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## ABSTRACT

### Tax Evasion in a Unionised Economy<sup>\*</sup>

In a unionised labour market, a substitution of a payroll for an income tax will not alter employment if tax obligations are fulfilled. However, if workers or firms can evade taxes this irrelevance result might no longer apply. This will especially be the case if the fine for tax evasion depends on undeclared income or on wage payments or if withholding regulations prevent optimal evasion choices. In such instances, tax evasion opportunities make the legal incidence of taxes an important determinant of their economic incidence and employment can rise with a substitution of an income for a payroll tax.

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## 1. Introduction

The legal incidence of a tax is irrelevant for its economic incidence. For the labour market this "most basic theorem of public finance" (Blinder 1988, p. 12) implies that it does not matter for employment whether taxes are paid by workers or firms. However, empirically the irrelevance proposition is not always supported (Calmfors 1990, Lockwood and Manning 1993, Tyrväinen 1995) and there are also theoretical arguments why the statutory incidence of taxes can affect its economic impact. If, for example, tax bases differ, a balanced-budget substitution will alter the progressivity of the tax system. Since changes in tax progression usually affect employment in models of imperfectly competitive labour markets, a tax reform can alter the market outcome.<sup>1</sup> A further explanation for a shift of taxes to influence employment is that the alternative income might depend on one tax rate but not the other (Muysken et al. 1999, Goerke 2000, Picard and Toulemond 2001).

In this paper, an additional channel is established by which a shift from a tax on labour income paid by firms, labelled a *payroll* tax, to a tax on labour income imposed on workers, denoted as an *income* tax, can affect employment in a unionised labour market: tax evasion. In OECD countries union density often exceeds 30%, while collective bargaining coverage might easily reach 70% to 90% (OECD 1997). Moreover, a substantial amount of taxes on labour income appears to be evaded (Andreoni et al. 1998). Hence, the employment effects of shifting the tax burden in unionised economies with tax evasion opportunities can be of significant relevance.

The analysis shows that a shift from a payroll to an income tax will raise employment, if the penalty for tax evasion by workers not only depends on the evaded tax but also on the undeclared income. The intuition for the employment effects can best be derived if initially a penalty which depends on evaded taxes instead of undeclared income is considered. In this case, a shift of the tax burden does not alter employment because all the employees' payoffs remain unaffected. In addition, the firms' employment decision is independent of its tax evasion activities. Hence, the gain from changing the wage for the trade union is the same as before the variation in the tax structure. Accordingly, the net wage and also labour costs and employment remain constant. However, if the penalty for tax evasion also depends on the undeclared income, a higher income tax rate will reduce the penalty relative to the fine being a function of the evaded tax and raises the incentives to evade. Since higher evasion reduces the effective tax burden and because workers are risk-averse, the union's gain from a higher wage declines. As a shift from an income to a payroll tax leaves employment unaffected in a set-up in which the penalty is a function only of the evaded tax, a less pronounced wage rise implies more employment.

The paper is structured as follows: Section 2 investigates the firm's and workers' decisions and the trade union's behaviour.<sup>2</sup> Section 3 analyses a shift from a payroll to an income tax for a

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<sup>1</sup> See, inter alia, Holm and Koskela (1996), Koskela and Schöb (1999), and Picard and Toulemond (2001). Holmlund (1981) analyses the validity of the tax base argument in the context of a competitive labour market.

<sup>2</sup> Tax evasion in unionised labour markets has not found much attention. See Lai et. al (1995) for an exception who analyse the relationship between tax evasion and tax revenues.

penalty which depends only on the evaded tax. This tax reform does not change employment. However, the irrelevance proposition will only apply in this setting if evasion choices are optimal. Thus, Section 3 also looks at the impact of withholding regulations. In Section 4, the workers' penalty for evading taxes is a function of the undeclared income instead of the evaded tax. Under this assumption employment can rise, as explained above. Section 5 discusses these results.

## 2. Model

The economy consists of a large number of firms, each of which bargains with a trade union over wages. All potential employees are members of the respective utilitarian trade union. Workers are strictly risk-averse and have to pay an income tax of which they are able to evade a fraction. Firms are subject to a payroll tax which they can also evade. Linear taxes without exemptions ensure that variations in employment are not caused by changes in tax progressivity. In addition, the alternative income is exempt from taxes, in order to rule out this potential cause of employment effects. The timing of decisions is as follows: first, the government announces the tax rates and parameters of the tax enforcement system, such as the penalty and audit probabilities. Second, the wage is determined. The trade union takes into account the impact of a wage variation on evasion activities. Third, workers select their optimal degree of tax evasion and firms make employment and evasion choices. Since firms are identical and as unions represent workers with the same preferences, the analysis focuses on one trade union - firm pair.

