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Alleviating unemployment: The case for green tax reforms

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Abstract

It has been argued recently that imposing taxes on pollution produces additional tax revenues which can be used to replace labour taxes and thus reap a double dividend in the form of improving environmental quality and alleviating unemployment. This paper analyses the employment effects of revenue-neutral green tax reforms by focusing on the revenue-recycling effect. Our model contains three features which are important when looking at the employment effects of green tax reforms. First, there is unemployment in equilibrium. Second, wages are determined endogenously. Third, various institutional arrangements for taxing unemployment benefits, for the price-indexation of unemployment benefits and the personal tax exemption are considered. It is shown that these institutional arrangements are crucial for the effectiveness of green tax reforms. A revenue-neutral green tax reform will boost employment if unemployment benefits are nominally fixed and taxed at a lower rate than labour income. Employment actually falls if unemployment benefits are price indexed and taxed at the same rate. A revenue-neutral green tax reform which increases the personal tax credit will never increase employment.

JEL classification: H20; H30; J51

Keywords: Environmental tax reform; Tax shifting; Equilibrium unemployment; Trade union behaviour; Wage bargaining; Unemployment benefit taxation; Indexation

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1. Introduction

Fighting unemployment has been at the top of the political agenda for the last decade. Europe suffers from persistently high levels of unemployment. At the end of 1997, the unemployment rates in the European Union were between 2.5% in Luxembourg and 20.0% in Spain, with an average unemployment rate for the EU member countries of 10.5%.[1] As well as other factors which are made responsible for the high unemployment, such as the mismatch of skills and the shortfall in demand, it is frequently claimed that the government's interventions in the labour market also significantly contribute to unemployment. High taxes on labour income combined with high levels of unemployment benefits distort labour supply and increase wage pressure in the wage negotiations between trade unions and employer organizations. Indeed, there is lot of empirical evidence showing that taxes have significant effects on unemployment. Surveying the empirical literature on this issue, a recent OECD (1995) study on taxation, employment and unemployment concludes:

> 'Evidence that taxes on labour increase wage pressure and thereby increase unemployment (at least in the short-run) is, with some exceptions, reasonably convincing and in some countries, the increase in the tax wedge may have accounted for a significant proportion of the increase in unemployment.' (OECD, 1995, p. 68)

It is now widely accepted in political discussion that reducing the share of the tax burden borne by labour is a necessary policy measure for boosting employment. One possibility for lowering taxes is to reduce the size of the public sector. The other possibility is to shift the tax burden away from labour. One popular proposal for this is to increase consumption taxes as these taxes are also paid by other income groups. This will partly reduce the tax burden borne by labour while leaving the overall tax burden constant. Another possibility is to shift the tax burden to environmentally damaging behaviour. For the last two decades environmental problems have ranked high on the political agenda and the introduction of green taxes to fight pollution has become quite popular. It is therefore no surprise that it is politically very appealing to combine the two policy issues. Imposing taxes on pollution raises additional tax revenues which can be used to replace labour taxes and thus reap a double dividend in the form of improving the environmental quality and alleviating unemployment.

In the literature, however, we observe widespread pessimism as to whether there is a double dividend. Bovenberg and de Mooij (1994) and Bovenberg and

[1] These are standardized unemployment rates in the definition of the OECD, cf. Main Economic Indicators, June 1998, p. 40.

van der Ploeg (1994a) show that normally we can expect labour supply to fall as a result of a green tax reform. These authors develop their arguments using a model with market clearing in the labour market. With full-employment, however, the reduction of labour supply only indicates the willingness of society to produce fewer consumption goods in order to enjoy better environmental quality. The decrease in labour supply is always welfare improving.[2]

There are also some papers which find positive employment effects. In a model with production externalities, Bovenberg and van der Ploeg (1996) show that if green taxes are low initially, employment may increase if substitution between labour and resources within the production sector is easy. The shortcoming of their approach is, however, that the nominal net wage is exogenously fixed, so that both labour taxes and green taxes are assumed to be fully borne by the production sector.

