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Non-Equivalence of Employment and Payroll Taxes in Imperfectly Competitive Labour Markets*

Bo Sandemann Rasmussen†

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Abstract

Equilibrium allocations in competitive labour market models are independent of whether labour taxes on rms are levied as employment taxes or payroll taxes, for given tax revenue. Turning to non-competitive labour market models, like wage bargaining of efficiency wage models, the two taxes cease to be equivalent in the sense that balanced-budget substitutions of one tax for the other affect equilibrium allocations. However, while more extensive use of payroll taxes always increases equilibrium employment in the wage bargaining model, it may lead to a lower level of equilibrium employment in the efficiency wage model.

Keywords: Employment taxes, payroll taxes, tax equivalence, employment, wage bargaining, efficiency wages.

JEL: H22, J51.

1. Introduction

Labour taxes are levied on rms either as employment taxes or payroll taxes, i.e. either as a head tax on the number of employees or as a tax on the costs of labour. For most countries it may appear rather arbitrary how total labour taxation on rms is divided between employment taxes and payroll taxes, and

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for fully competitive labour markets the division is immaterial. With imperfectly competitive labour markets, however, matters are quite different. The important aspect of imperfect competition in this connection is that (some) agents are wage setters instead of being wage takers. For a general class of efficiency wage models where rms set wages, Pisauro (1991) has shown that the incidence of employment taxes and payroll taxes differ. He does not, however, undertake the potentially interesting exercise considering whether the composition of labour taxation on rms matters, given the level of tax revenue, for equilibrium unemployment e.g. by analyzing the effects of balanced-budget tax reforms on equilibrium unemployment.[1] Another interesting extension of the analysis in Pisauro (1991) is to consider whether similar differences in the incidence of employment taxes and payroll taxes may appear in other kinds of labour market models exhibiting wage setting agents and equilibrium unemployment, like wage bargaining models. Then, it may be established whether some general results apply on which source of labour taxation on rms provides the better incentives for job creation when equilibrium employment due to imperfectly competitive labour markets is below its socially optimal level.

This will be our point of departure. After having established equivalence of employment taxes and payroll taxes in competitive labour markets, we consider, in turn, the effects on equilibrium employment of balanced-budget changes in the composition of labour taxation on rms in a wage bargaining model and an efficiency wage model. From the recent literature on the incidence of income taxation in imperfectly competitive labour markets follows that qualitatively similar results emerge in wage bargaining and efficiency wage models, respectively (see e.g. Hoel (1990) who shows that the results on the incidence of average and marginal income tax changes found in the wage bargaining literature by e.g. Malcomson and Sartor (1987) and Lockwood and Manning (1993) qualitatively carry over to efficiency wage models). Incidence analysis cannot by itself, however, lead to equivalence results where the revenue effects of tax changes must be taken properly into account. Instead, balanced-budget tax changes must be considered.

Our results reveal that for the choice between employment taxes and payroll taxes it matters qualitatively whether the tax changes are considered in wage bargaining models or in efficiency wage models. In the wage bargaining model, balancing the government budget, payroll taxes provide unambiguously better incentives for wage restraint, thereby leading to a higher level of employment. In the efficiency model payroll taxes also provide better incentives for wage restraint than employment taxes do, but since the effort of workers depends on wages, wage

[1]Since equilibrium unemployment prevails and the unemployed may receive tax- nanced bene ts the relevant comparison is between taxes that generate the same tax revenue net of any expenditures on unemployment bene ts, i.e. balanced-budget tax changes should be considered.

restraint in itself is not necessarily a desirable feature of the tax policy. Balancing the government budget, an increase in the employment tax rate and a fall in the payroll tax rate will in general have an ambiguous effect on employment, but in an interesting special case the level of employment will increase unambiguously. Therefore, since the qualitative nature of the results depends on the source of labour market imperfectness, no general recommendation of how labour taxation on firms in imperfectly competitive labour markets should be structured in order to lower equilibrium unemployment can be given.