### 2.1 Firms

Models of tax evading firms have either been based on the assumption of convex concealment costs or the hypothesis of risk-aversion. In order to minimise differences in behavioural assumptions for firms and workers which, in turn, may create an impact of the legal incidence of taxes for their economic incidence, the second approach is chosen. Denoting by  $S$  the utility function of firms or their owners, this implies  $S' > 0$  and  $S'' < 0$ . Moreover, non-increasing absolute risk-aversion is presumed, where  $\Theta$ ,  $\Theta \equiv -S''/S' > 0$ , defines the Arrow-Pratt measure of absolute risk-aversion. Firms sell their product in a perfectly competitive output market, such that the output price can be normalised to unity. The sole variable input is labour. The production function  $f$  is strictly concave in employment  $n$ ,  $f'(n) > 0$ ,  $f''(n) < 0$ . The wage is denoted by  $w$ . Firms can evade a fraction  $\lambda$ ,  $0 \leq \lambda \leq 1$ , of their payroll tax obligations  $w\tau n$ . Normalising fixed costs to zero, profits  $\pi^e$  if not caught evading taxes will be  $\pi^e \equiv f(n) - wn(1 + \tau(1 - \lambda))$ . With an exogenous probability  $q$  firms are detected and have to pay a penalty for tax evasion which - initially - is defined as a multiple  $G$ ,  $G > 1$ , of evaded taxes  $w\tau\lambda$ , yielding profits of  $\pi^c \equiv \pi^e - Gw\tau\lambda$ . The expected utility  $E(S, q)$  of a tax evading firm can be expressed as:

$$E(S, q) = (1 - q)S[f(n) - wn(1 + \tau(1 - \lambda))] + qS[f(n) - wn(1 + \tau(1 - \lambda)) - Gw\tau\lambda] \quad (1)$$

The firm chooses employment  $n$  and the degree of tax evasion  $\lambda$ , given the wage. The optimal degree of tax evasion results from  $\partial E(S, q)/\partial \lambda = wn\tau J = 0$ , where  $J$  is defined by:

$$J \equiv (1 - q)S'(\pi^e) + qS'(\pi^c)(1 - G) = 0 \quad (2)$$

An interior solution requires  $1 < G < 1/q$ . This is, henceforth, assumed to be the case. Combining  $\partial E(S, q)/\partial n = 0$  with  $J = 0$  yields the standard finding that the firm's employment (or output) decision is separable from the evasion choice.<sup>3</sup> Therefore, the first-order condition implies:

$$K \equiv f'(n) - w(1 + \tau) = 0 \quad (3)$$

This condition for the choice of employment has the usual properties. In particular,  $K_n = f''(n) < 0$ ,  $K_w = -(1 + \tau) < 0$ ,  $K_\tau = -w < 0$  and, finally,  $K_\lambda = 0$ . The derivatives of  $J$  are:

$$J_\lambda = wn\tau \left[ (1 - q)S''(\pi^e) + qS''(\pi^c)(1 - G)^2 \right] = nJ_n / \lambda < 0 \quad (4)$$

Defining a variable  $C$ ,  $C \equiv (1 - q)S''(\pi^e) + qS''(\pi^c)(1 - G) \geq 0$ , where  $C$  is non-negative owing to the assumption of non-increasing absolute risk-aversion,<sup>4</sup> yields:

$$J_w = J_\lambda \lambda / w - n(1 + \tau)C = \tau J_\tau / w - nC < 0 \quad (5)$$

The changes in employment due to a higher wage  $w$  or payroll tax  $\tau$  are independent of evasion choices and given by  $n_w = (1 + \tau)/f'' = n_\tau(1 + \tau)/w < 0$ . Using the first-order condition (3), the impact of changes in the wage and the payroll tax rate on the optimal degree of tax evasion are:

$$\frac{d\lambda}{dw} = \frac{K_w J_n}{K_n J_\lambda} - \frac{J_w}{J_\lambda} = -\lambda \frac{(1 + \tau)w + f''n}{f''nw} + \frac{n(1 + \tau)C}{J_\lambda} = -\lambda \frac{f' + f''n}{f''nw} + \frac{n(1 + \tau)C}{J_\lambda} \quad (6)$$

$$\frac{d\lambda}{d\tau} = \frac{K_\tau J_n}{K_n J_\lambda} - \frac{J_\tau}{J_\lambda} = -\lambda \frac{\tau(f' + f''n) + f''n}{f''n\tau(1 + \tau)} + \frac{wnC}{J_\lambda} \quad (7)$$

These findings can be summarised as:

### *Proposition 1*

The firm's employment decision is independent of the degree of payroll tax evasion. Tax evasion changes in an ambiguous manner with the wage or the payroll tax rate.

While the first part of Proposition 1 is well established (see footnote 3), the second component conflicts with the assertion by Yaniv (1995, p. 114) that "a tax rate increase must always decrease the firm's statement deviation from the true value of its tax base". This differential result is due to Yaniv's assumption that the penalty is independent of employment. While the

<sup>3</sup> Marelli (1984) and Marelli and Martina (1988) show that the firm's evasion choices will have no impact on its production choice if the detection probability is independent of tax declarations. Yaniv (1995) has demonstrated that the separability feature will also apply if the firm faces withholding regulations. For further results with respect to the separability under different assumptions about market structure and enforcement parameters see, inter alia, Wang and Conant (1988), Yaniv (1996), Lee (1998), and Panteghini (2000).

<sup>4</sup> Making use of the first-order condition (2), the variable  $C$  can be rewritten as:

$$C \equiv -qS'(\pi^c)(1 - G)S''(\pi^e) / S'(\pi^e) + qS''(\pi^c)(1 - G) = qS'(\pi^c)(1 - G) \left[ \Theta(\pi^e) - \Theta(\pi^c) \right]$$

Since an interior solution requires  $G > 1$ , non-increasing absolute risk-aversion ( $\Theta(\pi^e) < \Theta(\pi^c)$ ) implies  $C \geq 0$ .

assumption might be plausible for profit taxes, it does not seem adequate for payroll tax evasion since the required tax payment and the overall level of evasion are linear functions of employment. Accordingly, the relationship between tax evasion and the payroll tax rate is uncertain.

