reform. From the point of view of a politician, aiming to expand employment, a tax reform involving a higher level of value-added taxation while reducing the payroll tax is therefore advisable in an efficiency wage context, where effort does only depend on the net wage w^n . If, however, effort depends on the real net wage w^{nr} , such that (19) holds, the overall wage and employment effect will become ambiguous. A shift towards indirect taxation in order to lower labour cost will thus entail uncertain consequences even in a simple efficiency framework.¹⁵

5.2 Efficiency Wages and a Monopoly Union

There exists a sizeable literature on wage determination which rests on the assumption that, on the one hand, there exists a positive relationship between effort or productivity and the wage level but that, on the other hand, collective wage negotiations take place.¹⁶ The combination of these two approaches might also be the most important one empirically. In this section some tentative answers to the question will be provided, in how far the tax effects derived above continue to hold - or for that case - will perhaps be overturned if a trade union influences wages. If the wage

¹⁵ Hoon/Phelps (1996) demonstrate in a general equilibrium model that a revenue-neutral shift from value-added taxation to an ad valorem payroll tax increases unemployment, either for a closed-economy or for a two country open-economy case. In this turnover variant changes in the value-added tax do not directly affect productivity. Hence, the results by Hoon/Phelps are compatible with the predictions derived in this paper, an exception being the case of a small open economy, for which the change in the tax structure has no impact on employment.

¹⁶ See, inter alia, Altenburg (1996), Bulkley/Myles (1996), Hoel (1989), Layard et al. (1991), Pichler (1993), Rødseth (1993), and references therein.

and employment effects of tax changes are similar in efficiency wage settings and in case of collective bargaining, policy advice can be provided on a more convincing basis.

To keep the analysis as simple and tractable as possible the existence of a monopoly union is presumed. The company then determines employment, such that an outcome on the labour demand results. Effort depends positively on the net wage, $e = e(w^n)$. Let there be a large number of identical companies all bargaining individually with 'their' union. The outcome of the wage determination process in one firm can then be generalised to the whole economy. The union is assumed to be utilitarian, ignoring the effects of changes in effort on the members' utility. Considering the same taxes as in previous sections, union utility Ω is given by:

$$(48) \Omega = N[\mu(w - T(w)) - \mu(b - T(b))],$$

where μ is the identical members' concave utility function. Profits are defined by equation (6) and the first order condition for an optimal choice of employment is given by equation (8). From (8) the slope of the (inverse) labour demand curve can be derived:

$$(49) N_w = -\frac{e'(1-T')[f''eN + f']}{f''e^2} + \frac{1 + \Lambda'}{p(1-V(1-s))f''e^2}$$

The union maximises Ω with respect to the gross wage w , taking into account the adjustment described by (49). The first and second order condition for a maximum are found to be:

$$(50) \Omega_w = N_w [\mu(w^n) - \mu(b^n)] + N\mu'(1-T') = 0$$

$$(51) \Omega_{ww} = N_{ww} [\mu(w^n) - \mu(b^n)] + 2N_w\mu'(1-T') + N\mu''(1-T')^2 - T''\mu'N < 0$$

The first order condition can only be true if $N_w < 0$ at the optimum. For the second order condition to hold, sufficient conditions imply $N_{ww} \leq 0$ and $T'' \geq 0$. To obtain the impact of tax changes on the wage set by the union, the following derivatives have to be calculated:

$$(52a) N_T = \frac{e'(f''eN + f')}{f''e^2} < 0$$

$$(52b) N_V = \frac{(1-s)f'}{(1-V(1-s))f''e} < 0$$

$$(52c) N_\Lambda = \frac{1}{p(1-V(1-s))f''e^2} < 0$$

$$(52d) N_{wT'} = \frac{e'[f''eN + f']}{f''e^2} < 0$$

$$(52e) N_{w\Lambda'} = \frac{1}{p(1-V(1-s))f''e^2} < 0$$

$$(52f) N_{wV} = \frac{(1-s)(1+\Lambda')}{p(1-V(1-s))^2 f'' e^2} < 0, \text{ if } s < 1,$$

Moreover, $N_{T'} = 0$, $N_{\Lambda'} = 0$, and $N_{w\Lambda} = 0$ hold. The sign of N_{wT} cannot be determined unambiguously. The wage effect of a change in any of the fiscal parameters x , $x = T, T', V, \Lambda, \Lambda'$, is given by $-\Omega_{wx}/\Omega_{ww}$. As $\Omega_{ww} < 0$ by the second order condition, Ω_{wx} determines the direction of the wage change. The relevant derivatives are found to be:

$$(53a) \Omega_{wT'} = N_{wT'}[\mu(w^n) - \mu(b^n)] - N\mu' < 0$$

$$(53b) \Omega_{w\Lambda} = N_{\Lambda}\mu'(1-T') < 0$$

$$(53c) \Omega_{wV} = N_{wV}[\mu(w^n) - \mu(b^n)] + N_V\mu'(1-T') < 0$$

$$(53d) \Omega_{w\Lambda'} = N_{w\Lambda'}[\mu(w^n) - \mu(b^n)] < 0$$

$$(53e) \Omega_{wT} = N_{wT}[\mu(w^n) - \mu(b^n)] + N_w[\mu'(b^n) - \mu'(w^n)] + (1-T')\{N_{T'}\mu' - N\mu''\}$$

The wage effect of a rise in T cannot be determined unambiguously as N_{wT} and the expression in curly brackets of (53e) cannot be signed. Thus, employment consequences of alterations in T are also ambiguous. An increase in the marginal income tax rate T' , the tax on labour cost Λ , the marginal payroll tax Λ' and the value-added tax V , which is not overshifted, lower the wage set by the monopoly union. As employment is unaffected by variations in the marginal rates, increases in T' and Λ' imply a higher level of employment.