Only recently have first attempts been made to consider green tax reforms within models which allow for unemployment in equilibrium and for endogenous wage setting. Schneider (1997) shows within an efficiency wage model that employment may increase due to an increase in green taxes. Nielsen et al. (1995) choose a monopoly union labour model where production externalities are present. In their model, however, marginal tax revenues of green taxes are always zero. Employment effects only result from changes in the provision of public goods and not because additional tax revenues are used to cut labour taxes. Carraro et al. (1996) use numerical simulations to study the effects of a carbon tax reform using a bargaining model for the labour market. They find some evidence in favour of a short-run employment dividend. Bovenberg and van der Ploeg (1995) look at the effects of revenue-neutral environmental tax reforms on wage formation, employment and environmental quality within a search theoretic framework where unemployment is caused by hiring costs. They show that, if an energy tax is levied on the polluting factor of production, a revenue-neutral cut in labour taxes may boost employment if the green tax reform succeeds in shifting the tax burden away from labour income to transfer income. Holmlund and Kolm (1997) examine the role of an environment tax reform for a small open economy with monopolistic competition. Assuming a Cobb–Douglas technology, they show for a two sector economy that a revenue-neutral tax reform on the production side, which increases the energy tax and reduces the labour tax, increases employment if tradable sector wages are higher than those in the non-traded sector. Koskela et al. (1998) allow for a CES production technology with production externalities and show that a green tax reform will boost employment if trade unions cannot increase or can only slightly increase the after-tax wage rate in wage negotiations.

[2] For surveys of the literature on the double dividend hypothesis, see e.g. Goulder (1995) and, with particular focus on the employment effects, Bovenberg (1995).

This paper considers the introduction of green taxes in a model where pollution is caused by the consumption of the dirty good and the nominal wage is endogenously determined in a bargaining process between a trade union and an employer organization. The main focus is on the impact the revenue-recycling effect has on the wage negotiations and employment. Wage negotiations are analysed using a 'right-to-manage' model. Trade unions and employer organisations bargain over wages and firms then choose the employment level that maximizes profits. Thereby, negotiations may take place on either an industrial or national level. This is an appropriate framework for analysing tax reforms in Europe, as in most European countries over three-quarters of the workforce earn wages that are covered by collective bargaining (cf. Layard et al., 1991).

The model contains three important features. First, there is involuntary unemployment in equilibrium. Second, wages are determined endogenously. Third, we explicitly distinguish between various institutional arrangements existing in the 15 EU member states, concerning the taxation of unemployment benefits, the type of tax exemption, and the price-indexation of unemployment benefits and tax exemptions. It will be shown that these institutional features, which have been largely neglected both in the literature on tax reforms and trade unions,[3] are crucial in terms of how green tax reforms actually work.

The paper is organized as follows. Section 2 gives a brief sketch of the institutional arrangements for unemployment benefit regulations and personal tax exemptions granted to workers in the EU member states. It also presents the basic model for the wage negotiations and provides comparative statics of the tax parameters for various institutional arrangements. Two different types of revenue-neutral green tax reforms are considered. In Section 3 the implications of a revenue-neutral green tax reform, which increases the tax rate on the dirty good and reduces the income tax accordingly, are analysed. Section 4 in turn develops the consequences of increasing the personal tax exemption. Finally, there is a brief conclusion.