## 2.2 Workers

All workers are identical ex-ante. If they are employed, they will earn a wage  $w$  and be subject to an income tax  $t$ ,  $0 < t < 1$ . Unemployed workers obtain unemployment benefits  $\bar{w}$ ,  $\bar{w} > 0$ , which are exempted from taxes. Employed workers decide to pay a fraction  $(1 - h)$  of their tax obligations,  $0 \leq h \leq 1$ . A worker successfully evading taxes has an income  $w^e$ ,  $w^e \equiv w(1 - t(1 - h))$ . A worker who is caught evading taxes with the exogenous probability  $p$  has to pay a fine which is - initially - a multiple  $F$ ,  $F > 1$ , of evaded taxes and obtains an income  $w^c$ ,  $w^c \equiv w^e - Fwth$ . Workers can be characterised by a strictly concave utility function  $u$ ,  $u' > 0$ ,  $u'' < 0$  and exhibit non-increasing absolute risk-aversion. Their expected utility  $E(u, p)$  then is:

$$E(u, p) = (1 - p)u[w(1 - t(1 - h))] + pu[w(1 - t(1 - h)) - Fwth] \quad (8)$$

The optimal degree of tax evasion  $h^*$  is defined by:

$$H \equiv \frac{1}{wt} \frac{dE(u, p)}{dh} = (1 - p)u'(w^e) + pu'(w^c)(1 - F) = 0 \quad (9)$$

A value of  $h^*$  which is strictly greater than zero but less than unity implies  $1 < F < 1/p$ . These restrictions are assumed to hold. The second-order condition is given by:

$$H_h = wt \left[ (1 - p)u''(w^e) + pu''(w^c)(1 - F)^2 \right] < 0 \quad (10)$$

For the further derivations it is helpful to compute the impact of changes in the income tax rate  $t$  and the wage  $w$  on the optimal degree of tax evasion.

$$H_t = -w \left[ (1 - h)A + hpu''(w^c)(1 - F)F \right] \quad (11)$$

$$H_w = A(1 - t(1 - h)) - pu''(w^c)(1 - F)Fth, \quad (12)$$

where  $A \equiv (1 - p)u''(w^e) + pu''(w^c)(1 - F) \geq 0$  is non-negative due to the assumption of non-increasing absolute risk-aversion. Hence, the optimal degree of tax evasion declines with a higher income tax rate (Yitzhaki 1974). The impact of a change in the wage is uncertain.

## 2.3 Trade Union

Workers in each firm are represented by a utilitarian trade union. The individual union takes the behaviour of other unions, firms, and the government as given. For simplicity, a wage setting union is assumed. Given the wage  $w$ , the firm selects the level of employment  $n$ . The trade union has  $m$ ,  $m \geq n$ , ex-ante identical workers. Since a utilitarian trade union simply aggregates the expected utility of its members who adjust their evasion activities to changes in tax rates and wages, optimality of the union's behaviour requires it to take into account these



adjustments in the degree of tax evasion. Accordingly, the union maximises the sum of the expected utility of  $n$  employed workers who obtain a wage  $w$  and are caught evading taxes with probability  $p$ , and of  $m - n$  unemployed workers who receive benefits  $\bar{w}$ :

$$\bar{V} = n(w) \left[ (1-p)u(w^e) + pu(w^c) \right] + (m - n(w))u(\bar{w}) \quad (13)$$

Maximisation of  $\bar{V}$  with respect to the wage  $w$ , assuming a constant labour demand elasticity  $\varepsilon$ ,  $\varepsilon = -wn_w/n > 0$ , yields after some manipulations  $V \equiv -(w/n)d\bar{V}/dw$ , where:

$$V = \varepsilon \left[ (1-p)u(w^e) + pu(w^c) - u(\bar{w}) \right] - w(1-t) \left[ (1-p)u'(w^e) + pu'(w^c) \right] = 0 \quad (14)$$

The trade union balances the costs of a wage increase, the first term in (14), measured by the decline in the number of workers owing to a wage increase and weighted by the utility reduction which each worker will experience if becoming unemployed, against the gain from a higher wage, the second term in (14), which expresses the increase in utility of each employee owing to a higher wage. The second-order condition requires  $V_w > 0$ , as  $d\bar{V}/dw$  has been multiplied by  $(-w/n)$ , that is a labour demand elasticity which is not less than unity. This prerequisite is independent of evasion opportunities. The derivative of  $V$  with respect to the payroll tax is zero ( $V_\tau = 0$ ), while the impact of the income tax is defined by  $V_t(1-t) = -V_w w < 0$  (see appendix 1).<sup>5</sup>

### 3. Shifting the Tax Burden to Workers if the Penalty Depends on the Evaded Tax

A shift of the tax burden will have no impact on employment in a competitive labour market in the absence of tax evasion either if the wedge between (official) labour costs  $w(1 + \tau)$  and the net wage  $w(1 - t)$  or if tax revenues are held constant. Denote the wedge by  $\gamma$ ,  $\gamma \equiv (1 + \tau)/(1 - t)$ . Initially, the decline in the payroll tax is determined by the requirement of a constant wedge. Subsequently, it is shown that the same employment effects will result if the requirement of constant tax revenues is imposed. These analyses presume that workers can attain their optimal degree of tax evasion. In Section 3.2, the impact of withholding regulations is investigated.