Employment effects of a rise in Λ are ambiguous. On the one hand the reduction in the wage induces a lower effort, which will reduce labour demand N for a given wage. Moreover, the rise in Λ as such reduces N . On the other hand the reduction in the wage - retaining the effort level - will increase labour demand.

$$(54) \frac{dN}{d\Lambda} = \frac{\partial N}{\partial e} e'(1-T')w_{\Lambda} + \left[\frac{\partial N}{\partial \Lambda} + \frac{\partial N}{\partial w} w_{\Lambda} \right]$$

Whether the "effort effect" $N_e e'(1-T')w_{\Lambda}$ is sufficiently negative to overcome the ambiguous "union effect" $[N_{\Lambda} + N_{ww}\Lambda]$ depends on the precise curvature of the effort function, of the utility and production function. Given a wage which exceeds the level the firm would set in the absence of a union, employment reductions are more likely than in a union-firm bargaining model without effort effects as the negative employment impact is amplified via its repercussions through the effort function. The same results as for Λ will hold for an increase in V , if $s \leq 1$.

If the payroll tax is modelled as an ad valorem or as a specific employment tax, an increase will lower wages while having uncertain employment consequences, because the magnitude of the reduction in labour demand for a given wage and the wage reduction the union grants both depend on the curvature of the labour demand curve and the union's utility function.

For a simple effort function the inclusion of union wage determination reinforces the wage and employment effects of alterations in marginal tax rates derived for a pure efficiency wage or a pure union-firm bargaining model, while changes in levels tend to imply different results than obtained from a simple efficiency wage model. Negative employment effects of tax changes in a pure efficiency wage framework are mitigated by the existence of a trade union. The wage and employment consequences of tax variations in a combined efficiency wage and trade union setting are similar to those in a pure right-to-manage model (Lockwood/Manning 1993, Goerke 1996).

6. Conclusions

Wage and employment effects of tax changes in efficiency wage models are summarised below.

Table 2: Summary of Wage and Employment Effects of Tax Changes

	Income Tax T		Marginal Income Tax T'		Labour Tax Λ		Marginal Labour Tax Λ'		Ad Valorem Tax t^*w		Employment Tax t^*N		Value-added Tax V f)	
	w	u	w	u	w	u	w	u	w	u	w	u	w	u
$e(w^n)$, firm wage setting	↑	↑	↓	↓	↑a)	↑a)	↓	↓	0	↑	↑	↑	0b),c)	↑b)
$e(w^n)$, union wage setting	?	?	↓	↓	↓	?	↓	↓	↓	?	↓	?	↓	?
$e(w^n, b^n, u)$?	?	↓	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓d)	↑d)

- a) If the increase in Λ is compensated by a decrease in T (V), to warrant a balanced-budget, the wage will fall (rise) while the employment effect will be uncertain (unemployment will rise).
b) If the increase in V is compensated by a decrease in T to warrant a balanced-budget the wage will fall while the employment effect will be uncertain. For $w^n = w^{nr}$ the wage effect becomes uncertain, too.
c) For $w^n = w^{nr}$, the wage effect is positive.
d) For $w^n = w^{nr}$ wage and employment effects become uncertain, although an increase in unemployment is likely.
f) Results, in general, presume less than complete forward shifting of V.

The only tax alterations which induce the same qualitative wage and employment effects across all specifications and for all assumptions are variations in marginal rates, while the level of the respective tax is held constant. Changes in the level of income taxation yield ambiguous consequences, unless a simple effort function is assumed or restrictions on the relation between net wage and net alternative income are imposed. As in the case of collective bargaining, changes in the level of income taxes appear to be unsuitable policy instruments for improving the performance of the labour market. Changes in the tax on labour, irrespective of whether the marginal rate is held constant or not, will have ambiguous employment consequences only if the union influence on wage determination is sufficiently large. If there is no union influence on wages, increases in

the tax on labour Λ , in an ad valorem or a specific employment tax will reduce employment. High taxes on labour are therefore detrimental to employment, unless union influence on wages is substantial and serves to reduce labour cost. Finally, increases in V can aggravate unemployment if the plausible assumption of less than complete forward shifting is made.