The paper is organized as follows. In section 2 we present the common features of the models to be considered in the following sections. Section 3 establishes equivalence of employment and payroll taxes in a competitive labour market model. Then, turning away from wage taking to wage setting behaviour we study tax incidence and possibly tax equivalence in a simple wage bargaining model in section 4, while section 5 is devoted to the same kind of analysis in an efficiency wage model of the shirking-type. Finally, some concluding remarks are offered in section 6.

2. The General Set Up

The models to be considered in the forthcoming sections share some general features. All models capture a small open economy consisting of a large number of identical sectors each comprising a large number of competitive firms. Output consists of a single composite tradable good whose price is given from the world market and normalized at unity. The government collects employment taxes and payroll taxes to finance an exogenously given level of government expenditures (and possibly expenditures on unemployment benefits if unemployment is present in equilibrium).[2] Even though wage setting agents are present in some of the models, the individual wage setters are so small that they neglect the effects of their own actions on the spending and taxation decisions of the fiscal authorities, i.e. there is no strategic interaction between wage setters and the government.[3]

[2]Throughout the analysis we consider balanced-budget tax changes only, implying that the assumption of exogenously given public expenditures is innocuous.

[3]If e.g. wages were set at an economy-wide level by a single trade union, the government and the union would be involved in a game as in Calmfors and Horn (1986). By assuming wage setters are small we omit such game-theoretic considerations, implying that tax policies can be treated parametrically and not in terms of reaction functions.

2.1. Households

Households[4] derive utility from consumption of goods and leisure. Each household is endowed with one unit of leisure. Since all income is spent on the single consumption good we can generally express the utility function as depending on wage income, m, and leisure $1-\varepsilon$, where $\varepsilon = el$ is the effective supply of labour, e being the effort provided by the household while l is the supply of labour of the household (i.e., l is the supply of raw labour measured in hours). In sections 3 and 4 we disregard efficiency wage effects by fixing e exogenously at unity while in sections 4 and 5 working hours are made exogenous by fixing l at unity. The utility function is[5]

$$U = U(m, 1-\varepsilon), \tag{2.1}$$

where $\frac{\partial U(m,1-\varepsilon)}{\partial m} > 0$, $\frac{\partial^2 U(m,1-\varepsilon)}{\partial m^2} < 0$, $\frac{\partial U(m,1-\varepsilon)}{\partial(1-\varepsilon)} > 0$, $\frac{\partial^2 U(m,1-\varepsilon)}{\partial(1-\varepsilon)^2} \leq 0$ and $\frac{\partial^2 U(m,1-\varepsilon)}{\partial(1-\varepsilon)\partial m} \leq 0$.[6] The choice of labour supply (or effort) follows from maximizing utility with respect to the relevant constraints (those derivations are deferred to the sections where they are needed).

2.2. Firms

The representative firm in a sector produces output, y, using labour, n, as the only variable input. The production function is

$$y = f(en), \tag{2.2}$$

with positive, but decreasing marginal productivity of labour, $f' \equiv \frac{df(en)}{d(en)} > 0$, $f'' \equiv \frac{d^2 f(en)}{d(en)^2} < 0$. Profits are

$$\Pi = f(en) - wn - tn - \tau wn, \tag{2.3}$$

where w is the wage rate, t is the employment tax rate, τ is the payroll tax rate, while fixed costs are left out for convenience. The demand for labour can be derived from maximizing profits with respect to n, the first-order condition being

$$ef'(en) = w(1+\tau) + t. \tag{2.4}$$

[4] Throughout the paper we use the terms households and workers interchangeably.

[5] Households also derive utility from a publicly provided good but since the amount of the public good, g, is kept fixed throughout the analyses it is suppressed in the utility function.

[6] In the efficiency wage model we restrict household preferences by assuming weak separability between income and leisure, and linearity of utility in effort, implying that the cross derivative of the utility function and the second derivative of the utility function with respect to leisure both are zero.

Then, for a given level of efficiency the demand for labour depends negatively on the marginal cost of labour, $c = w(1+\tau)+t$,

$$n = n(w(1+\tau)+t) = n(c), \tag{2.5}$$

where $n'(c) \equiv \frac{dn(c)}{dc} = \frac{1}{ef''(en)} < 0$.