#### 3.1 Optimal Evasion Choices

The change in employment owing to a shift from payroll to income taxes is determined by the direct tax effects and the indirect consequences which operate via the wage. From the firm's first-order condition (3) it is known that employment depends on the wage  $w$  and the payroll tax rate  $\tau$ ,  $n = n(w, \tau)$ . The wage which the union sets is influenced by the income tax rate - also due to the repercussion via the optimal degree of tax evasion - but independent of the payroll tax rate owing to the assumption of a constant labour demand elasticity. Thus, employment is given by  $n = n(w(t, h(t)), \tau)$ . Differentiating  $n$  with respect to the income tax  $t$  and noting that

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<sup>5</sup> The assumption of a constant labour demand elasticity simplifies the subsequent calculations since it ensures that the wage effect of a higher payroll tax is zero and that wages rise with a higher income tax. However, the restriction does not affect the results with respect to the employment effects of a shift in the tax burden.

$w_t = -V_t/V_w$ ,  $n_\tau/n_w = w/(1 + \tau)$ , and  $V_t(1 - t) + V_w w = 0$  hold, the employment change can be computed as:

$$\left. \frac{dn}{dt} \right|_{\substack{d\gamma=0, h=h^*, \lambda=\lambda^* \\ F(\cdot)=Fw\tau h, G(\cdot)=Gw\tau\lambda}} = n_w w_t + n_\tau \frac{d\tau}{dt} = -n_w \frac{V_t(1-t) + wV_w}{V_w(1-t)} = 0 \quad (15)$$

Constant employment entails rigid labour costs  $w(1 + \tau)$  and taken in conjunction with the requirement of a constant wedge, this implies an unchanged net wage. Equation (15) yields:

*Proposition 2*

In an economy with collective wage determination in which firms and workers choose tax evasion optimally and in which the penalty for tax evasion is a function of the evaded tax, a shift from a linear payroll to a linear income tax which leaves the wedge between labour costs and the net wage unaffected, does not alter labour costs, employment and the net wage.

The intuition for this result is the following: the employment consequences of a shift from payroll to income taxes are determined solely by the trade union's reaction to the tax variation. This is because the trade-offs between employment and wages and employment and payroll taxes are unaffected by variations in the firm's tax evasion behaviour (cf. equation (3)). Thus, the impact of a shift in the tax burden consists of the direct effects on the trade union's payoff and the indirect effects, via changes in income tax evasion owing to tax and wage variations. Changes in the wage  $w$  and the income tax rate  $t$  alter the union's first-order condition symmetrically. This is because all components of the union's marginal payoff are a function of the wage and the tax. Hence, any fall in the wage has a qualitative impact on trade union utility which is equivalent to the effect of a higher income tax. Effectively, the union's maximisation problem in the presence of optimal evasion activities by workers is the same as in their absence.

The same net wage and the same labour costs as they prevailed before the tax reform will only allow workers and firms to obtain their optimal degree of tax evasion  $h^*$  and  $\lambda^*$ , respectively, if the levels of evaded taxes  $w\tau h$  and  $w\tau\lambda$  are unaffected (cf. equations (2) and (9)). Since the government's tax revenues  $B$  can be expressed as  $B = n[w(1 + \tau) - w(1 - t) - w\tau\lambda - w\tau h]$ , constancy of the net wage, labour costs and the level of evaded taxes also implies unchanged tax receipts.<sup>6</sup> For a given level of government expenditure this gives rise to:

*Proposition 3*

In an economy with collective wage determination, in which firms and workers choose tax evasion optimally and in which the penalty for evasion is a function of the evaded tax, a shift from a linear payroll to a linear income tax, which leaves the government's budget balance unaffected, changes neither employment nor the payoffs of workers and firms.

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<sup>6</sup> If the expected revenues from fine payments  $npFw\tau h$  and  $qGw\tau\lambda$  were included into  $B$ , the result of unchanged government revenues would obviously not be altered.

The irrelevance of the legal for the economic incidence also holds in a Nash-bargaining framework.<sup>7</sup> The tax reform which leaves the net wage and employment constant in a monopoly union setting induces an adjustment in the degree of tax evasion such that the trade union's payoff from raising the wage remains the same. Moreover, the level of the union's and the firm's payoffs is not affected. Since, finally, the firm's marginal payoff is constant, the wage change which warrants the original employment level in the monopoly union model implies that all the components of the Nash-solution are unaffected. There is no need for additional wage alterations and continues to be no employment impact of the balanced-budget tax reform.

### 3.2 Withholding Regulations

Throughout the analysis it has been assumed that tax evasion choices are optimal. However, in many countries there are regulations according to which the employer has to withhold the employees' taxes and make according payments to the government. On the one hand, such regulations increase evasion opportunities for firms. On the other hand, they restrict or abolish the employees' ability to evade taxes. Nevertheless, tax evasion opportunities persist, for example, because withheld taxes fall short of statutory tax payments or since withheld taxes can be reclaimed due to the existence of tax deductible expenses. As withholding regulations restrict the workers' ability to adjust their tax evasion behaviour, the irrelevance of the legal incidence of taxes for their economic incidence no longer holds.