2. The model

Consider a small open economy which consists of H households split into two groups. There are N workers and M shareholders. A worker's income consists of labour income if she is employed, and of unemployment benefits, paid by the government, if she is unemployed. Shareholder have internationally diversified portfolios, their total income consists of foreign profits π_f (which are kept

[3] For a rare exception see Bovenberg and van der Ploeg (1994b) and Pissarides (1998) who independently analyse the impact of different types of unemployment benefit indexations in models with alternative assumptions on the functioning of the labour market.

constant throughout the analysis) and domestic profits π. To finance the unemployment benefit payments and a fixed amount of some public goods G, the government imposes a tax t_L on income, and a so-called green tax t_D on the consumption of the dirty good D. Choosing the quantities of all commodities so that all producer prices are equal to unity, we can define a consumer price index P that only depends on the green tax. The partial derivative of the domestic consumer price level with respect to the tax on the dirty good is assumed to be positive, i.e.[4]

$$P_{t_D} > 0. \tag{1}$$

The environmental quality E depends negatively on the consumption of the dirty good D, i.e. $E(D)$, with $E' < 0$.

2.1. Firm behaviour

Firms produce output Q with labour as the only variable input, $Q = f(L)$. As they consider the wage rate and producer prices (normalized to unity) as given, they maximize profit with respect to labour input. The profit maximization of the firms,

$$\max_L \ \pi = Q(L) - wL \tag{2}$$

which, with a strictly concave production function, yields the labour demand function $L = L(w)$ with $L_w < 0$ and the output supply function $Q = Q(w)$ with $Q_w < 0$. The production process applies to the production of clean goods, the dirty good, and the (clean) public good G. In the following we assume that the wage elasticity of labour demand $\delta = -wL_w/L$ is constant.[5]

2.2. Trade union objective function

Trade unions act either on the industry level or on a national level. In the former case, Q represents the aggregate output of the industry; in the latter case, Q denotes the aggregate domestic output. The objective of the trade union is to maximize its members' real income. This consists of the *real after-tax wage*

[4] This assumption holds if the elasticity of substitution between the clean and the dirty goods is finite. If, e.g., preferences are given by a CES utility function, then

$$P_{t_D} = [1 + (1 + t_D)^{1-\sigma}]^{-\sigma/(1-\sigma)}(1 + t_D)^{-\sigma}$$

where σ is the elasticity of substitution between the clean good and the dirty good.

[5] This production function implicitly assumes that there is some fixed factor, e.g., capital, leading to decreasing marginal productivity of labour. Assuming a Cobb–Douglas production technology, e.g., guarantees a constant labour demand elasticity.

income and the real after-tax unemployment benefits. Each worker inelastically supplies one unit of labour if employed, or zero labour if unemployed. In the former case the worker receives a wage income, in the latter case the unemployed member is entitled to unemployment benefits. As the actual form of the objective function depends on the various institutional arrangements, it is worthwhile discussing the variables which determine the trade union behaviour before modelling the labour market completely.

2.2.1. Labour income

The real after-tax wage depends on the nominal wage rate w, the income tax t_L, and the personal tax allowance a which is granted to each taxpayer. The personal tax allowance a may be either nominally fixed or price indexed.[6] If a is nominally fixed, the nominal after-tax wage is given by $w - t_L(w - a) = w(1 - t_L) + t_L a$. If the tax allowance is price indexed, it is given by $w(1 - t_L) + t_L aP$. Countries such as Portugal and Spain grant a tax credit instead of a personal tax allowance. The nominal after-tax wage is then given by $w(1 - t_L) + a$ and $w(1 - t_L) + aP$, respectively. To obtain the real after-tax wage $\tilde{w}$ the nominal after-tax wage has to be divided by the consumer price index P. Column 2 of Table 1 shows the type of tax exemptions granted in the 15 EU member states.

2.2.2. Unemployment benefits

In Europe, we can classify three types of unemployment benefits.[7] Most countries have introduced an unemployment insurance scheme where unemployment benefits are related to past contributions. Usually, unemployment insurance payments are limited to a certain maximum time period of unemployment. Either unemployment assistance or some type of guaranteed minimum income then replaces insurance payments.