3. Tax Equivalence: Competitive Labour Markets

Consider first a competitive labour market where workers supply labour and firms demand labour, all agents taking the equilibrium wage for given. Since we want to disregard efficiency wage effects the effort of workers is assumed to be perfectly observable and exogenously given. Thus, we can set $e = 1$ without loss of generality such that $\varepsilon = l$.

3.1. Households

Maximizing the utility function with respect to the supply of labour subject to the budget constraint, $m = wl$, leads to

$$\frac{\frac{\partial U(m,1-l)}{\partial(1-l)}}{\frac{\partial U(m,1-l)}{\partial m}} = w, \tag{3.1}$$

which is just the familiar condition that the wage should equal the marginal rate of substitution between income and leisure. The labour supply function, implicitly defined by 3.1, relates the supply of labour to the wage rate,

$$l = l(w), \tag{3.2}$$

where $l'(w) \gtreqless 0$, due to income and substitution effects possibly working in opposite directions.

3.2. Firms

With e fixed at unity, the representative firm demands labour according to

$$n = n(w(1+\tau)+t). \tag{3.3}$$

3.3. Equilibrium

Equilibrium in this competitive labour market then requires that the demand for labour equals the supply of labour:

$$n(w(1+\tau)+t) = l(w), \tag{3.4}$$

de ning the equilibrium wage rate as a function of tax rates:

$$w = w(\tau, t), \tag{3.5}$$

such that the equilibrium level of employment may be written as

$$n = n(w(\tau, t)\,(1+\tau)+t). \tag{3.6}$$

3.4. Tax Equivalence

Based on the competitive equilibrium just outlined we will demonstrate the following proposition.

Proposition 3.1. *Employment and payroll taxes are equivalent when labour markets are competitive.*

Proof. *To establish equivalence of employment taxation and payroll taxation, we show that a balanced budget substitution of one tax for the other does not affect equilibrium employment. The government budget constraint reads* $g = \tau wn + tn$. *Using equation 3.6 it follows that the effect on equilibrium employment of a balanced-budget change in labour taxation is (assuming* $\frac{\partial g}{\partial \tau} \neq 0$*)*

$$\left.\frac{dn}{dt}\right|_{dg=0} = \frac{n'(c)wn}{\frac{\partial g}{\partial \tau}}\left(\frac{\partial w}{\partial t} - \frac{1}{w}\frac{\partial w}{\partial \tau}\right), \tag{3.7}$$

and since it follows from the market equilibrium condition, equation 3.4, that

$$\frac{\partial w}{\partial \tau} = w\frac{\partial w}{\partial t}, \tag{3.8}$$

insertion of 3.8 into 3.7 obviously leads to

$$\left.\frac{dn}{dt}\right|_{dg=0} = 0, \tag{3.9}$$

which is what is required for equivalence. ■

Thus, we have established that as long as agents are wage takers, employment taxes and payroll taxes are indeed equivalent taxes. The result follows from the

two taxes entering symmetrically in the labour market equilibrium condition, equation 3.4, implying that all what matters for equilibrium employment is the total tax burden on labour, not the division of the tax burden between employment taxes and payroll taxes.

4. A Wage Bargaining Model

We now change the model by assuming that workers associated with rms in a given sector are organized in a trade union, and that unions act as wage setters. The effort of workers is still exogenously given and set equal to one, $e = 1$. Due to the wage setting behaviour of unions, the equilibrium will generally involve unemployment, and it becomes interesting from a policy point of view whether the unemployment problem may be alleviated by balanced budget tax reforms.

4.1. Households

If employed, a worker receives wage income, w, and supplies one unit of labour inelastically,[7] while an unemployed worker receives unemployment bene ts, b, and enjoys his full endowment of time as leisure. Thus, $\varepsilon = 1$ for employed workers while $\varepsilon = 0$ for unemployed workers, implying we can specify the individual indirect utilities of employed and unemployed workers, respectively, as

$$u = U(w, 0) \equiv u(w) \tag{4.1}$$

$$v = U(b, 1) \equiv v(b), \tag{4.2}$$

where $u' \equiv \frac{\partial U(w,0)}{\partial w} > 0$. For the resulting equilibrium to be incentive compatible, wages must be set such that no employed worker would desire to quit a job and become unemployed, i.e. $u(w) > v(b)$ must hold in equilibrium.