In order to demonstrate this claim, suppose that payroll tax evasion opportunities are not limited and that firms cannot evade income taxes. Hence, the analysis focuses on the suboptimality of employees' evasion activities. A convenient way of modelling withholding regulations under such assumptions is to impose a maximum degree of employees' tax evasion  $h^m$ ,  $0 < h^m < h^*$  before and after the tax reform. Tax revenues  $B$  are given by  $B = wn[t(1 - h^m) + \tau(1 - \lambda)]$ . For a given government expenditure, a balanced-budget substitution of the income for the payroll tax implies  $dB = B_t dt + B_\tau d\tau = 0$ , where  $B_t$ ,  $B_\tau$  are assumed to be positive:

$$B_t = w_t (n + n_w w) \left[ t(1 - h^m) + \tau(1 - \lambda) \right] + wn \left[ 1 - h^m - \tau \lambda_w w_t \right] > 0 \quad (16)$$

$$B_\tau = n_\tau w \left[ t(1 - h^m) + \tau(1 - \lambda) \right] + wn \left[ 1 - \lambda - \tau \lambda_\tau \right] > 0 \quad (17)$$

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<sup>7</sup> Defining the trade union's (firm's) bargaining power by  $\alpha$  ( $1 - \alpha$ ) and the respective fallback positions by  $\bar{V}$  and  $\bar{V}_w$ , the Nash-solution can be written as:  $\alpha(E(S) - \bar{V}) + (1 - \alpha)(\bar{V} - \bar{V}_w)E(S)_w (-w/n) = 0$ . Suppose, the wage adjusts such as to leave  $E(S)$ ,  $\bar{V}$ , and  $\bar{V}_w$  and the fallback utility unaffected. The only component of the Nash-solution which might then change is  $E(S)_w(-w/n)$ , that is the derivative of the firm's payoff with respect to the wage. Since employment does not vary - given constant labour costs -, the focus can be on  $-wE(S)_w$ :

$$-wE(S)_w = wn \left[ \tau \lambda - w \tau \lambda_w \right] \left\{ (1 - q)S'(\pi^e) + qS'(\pi^c)(1 - G) \right\} + nw(1 + \tau) \left( (1 - q)S'(\pi^e) + qS'(\pi^c) \right)$$

As the term in curly brackets is zero (cf. the first-order condition (2)) and because labour costs  $w(1 + \tau)$  have to be unaffected by the tax reform for the employment level to be the same, the wage adjustment which warrants the optimality of the wage demand subsequent to the tax reform in the monopoly union model also guarantees the optimality of the original Nash-solution.

Since employees' cannot adjust their tax evasion choices to variations in the income tax rate, the trade union's first-order condition for an optimal wage yields:

$$V = \varepsilon \left[ (1-p)u(w^e) + pu(w^c) - u(\bar{w}) \right] - w \left[ (1-p)u'(w^e)(1-t(1-h^m)) + pu'(w^c)(1-t(1-h^m) - Fth^m) \right] = 0 \quad (18)$$

The effect due to an increase in the income tax rate  $t$  is determined by  $w_t = -V_t/V_w$ , where:

$$\begin{aligned} V_w &= (\varepsilon - 1) \left[ (1-p)u'(w^e)(1-t(1-h^m)) + pu'(w^c)(1-t(1-h^m) - Fth^m) \right] \\ &\quad - w \left[ (1-p)u''(w^e)(1-t(1-h^m))^2 + pu''(w^c)(1-t(1-h^m) - Fth^m)^2 \right] > 0 \quad (19) \\ V_t &= (1-\varepsilon)w \left[ (1-p)u'(w^e)(1-h^m) + pu'(w^c)(1-h^m + Fh^m) \right] \\ &\quad + w^2 (1-p)u''(w^e)(1-t(1-h^m))(1-h^m) \\ &\quad + w^2 pu''(w^c)(1-t(1-h^m) - Fth^m)(1-h^m + Fh^m) \quad (20) \end{aligned}$$

The employment change owing to a substitution of the income for the payroll tax, using  $wn_w = n_\tau(1 + \tau)$  and the fact that the expression in curly brackets below is zero, is:

$$\begin{aligned} \frac{dn}{dt} \Big|_{\substack{dB=0, G(\cdot)=Gwn\tau\lambda \\ h=h^m, F(\cdot)=Fwth, \lambda=\lambda^*}} &= n_w w_t - n_\tau \frac{B_t}{B_\tau} \\ &= -\frac{nn_\tau}{B_\tau} \left[ w_t (t(1-h^m) - 1) + w(1-h^m) - w_t \{w\tau\lambda_w - \lambda - (1+\tau)\tau\lambda_\tau\} \right] \\ &= -\frac{nn_\tau}{B_\tau V_w} \left[ V_t (1-t(1-h^m)) + V_w w(1-h^m) \right] \\ &= \frac{nn_\tau Fwph^m}{B_\tau V_w} \left[ (\varepsilon - 1)u'(w^c) - wu''(w^c)(1-t(1-h^m) - Fth^m) \right] \quad (21) \end{aligned}$$

A sufficient condition for employment to fall with a substitution of the income for the payroll tax is  $1 - t + th^m(1 - F) \geq 0$ . Since fines rarely exceed twice the level of the evaded tax (Andreoni et al. 1998, p. 820), a tax rate of less than 50% guarantees the negative employment effects. The result can be summarised as:

*Proposition 4*

If tax evasion choices are restricted, a balanced-budget shift of the tax burden will alter employment in a unionised economy. In particular, if a trade union sets the wage, the penalty for evasion is a function of the evaded tax, and evasion activities by firms are unrestricted, while workers cannot attain their optimal degree of evasion, a balanced-budget shift from a linear payroll to a linear income tax will reduce employment for  $1 - t + th(1 - F) \geq 0$ .