A requirement of budget-neutral tax changes in many instances does not allow for clear-cut wage and employment predictions. At first sight it thus appears as if governments have not only lost monetary and fiscal policy as instruments for economic policy but that, in addition, tax policy cannot be used either, because non-competitive wage determination processes have made the labour demand effects of tax changes unpredictable. Such an interpretation is, however, not adequate for alterations in the structure of taxation. Efficiency wage models and models of union wage determination on their own and also in combination predict that higher marginal tax rates on income and on labour (cost), while holding constant the level, reduce wages and increase employment. The investigation of an efficiency wage framework strengthens policy proposals based on union-firm bargaining models. Tax policy might therefore not be an instrument governments can use as a full-fledged substitute for monetary or fiscal policy, but its suitability as economic policy tool has not vanished, even if wages are not determined competitively.

The results summarised above have been based on a number of assumptions, which might have an impact on the wage and employment consequences of tax changes. The analysis employs either a simple effort function, which is not restricted to a specific motivation for the relation between effort and net wage, or it rests on a shirking framework. Petrucci (1994) has shown that results derived for an ad valorem tax or a specific employment tax can be extended to a labour turnover model. But it cannot be ruled out that other motivations for efficiency wages, such as the desire to obtain high quality applicants for job openings (Weiss 1980) or the intention by firms to reduce theft by its employees (Rasmusen 1992), can affect the relationship between taxes and productivity or effort. Moreover, it is possible that changes in the gross wage - for which the firm is responsible in a pure efficiency wage framework - can affect effort differently than a tax change, that has the same impact on the net wage as the wage alteration but which is due to government action. Hence, effort e might not be homogenous of degree zero in wages and the level of income taxes. In addition, a closed economy has been presumed throughout the analysis in which no product market repercussions or productivity effects - other than via the wage level - resulting from tax alterations exist. But trans-border competition can influence the choice of location, either because high taxes deter investment or because the associated high level of public and private goods provision for investors attracts them. Such long-run considerations have played no part in the above analysis. Finally, Aronsson et al. (1995) argue that most real world tax systems consist of piece-wise linear taxes such that a change solely of the marginal rate, which only involves a substitution but no income effect, is not feasible in practice.

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Appendix:

I) Second Order Conditions for the Model of Section 3

Wage and employment decisions implied by equations (8) and (9) will maximise profits, if Π_{NN} , $\Pi_{ww} < 0$ and $\Pi_{NN}\Pi_{ww} - (\Pi_{wN})^2 > 0$.

From (7) and (8) the following expressions are obtained:

$$(I.1) \Pi_{ww} = p[f''(e')^2 N(1-T')^2 + f'e''(1-T')^2 - f'e'T'']N\Psi - N\Lambda'' < 0,$$

for $\Psi = 1 - V(1-s)$, if $e'' < 0$, $T'' \geq 0$ and $\Lambda'' \geq 0$.

$$(I.2) \Pi_{NN} = pf''e^2\Psi < 0$$

After substituting, using the first order condition, the cross derivative is given by:

$$(I.3) \Pi_{Nw} = pf''ee'(1-T')N\Psi < 0$$

Manipulating (I.1), (I.2) and (I.3) and subsequent combination yields the following expression:

$$(I.4) J = \Pi_{NN}\Pi_{ww} - (\Pi_{wN})^2 = pf''e^2N\Psi \left[pf'\Psi(e''(1-T')^2 - e'T'') - \Lambda'' \right] > 0,$$

where J is (also) the value of the Jacobian determinant.

II) Wage Effects of an Increase in the Level of Labour Taxation Λ

Note, that the wage effect of an increase in Λ is given by:

$$(II.1) \frac{\partial w}{\partial \Lambda} = \frac{-LD_{\Lambda} SC_{\tilde{N}} + LD_{\tilde{N}} SC_{\Lambda}}{J}, \text{ where}$$

$$(II.2) J = LD_w SC_{\tilde{N}} - LD_{\tilde{N}} SC_w$$

is the value of the Jacobian Determinant and LD_i and SC_i , $i = w, \tilde{N}, \Lambda$, are the respective partial derivatives. They are given by:

$$(II.3) LD_w = pF'' \frac{v'}{2\beta} (1-T') \tilde{N} e \Psi < 0 \quad (II.4) LD_{\tilde{N}} = p\Psi \left[F''(e - (1-u)e_u) e - \frac{e_u}{L} \right] < 0$$

$$(II.5) LD_{\Lambda} = -1 \quad (II.6) SC_w = -T'' \frac{v'}{2\beta} (w + \Lambda) + (1-T')^2 \frac{v''}{2\beta} (w + \Lambda) - e\Lambda'' < 0$$

$$(II.7) SC_{\tilde{N}} = (1 + \Lambda') \frac{e_u}{L} > 0 \quad (II.8) SC_{\Lambda} = (1 - T') \frac{v'}{2\beta} > 0$$

From (II.3), (II.4), (II.7) and (II.8) $J < 0$ can be derived. Moreover, substituting in accordance with (8^a) and (9^a) the numerator of (II.1) is given by:

$$(II.9) -LD_{\Lambda} SC_{\tilde{N}} + LD_{\tilde{N}} SC_{\Lambda} = (1 - T') p \frac{v'}{2\beta} \Psi [F''(e - (1-u)e_u) e] < 0$$

Hence, the gross wage w will increase if the payroll tax Λ rises.