4.2. Firms

Since rms are still competitive the demand for labour is given by

$$n = n(w(1 + \tau) + t). \tag{4.3}$$

[7] It is an implication of the envelope theorem that none of our results would change if individual labour supply was endogenously determined by the household, as in the preceding section, since the effect on wages of a change in taxes is the same whether or not individual labour supply is adjusted, provided that labour supply at the outset is chosen optimally.

4.3. Unions

Workers are organized in trade unions. Each union, speci c to a single production sector, acts in a utilitarian manner maximizing the sum of its members utilities. Each union consists of a xed number of workers, $\overline{n}$, implying that the preferences of a union by the utility function can be expressed as

$$\Psi = n(w(1+\tau)+t)\left(u(w)-v(b)\right). \tag{4.4}$$

4.4. Equilibrium

To simplify, we assume that the unions possess all the bargaining power *vis-a-vis* the rms. Hence, the monopoly union model of wage formation applies. Maximizing 4.4 with respect to w, subject to the labour demand function, equation 4.3, leads to the rst-order condition,

$$n'(w(1+\tau)+t)\left(u(w)-v(b)\right)(1+\tau)+n(w(1+\tau)+t)u'(w)=0, \tag{4.5}$$

de ning the wage rate as an implicit function of the tax rates, τ and t,

$$w = w(\tau, t). \tag{4.6}$$

The rst-order condition for wage formation has the usual interpretation where the rst term represents the union s marginal cost in terms of lost utility resulting from a wage increase that reduces employment, while the second term is the marginal bene t to the union of increasing the wage due higher income levels of the employed union members (cf. Oswald (1985)). Equilibrium employment then follows as

$$n = n(w(\tau, t)\,(1+\tau)+t). \tag{4.7}$$

4.5. Non-Equivalence

Once wages are determined through bargaining, equivalence between employment taxation and payroll taxation ceases to hold, and more extensive use of payroll taxes instead of employment taxes, balancing the government budget, will generally lead to higher levels of employment.

Proposition 4.1. *Employment and payroll taxes will be non-equivalent in the wage bargaining model. In particular, a balanced-budget substitution of the payroll tax for the employment tax will increase employment.*

Proof. *The government budget constraint now reads* $g + b(\overline{n}-n) = \tau wn + tn$ *indicating that taxes now nance expenditures on unemployment bene ts in*

excess of the expenditures on the publicly provided good. The effect of a balanced-budget tax change on the level of employment is[8]

$$\left.\frac{dn}{dt}\right|_{dg=0} = \frac{n'(c)wn}{\frac{\partial g}{\partial \tau}}\left(\frac{\partial w}{\partial t} - \frac{1}{w}\frac{\partial w}{\partial \tau}\right). \tag{4.8}$$

From the equilibrium condition for wages, equation 4.5, the effects on wages of changes in tax rates can be derived to be

$$\frac{\partial w}{\partial t} = \frac{1}{w}\frac{\partial w}{\partial \tau} - \frac{n'(c)\left(u(w) - v(b)\right)}{w}, \tag{4.9}$$

implying that

$$\left.\frac{dn}{dt}\right|_{dg=0} = -\frac{(n'(c))^2 n}{\frac{\partial g}{\partial \tau}}\left(u(w) - v(b)\right) < 0, \tag{4.10}$$

as long as $\frac{\partial g}{\partial \tau} > 0$, *i.e. when the economy is on the upward sloping part of the net payroll tax-Laffer curve.* ■

The superiority of payroll taxation over employment taxation in terms of providing incentives for wage restraint has a straightforward interpretation. Employment and payroll taxes share some common effects on unions' incentives in wage formation since they both affect the marginal cost of labour to firms, $c = w(1+\tau) + t$, but on top of that effect an increase in the payroll tax rate increases the marginal cost to the union of increasing the wage since the term $(1+\tau)$ is present in the first term of equation 4.5. Thus, the two taxes no longer enter symmetrically in the labour market equilibrium condition. Another interpretation of the result follows from considering marginal tax rates. For the payroll tax the marginal tax rate with respect to the wage rate is positive while the marginal employment tax rate with respect to the wage rate is zero, and it is a well established fact that high marginal tax rates leads to wage restraint in labour markets with wage bargaining between firm and unions (of which the monopoly union model is a special case), cf. Lockwood and Manning (1993).