Withholding regulations or, more generally, restrictions on evasion choices destroy the symmetric impact of wage and tax rate variations on the employees' payoff. Thus, variations in wages and income taxes alter the trade union's objective in a different way than it is the case for unrestricted evasion choices. In the absence of restrictions on tax evasion activities, a balanced-budget substitution of an income for a payroll tax will have no employment effects if the penalty is a function of the evaded tax. A fixed degree of tax evasion implies that a given income tax increase raises tax revenues by less than in the case of unrestricted evasion activities because higher tax rates reduce optimal evasion (cf. equation (11)). Since the budgetary effects of a given decrease in the payroll tax are unaffected by evasion - due to the separability feature - a substitution of the income for the payroll tax which leaves the government's budget unaffected in a world of unrestricted tax evasion choices will induce a decline in tax revenues if the workers' evasion possibilities are limited. In order to balance the budget, the income tax has to be raised further. The more pronounced income tax increase induces an additional wage rise and an employment reduction.

#### 4. Employment Effects if the Penalty Depends on Undeclared Income

Suppose the penalty which has to be paid in the case of being detected is determined not solely by the amount of evaded taxes but also influenced by the level of undeclared income. Under this assumption, a shift from payroll to income taxes, holding constant the wedge between labour costs and the net wage, is likely to raise employment. It has been shown above that the firm's employment decision is independent of its evasion activities. This independence result will also apply if the penalty is a function of undeclared wage payments (see appendix 2). Accordingly, the focus of the subsequent analysis is on workers. Since already a shift of the tax burden in the presence of a constant wedge has employment effects, this is also the case for a balanced-budget requirement.

Assume that the workers' penalty for evasion increases with the evaded tax and the undeclared income, where the parameter  $\beta$  measures the importance of the two determinants. The penalty can then be expressed as  $Fwh(\beta t + 1 - \beta)$ ,  $0 \leq \beta \leq 1$ . To simplify the subsequent analysis,  $\beta = 0$  is assumed. The employment effects for  $0 < \beta \leq 1$  can be modelled by a combination of the impact for the case in which the penalty is a function of evaded tax and in which it depends on undeclared income. For a value of  $\beta = 0$ , the optimal degree of tax evasion is defined by:

$$H \equiv (1-p)u'(w^e)t + pu'(w^c)(t-F) = 0, \quad (22)$$

or  $w^c \equiv w(1 - t(1 - h) - Fh)$ . An interior solution requires  $t < F < t/p$ . Using a variable  $M$ ,  $M \equiv (1-p)u'(w^e) + pu'(w^c) > 0$ , the derivatives of  $H$  are:

$$H_h = w \left[ (1-p)u''(w^e)t^2 + pu''(w^c)(t-F)^2 \right] < 0 \quad (23)$$

$$H_w = (1-p)u''(w^e)t(1-t(1-h)) + pu''(w^c)(t-F)(1-t(1-h)-Fh) \quad (24)$$

$$H_t = M - w(1-h) \left[ (1-p)u''(w^e)t + pu''(w^c)(t-F) \right] \quad (25)$$

The first-order condition of the trade union's maximisation problem is given by equation (14), where  $w^c$  is redefined accordingly. The change in employment owing to a shift from the payroll to the income tax, holding constant the wedge  $\gamma$ , can be computed from equation (15). Substituting for  $V_t$  and  $V_w > 0$  one obtains (see appendix 3 for a derivation):

$$\begin{aligned} \frac{dn}{dt} \Big|_{\substack{d\gamma=0, G(\cdot)=Gwn\tau\lambda \\ h=h^*, \lambda=\lambda^*, F(\cdot)=Fwh}} &= -\frac{n_w}{(1-t)V_w} [V_t(1-t) + wV_w] \\ &= \frac{\varepsilon n}{V_w H_h} \left[ MQ - w^2(1-t)(1-p)u''(w^e)pu''(w^c)h(t-(t-F)F) \right], \end{aligned} \quad (26)$$

$$\text{where} \quad Q \equiv \varepsilon h H_h + w(1-t) \left[ (1-p)u''(w^e)t + pu''(w^c)(t-F) \right] \quad (27)$$

As  $H_h < 0$ , while the term in squares brackets in (27) will be positive (zero) if workers exhibit decreasing (constant) absolute risk-aversion,  $Q$  has an ambiguous sign (is negative). This yields:

*Proposition 5*

If (a) workers' absolute risk-aversion is not decreasing too strongly with income, (b) tax evasion decisions are optimal, and (c) the workers' penalty for tax evasion depends at least marginally on undeclared income, then a shift from payroll to income taxes, holding constant the wedge between labour costs and the net wage, will increase employment in an economy with a wage setting trade union.