5. An Efficiency Wage Model

Wage setting behaviour may appear in other models than wage bargaining models. In particular, efficiency wage models are usually specified with firms setting both wages and employment taking into account how their wage offers affect effort

[8] Notice that $\frac{\partial g}{\partial \tau}$ now includes the effect on the expenditures on unemployment benefits when a change in taxes affects the level of unemployment.

supplied by the employed workers. At the same time, involuntary unemployment will generally be present in equilibrium, implying, as in the wage bargaining model, that it may be of interest whether balanced-budget tax changes can lead to a higher level of employment.

We use a slightly generalized version of the shirking models in Moene (1995), Pisauro (1991) and Shapiro and Stiglitz (1984). To capture the idea of shirking, we consider a model with an in nite time horizon where in each period a rm offers a wage to workers. If a wage offer is accepted the worker chooses how much effort to provide. Effort cannot be costlessly observed but the rm can, at a cost, monitor the effort of its employees. The rm renews the contract with a worker unless an unsatisfactory level of effort has been observed.

5.1. Households

An employed worker chooses effort e and receives wage income, w. The choice of effort only affects the future income of the household through the possible detection of insufficient effort by the rm. An unemployed worker receives unemployment bene ts, b, and enjoys his full endowment of time as leisure. As in the wage bargaining model the individual supply of labour is set equal to one, $l = 1$, such that $\varepsilon = e$ for employed workers while $\varepsilon = 0$ for unemployed workers.

In a in nitely horizon framework households maximize at time t the expected present discounted value of utility, V_t,

$$V_t = E\left(\int_{s=t}^{\infty} e^{-\theta(s-t)} U_s ds\right), \tag{5.1}$$

where $\theta > 0$ is the subjective discount rate, E is the expectations operator and U_t is the (instantaneous) utility function of a household[9]

$$U = U(w, 1-e), \tag{5.2}$$

where $\frac{\partial U(w,1-e)}{\partial w} > 0$, $\frac{\partial^2 U(w,1-e)}{\partial w^2} < 0$, $\frac{\partial U(w,1-e)}{\partial (1-e)} > 0$, and following Pisauro (1991) we assume weak separability between income and leisure, and linearity of utility in effort, implying that $\frac{\partial^2 U(w,1-e)}{\partial w \partial (1-e)} = \frac{\partial^2 U(w,1-e)}{\partial (1-e)^2} = 0$. Notice that

$$\frac{dV}{dt} = \theta E\left(\int_{s=t}^{\infty} e^{-\theta(s-t)} U_s ds\right) - E(U) = \theta V - E(U), \tag{5.3}$$

[9]For simplicity, time subscripts are left out from now on whenever possible. Notice, that we implicitly assume $e = 1$ to be the maximum effort that can be provided. Throughout the section we assume an interior solution, $e < 1$, applies. This just requires sufficient concavity of the utility function with respect to income, see Pisauro (1991) for further details.

such that by de ning V^E (V^U) as the value of V for an employed (unemployed) worker, respectively, we can state the asset equations of an employed and an unemployed worker as

$$\theta V^E = U(w, 1-e) + (1 - p(e) + s)\left(V^U - V^E\right), \tag{5.4}$$

and

$$\theta V^U = U(b, 1) + \psi(N)\left(V^E - V^U\right), \tag{5.5}$$

where $\psi = \psi(N)$ is the exit probability from unemployment that depends positively on aggregate employment, N, i.e. $\psi'(N) > 0$, $p(e)$ is the probability of being red from the current rm due to provision of insufficient effort (see details below) and $s > 0$ is an exogenous separation rate. It follows implicitly from the speci cation of the asset equations that a worker starting out being unemployed receive unemployment bene ts, b, whereafter he in the following period obtains a job with probability $\psi(N)$ and remain unemployed with probability $1 - \psi(N)$. Solving the asset equations for V^E we obtain

$$V^E = \frac{(\theta + \psi(N))\, U(w, 1-e) + (1 - p(e) + s)\, U(b, 1)}{\theta\,(1 - p(e) + \theta + \psi(N) + s)}. \tag{5.6}$$

Maximizing V^E with respect to e we get (after some simple manipulations)

$$\frac{p'(e)\,(U(w, 1-e) - U(b, 1))}{1 - p(e) + \theta + \psi(N) + s} - \frac{\partial U(w, 1-e)}{\partial(1-e)} = 0, \tag{5.7}$$

de ning effort as an implicit function of the wage rate and aggregate employment, $e = e(w, N)$. Using 5.7 it is straightforward to show that $e_w \equiv \frac{\partial e(w,N)}{\partial w} > 0$, $e_N \equiv \frac{\partial e(w,N)}{\partial N} < 0$, $e_{ww} \equiv \frac{\partial^2 e(w,N)}{\partial w^2} < 0$ and $e_{wN} \equiv \frac{\partial^2 e(w,N)}{\partial w \partial N} = 0$.[10]

5.2. Firms

The production technology is the same in all periods (so time subscripts are left out).

$$y = f(en). \tag{5.8}$$

Pro ts of the representative rm are

$$\Pi = f(en) - wn - \tau wn - tn. \tag{5.9}$$

[10] $e_{wN} = 0$ follows from the assumption of utility being linear in leisure (effort). With decreasing marginal utility of leisure e_{wN} would be negative, and we would not be able to sign the determinant of the Jacobian of equations 5.13 and 5.14 (see below).

The rm chooses employment and wage rate to maximize pro ts taking into account how effort, e, is affected by the wage offer. Following Moene (1995) we assume that effort can only be observed through costly monitoring, and if an unsatisfactory level of effort is observed the employment relationship is terminated. The probability of continuation of the relationship, $p = p(e)$, depends positively on the effort provided by the worker, $p'(e) > 0$, but at a decreasing rate, $p''(e) < 0$.[11]. The rst-order conditions read

$$\frac{\partial \Pi}{\partial w} = f' e_w n - (1+\tau) n = 0 \tag{5.10}$$

$$\frac{\partial \Pi}{\partial n} = f' e - w(1+\tau) - t = 0. \tag{5.11}$$

The second-order condition can easily be shown to be satis ed due to $f'' < 0$ and $e_{ww} < 0$. Using 5.11 to eliminate f' from 5.10 yields

$$e_w \left(w \left(1+\tau \right) + t \right) - e \left(1+\tau \right) = 0, \tag{5.12}$$

which is a modi ed version of the familiar Solow condition (it is the presence of employment taxes that makes it a modi ed Solow condition since the equilibrium wage elasticity of effort is less than unity once the employment tax rate is positive).

5.3. Equilibrium

With a xed number of identical rms aggregate employment, N, is just a multiple of n, such that we can express the equilibrium conditions for w and N as

$$e_w \left(w, N \right) \left(w \left(1+\tau \right) + t \right) - e \left(w, N \right) \left(1+\tau \right) = 0 \tag{5.13}$$

$$f'(e(w,N)N) e \left(w, N \right) - w(1+\tau) - t = 0, \tag{5.14}$$

(implicitly setting the number of rms at unity). Since the determinant of the Jacobian of equations 5.13 and 5.14, J, is strictly positive,[12]

$$J = \left[f'' \left(e + e_N N \right) e + e_N f' \right] e_{ww} \left(w \left(1+\tau \right) + t \right) + f'' e_w e_N e N > 0, \tag{5.15}$$

[11] This is obviously a short cut to a full description of the behaviour of rms when effort is only observable at a cost. The full description would involve the amount of resources devoted to monitoring and speci cation of the wage contract to workers. Completing that description is a topic for future research.

[12] As in Pisauro (1991) we assume that an increase in aggregate employment also leads to an increase in aggregate effective labour input, i.e. that $\frac{d(e(w,N)N)}{dN} = e + e_N N > 0$.

5.13 and 5.14 de ne equilibrium levels of w and N as functions of the tax rates:

$$w = w(t, \tau) \tag{5.16}$$

$$N = N(t, \tau). \tag{5.17}$$

5.4. Non-Equivalence

It also holds in the efficiency wage model that for a balanced government budget it matters for equilibrium employment how the total tax burden on labour is divided between employment taxes and payroll taxes. Contrary to the wage bargaining model, however, the effect on employment of increasing one tax and decreasing the other, balancing the government budget, is now ambiguous.