The intuition for the positive employment effect is the following: assume for the sake of the argument a constant Arrow-Pratt measure of absolute risk-aversion. The employment expansion occurs because a higher income tax rate will raise the optimal degree of tax evasion if the penalty depends on the undeclared income while it will reduce evasion activities if the fine is a function of evaded taxes (cf. equations (10) to (12) and (23) and (25)). If the penalty depends on undeclared income and the optimal degree of tax evasion rises, the trade union's payoff from raising the wage will decrease, relative to a situation in which the penalty for evasion is a function of evaded taxes and the optimal degree of evasion has fallen, since the effective net wage has gone up while workers are risk-averse. Because, moreover, the change in employment due to a given wage rise is not altered, the incentives to raise wages will be lower if the penalty is a function of the undeclared income instead of the evaded tax. Thus, employment will rise if the measure of absolute risk-aversion is constant. If this measure is strongly decreasing with income, the degree of tax evasion might also decline with a higher income tax rate (cf. equation (25)). In this case, the employment effects of a shift from payroll to income taxes become uncertain.

If the firm's penalty for evasion depends on the amount of undeclared wage payments, the trade-offs between employment and wages or the payroll tax rate will remain unaffected. Thus,

the firm's evasion activities continue to have no impact on the employment decision. Moreover, the impact of a higher wage on the firm's degree of tax evasion  $\lambda$  is qualitatively unaffected by the fine structure and continues to be given by equation (6). However, the impact of a higher payroll tax rate on the optimal degree of tax evasion will vary in comparison to (7) if the penalty changes with undeclared wage payments (cf. appendix 2). This implies that a shift in the tax burden, holding constant tax revenues, induces a different wage change than for a constant wedge. Accordingly, employment changes. Thus, assuming a penalty for evasion for firms which depends on undeclared wage payments will undermine the irrelevance of the legal for the economic incidence if the tax reform is combined with a balanced-budget requirement.

## 5. Conclusions

The results of this paper may be summarised as follows: in the presence of tax evasion by firms and workers a change in the legal incidence of taxes is likely to have consequences for the economic incidence in a unionised economy. Accordingly, the existence of tax evasion opportunities can invalidate one of the 'most basic theorems of public finance'. This assertion will hold true either if the penalty for evasion depends on the level of undeclared income while evasion activities are chosen optimally or if evasion opportunities are restricted. In particular, this paper shows that a shift from payroll to income taxes can raise employment if the penalty for tax evasion depends on undeclared income and evasion choices are optimal. However, if workers cannot attain their optimal degree of evasion, a balanced-budget shift from a linear payroll to a linear income tax can lower employment. Thus, the direction of the employment change depends on whether evasion choices by workers are restricted and on the specification of the penalty structure.

In assessing the relevance of these findings, a number of issues are worth discussing. They include the prevalence of unionised labour markets and the adequacy of the tax evasion model. In OECD countries, wage bargaining is a salient feature of many labour markets and the findings of this paper are relevant for a substantial part of them. In how far the predicted direction of employment changes also occurs in other types of labour markets is an important issue. However, it can be conjectured that the impact of the legal incidence of a tax on labour income for its economic consequences in the presence of tax evasion opportunities is not restricted to unionised labour markets, as long as the wage determination process exhibits the same qualitative features as in a collective bargaining set-up. Another relevant aspect for an evaluation of the above findings is the model of tax evasion. The employment effects of a substitution of an income for a payroll tax if the penalty also depends on the undeclared income will be caused by the asymmetric impact of wage and tax changes on the penalty for evasion and the effective net wage. Thus, it is likely that the irrelevance hypothesis does not hold for any model of tax evasion in which wages and tax rates affect evasion choices non-symmetrically. While the direction of the employment change may be sensitive to the exact specification of tax evasion

behaviour, it seems that the pure tax evasion model is not required for a refutation of the irrelevance hypothesis.

## 6. References

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## 7. Appendix

### 1. Second-order Condition for the Trade Union's Maximisation Problem

Making use of  $M$ ,  $M \equiv (1 - p)u'(w^e) + pu'(w^c) > 0$ , the second-order condition is found to be:

$$\begin{aligned} V_w = & (\varepsilon - 1)(1 - t)M - w^2(1 - t)t \left[ (1 - p)u''(w^e) + pu''(w^c)(1 - F) \right] h_w^* \\ & - w(1 - t)^2 \left[ (1 - p)u''(w^e) + pu''(w^c)(1 - F) + pu''(w^c)F \right] \\ & - w(1 - t)th \left[ (1 - p)u''(w^e) + pu''(w^c)(1 - F) \right] \end{aligned} \quad (7.1)$$

Equation (7.1) can be simplified, employing  $A \equiv (1 - p)u''(w^e) + pu''(w^c)(1 - F) \geq 0$ :

$$V_w = (\varepsilon - 1)(1 - t)M - w(1 - t)^2 pu''(w^c)F - w(1 - t)A \left[ 1 - t + th - wtH_w / H_h \right] \quad (7.2)$$

The term in square brackets can be manipulated, using (10) and (12). This yields:

$$\begin{aligned} V_w = & (\varepsilon - 1)(1 - t)M - w(1 - t)^2 pu''(w^c)F + A pu''(w^c)(1 - F)Fw^2 t(1 - t)^2 / H_h \\ = & (\varepsilon - 1)(1 - t)M - w(1 - t)^2 pu''(w^c)F \left[ 1 - A(1 - F)wt / H_h \right] \\ = & (\varepsilon - 1)(1 - t)M - w^2(1 - t)^2 F^2 t(1 - p)u''(w^e)pu''(w^c) / H_h \end{aligned} \quad (7.3)$$

The change in  $V$  due to a higher income tax rate  $t$  is defined by:

$$\begin{aligned} V_t = & -(\varepsilon - 1)wM - w^2(1 - t)t \left[ (1 - p)u''(w^e) + pu''(w^c)(1 - F) \right] h_t^* \\ & + w^2(1 - t) \left[ (1 - p)u''(w^e)(1 - h) + pu''(w^c)(1 - h + hF) \right] \end{aligned} \quad (7.4)$$

Substituting for  $h_t^*$  (cf. equations (10) and (11)) and  $A$ , (7.4) can be rewritten as:

$$\begin{aligned} V_t = & -(\varepsilon - 1)wM - A \left[ (1 - p)u''(w^e)(1 - h) + pu''(w^c)(1 - F)(1 - h + hF) \right] w^3 t(1 - t) / H_h \\ & + w^2(1 - t) \left[ (1 - p)u''(w^e)(1 - h) + pu''(w^c)(1 - h + hF) \right] \end{aligned} \quad (7.5)$$

Simplification shows that  $V_t(1 - t) + V_w w = 0$  holds, since:

$$V_t = -(\varepsilon - 1)wM + w^3(1 - t)F^2 t(1 - p)u''(w^e)pu''(w^c) / H_h \quad (7.6)$$

### 2. Evasion Choices by Firms if the Penalty Depends on Undeclared Wage Payments

If the firm's penalty is a multiple  $G$  of undeclared wage payments  $wn\lambda$ , the optimal degree of tax evasion will be defined by  $\partial E(S, q) / \partial \lambda = wnJ = 0$ , where  $J$  is given by:

$$J \equiv (1 - q)S'(\pi^e)\tau + qS'(\pi^c)(\tau - G) = 0 \quad (7.7)$$

The maximisation of  $E(S, q)$  with respect to employment yields (3). The derivatives of  $J$  are:

$$J_\lambda = wn \left[ (1 - q)S''(\pi^e)\tau^2 + qS''(\pi^c)(\tau - G)^2 \right] = nJ_n / \lambda < 0 \quad (7.8)$$

Defining a variable  $C$ ,  $C \equiv (1-q)S''(\pi^e)\tau + qS''(\pi^c)(\tau - G) \geq 0$ , where  $C$  is non-negative owing to the assumption of non-increasing absolute risk-aversion, one obtains:

$$J_w = J_\lambda \lambda / w - nC < 0 \quad (7.9)$$

$$J_\tau = (1-q)S'(\pi^e) + qS'(\pi^c) - w(1-\lambda)nC \quad (7.10)$$

The consequences of a change in the wage on the optimal degree of tax evasion are defined by (6). The impact of a rise in the payroll tax is found to be:

$$\frac{d\lambda}{d\tau} = -\frac{w\lambda}{f'n} - \frac{(1-q)S'(\pi^e) + qS'(\pi^c)}{J_\lambda} + \frac{wn(1-\lambda)C}{J_\lambda} \quad (7.11)$$

### 3. Penalty as a Function of Undeclared Income

The derivatives of the union's first-order condition (14) with respect to  $w$  and  $t$  are:

$$\begin{aligned} V_w = (\varepsilon - 1)(1-t)M - w^2(1-t) \left[ (1-p)u''(w^e)t + pu''(w^c)(t-F) \right] h_w^* \\ - w(1-t) \left[ (1-p)u''(w^e)(1-t(1-h)) + pu''(w^c)(1-t(1-h) - Fh) \right] > 0 \end{aligned} \quad (7.12)$$

$$\begin{aligned} V_t = (1-\varepsilon(1-h))wM - w^2(1-t) \left[ (1-p)u''(w^e)t + pu''(w^c)(t-F) \right] h_t^* \\ + w^2(1-t)(1-h) \left[ (1-p)u''(w^e) + pu''(w^c) \right] \end{aligned} \quad (7.13)$$

The employment change due to a shift of the tax burden is determined by equation (26), where:

$$\begin{aligned} V_t(1-t) + V_w w = Mw(1-t)\varepsilon h - w^2(1-t)(1-p)u''(w^e) \left\{ h + t \left[ h_t^*(1-t) + wh_w^* \right] \right\} \\ - w^2(1-t)pu''(w^c) \left\{ h(1-F) + (t-F) \left[ h_t^*(1-t) + wh_w^* \right] \right\} \end{aligned} \quad (7.14)$$

Substituting for the derivatives of  $h$  (cf. equations (23) to (25)) shows:

$$h + t \left\{ h_t^*(1-t) + wh_w^* \right\} = -(1-t) \frac{pu''(w^c)(t-F)whF + tM}{H_h} \quad (7.15)$$

$$h(1-F) + (t-F) \left\{ h_t^*(1-t) + wh_w^* \right\} = (1-t) \frac{(1-p)u''(w^e)wth - (t-F)M}{H_h} \quad (7.16)$$

Combining equations (7.14) to (7.16) gives rise to equation (26) in the main text.

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