Proposition 5.1. *Employment and payroll taxes are non-equivalent in the ef- ciency wage model. The sign of the employment effect of a balanced-budget substitution of one tax for the other is ambiguous.*

Proof. *For a given amount of the public good, $dg = 0$, the marginal rate of substitution of the employment tax rate for the payroll tax rate is*

$$-\frac{d\tau}{dt}\bigg|_{dg=0} = \frac{\frac{\partial g}{\partial t}}{\frac{\partial g}{\partial \tau}} = \frac{N + (w\tau + t + b)\,\frac{\partial N(t,\tau)}{\partial t} + \tau N \frac{\partial w(t,\tau)}{\partial t}}{wN + (w\tau + t + b)\,\frac{\partial N(t,\tau)}{\partial \tau} + \tau N \frac{\partial w(t,\tau)}{\partial \tau}}. \tag{5.18}$$

Then, using the equilibrium conditions for w and N, equations 5.16 and 5.17, the effects on employment of a balanced-budget substitution of the employment tax for the payroll tax is

$$\frac{dN}{dt}\bigg|_{dg=0} = \frac{N\left[w\frac{\partial N(t,\tau)}{\partial t} - \frac{\partial N(t,\tau)}{\partial \tau}\right] + \tau N\left[\frac{\partial N(t,\tau)}{\partial t}\frac{\partial w(t,\tau)}{\partial \tau} - \frac{\partial N(t,\tau)}{\partial \tau}\frac{\partial w(t,\tau)}{\partial t}\right]}{\frac{\partial g}{\partial \tau}}. \tag{5.19}$$

Differentiating the equilibrium conditions 5.13 and 5.14 implicitly and solving for the effects on wages and employment yields

$$\frac{\partial w(t,\tau)}{\partial t} = \frac{-f''\,(e + e_N N)\,e_w e}{J} > 0 \tag{5.20}$$

$$\frac{\partial w(t,\tau)}{\partial \tau} = \frac{e_N\,(w\,(1+\tau) + t) + f''\,(e + e_N N)\,e f' t}{J} < 0 \tag{5.21}$$

$$\frac{\partial N(t,\tau)}{\partial t} = \frac{f'' e_w^2 e N + e_{ww}\,(w\,(1+\tau) + t)}{J} < 0 \tag{5.22}$$

$$\frac{\partial N(t,\tau)}{\partial \tau} = \frac{-f''e_N eNf't + e_{ww}w\left(w\left(1+\tau\right)+t\right)}{J} < 0. \tag{5.23}$$

From the signs of the partial derivatives follow that the second bracket in 5.19 is positive while the sign of the rst bracket is ambiguous, such that we generally cannot sign the overall effect on employment ■

Again, the non-equivalence result follows because the two taxes do not enter symmetrically in the labour market equilibrium conditions, cf. equations 5.13 and 5.14 where $1+\tau$ enters the second term in 5.13. As in the wage bargaining model the payroll tax provides better incentives for wage restraint than the employment tax.[13] In the efficiency wage model, however, wage restraint does not necessarily lead to a high level of employment since effort also depends on wages, implying that we generally cannot sign the employment effect unambiguously. Rasmussen (1997) has shown, however, that in a long run version of the model with constant returns to labour and aggregate employment determined by free entry and exit of rms satisfying a zero pro t condition, the sign of 5.19 becomes unambiguously positive, implying that the employment tax provides better incentives for job creation than payroll taxes, even though the payroll tax generally provides better incentives for wage restraint. This result can be stated as follows.

Proposition 5.2. *With constant returns to labour and aggregate employment determined by free entry and exit of rms, a balanced-budget substitution of the employment tax for the payroll tax increases employment.*

Proof. *Constant returns to labour implies that* $f''(en) = 0$. *The equilibrium employment equation 5.14 is then replaced by a zero pro t condition*

$$f'e(w,N) - w - \tau w - t = 0, \tag{5.24}$$

where f' *is the constant marginal product of labour. The effects of taxes on wages and employment become*

$$\frac{\partial w(t,\tau)}{\partial t} = 0 \tag{5.25}$$

$$\frac{\partial w(t,\tau)}{\partial \tau} = \frac{1}{f'e_{ww}} < 0 \tag{5.26}$$

$$\frac{\partial N(t,\tau)}{\partial t} = \frac{1}{f'e_N} < 0 \tag{5.27}$$

$$\frac{\partial N(t,\tau)}{\partial \tau} = \frac{w}{f'e_N} < 0. \tag{5.28}$$

[13] Pisauro (1991) obtains similar results regarding the effects on wages of changes in employment taxes and payroll taxes in an efficiency wage model that shares some similarities to ours. He does not, however, analyze the effects of balanced-budget changes in the two taxes.

Inserting equations 5.25-5.28 into 5.19 reveals that

$$\left.\frac{dN}{dt}\right|_{dg=0} = \frac{\frac{\tau N}{(f')^2 e_N e_{ww}}}{\frac{\partial g}{\partial \tau}} > 0, \tag{5.29}$$

for $\frac{\partial g}{\partial \tau} > 0$. ■

In fact, it is the wage moderating effects of the payroll tax leading to an erosion of the payroll tax base that accounts for the superiority of the employment tax in terms of promoting employment in the long run version of the model. As a consequence, the marginal rate of substitution of the employment tax for the payroll tax (balancing the government budget) exceeds unity,[14]

$$-w\left.\frac{d\tau}{dt}\right|_{dg=0} = \frac{N + \frac{w\tau+t+b}{f'e_N}}{N + \frac{w\tau+t+b}{f'e_N} + \frac{\tau N}{wf'e_{ww}}} > 1, \tag{5.30}$$

such that for a given increase in the employment tax rate a relatively larger fall in the payroll tax rate is consistent with a balanced budget. Therefore, increasing the employment tax and decreasing the payroll tax, balancing the government budget, leads to a higher of equilibrium employment. A similar effect is not present in the wage bargaining model where there is a one-to-one relation between wages and employment through the rms demand for labour, such that the wage restraining effects of the payroll tax also materialize in a higher level of equilibrium employment.

6. Concluding Remarks

We have shown that once labour markets no longer are atomistic, it generally matters how labour taxation on rms is divided between employment taxes and payroll taxes. Somewhat surprisingly, however, it turned out that the results differ qualitatively in wage bargaining and efficiency wage models where previously the incidence of income taxes has been shown to be qualitatively the same. The important difference between the two models accounting for the differences in results is that there does not exist a one-to-one relation between wages and employment in the efficiency wage model due to the dependence of effort on wages. Therefore, even though payroll taxes provide better incentives for wage restraint

[14]Notice that we have multiplied $\frac{d\tau}{dt}$ by w in order to measure the marginal rate of substitution of one unit of tax revenue from the employment tax with one unit of revenue from the payroll tax. Both the numerator and the denominator (equal to $\frac{\partial g}{\partial t}$ and $\frac{\partial g}{\partial \tau}$, respectively) are by assumption positive, such that the numerator exceeds the denominator.

than employment taxes do in both models, more extensive use of employment taxes, balancing the government budget, may yield a higher level of employment in an efficiency wage model. In a wage bargaining framework, however, there is a one-to-one relation between wages and employment, such that the tax policy providing incentives for wage restraint, i.e. payroll taxation, unambiguously leads to the higher level of employment.

Turning to prescriptions for tax policies, our results may be interpreted as providing (weak) support for the use of both kinds of labour taxation on rms, since equilibrium unemployment in actual economies presumably is caused by several sources of market imperfections, including wage bargaining and efficiency wage effects. Hence, the optimal labour tax policy[15] must balance the costs and bene ts of the two sources of labour taxation on equilibrium unemployment resulting from the various kinds of labour market imperfections, making it likely that both kinds of labour taxation on rms belong to the optimal labour tax policy.

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[15] Of course, we cannot discuss properly optimal tax policies without having speci ed the objective function of the government. See Sørensen (1997) for an optimal income tax analysis where the objective of the government is speci ed as maximization of the expected utility of a worker.

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