In most countries, unemployment insurance is linked to previous gross earnings. An exception is Germany where unemployment benefits are linked to previous net earnings. Payments may be strictly proportional to earnings as e.g. in Belgium and Germany, or may increase linearly with previous earnings, starting from a minimum compensation, as e.g. in Austria and France. In most countries, unemployment benefits are subject to income taxation. In this case

[6] Price indexation may be institutionalized as e.g. in Belgium. It may also be the case that the government increases the personal tax allowance on a regular basis according to the preceding inflation rate as in the U.K.

[7] We focus here on unemployment benefits only. Depending on the availability and attractiveness of other social security contributions such as early retirement or disability benefits, these may be substitutes for unemployment benefits for individuals who become unemployed. In this case, the trade union has to take account of these substitutes and the frequency with which these alternative benefits are used by the unemployed or the government to hide unemployment in the unemployment statistics. For a survey, see Blöndal and Pearson (1995).

the personal tax allowance (tax credit) is granted for the unemployed as well. In Austria, Germany and Portugal, unemployment benefits are exempted from taxation.

As we are interested in price changes and changes in the wage rate, we have to be careful about how price and wage changes interfere with the unemployment benefit payments. In the following we define unemployment benefits b as nominally fixed if they are determined by the wage rate and the income tax, which prevail before a tax reform takes place.[8] Unemployment benefits are determined by $b = \gamma w^0$ if they are proportional to previous gross earnings w^0, and by $b = \gamma w^0(1 - t_L^0)$ if they are proportional to previous net earnings $w^0(1 - t_L^0)$. Unemployment benefits in the U.K., as well as the unemployment assistance in many other countries, are fixed but are adjusted regularly according to the inflation rate. We refer to this as the case of price indexed unemployment benefits. Column 3 of Table 1 summarizes the institutional regulations with respect to the unemployment benefit payments.

Given the stylized facts as presented in Table 1, we distinguish four relevant cases for the 15 EU countries with respect to the nominal after-tax unemployment benefits.

1. *Cases A and A**: If unemployment benefits and the personal tax allowance are nominally fixed as e.g. in France or Germany, the nominal after-tax unemployment benefits are given by $b(1 - \alpha t_L) + \alpha t_L a$, where αt_L denotes the tax rate on unemployment benefits. The standard cases, here case A, always consider $\alpha < 1$, i.e. unemployment benefits are taxed at a lower rate than labour income. Cases with an asterisk here and in what follows consider the limiting case of $\alpha = 1$, where unemployment benefits are taxed at the same rate as labour income. Case A*, e.g., may be relevant for countries with a large income interval for the lowest tax bracket. If workers receive both labour income and unemployment benefits within a fiscal year, the marginal tax rate might be the same for both types of income.

2. *Cases B and B**: In some countries e.g., Belgium or Finland, unemployment benefits are nominally fixed, the personal tax allowance, however, is price indexed. In this case we have $b(1 - \alpha t_L) + \alpha t_L aP$ for the nominal after-tax unemployment benefits.

3. *Cases C and C**: If both unemployment benefits and the personal tax allowance are price indexed, as in the U.K., we have $bP(1 - \alpha t_L) + \alpha t_L aP$.

4. *Cases D and D**: In some countries such as Austria, Denmark, Italy, Portugal and Spain, a tax credit is granted instead of a tax allowance. If b is taxed sufficiently high, a tax credit implies that the same tax exemption applies to employed and unemployed workers. If both unemployment benefits and tax

[8] Bovenberg and van der Ploeg (1994b) refer to this case as nominal wage indexation.

Table 1
Tax exemption and unemployment benefit regulations in the EU

Country	Personal tax allowance, tax credit	Unemployment benefit rules	Case
Austria	Tax credit	(a) Linear indefinite; (b) non-taxable	D
Belgium	Tax allowance, Price indexed	(a) Proportional indefinite; (b) taxable	B
Denmark	Tax credit[1]	(a) Proportional 36/48 months; then fixed; (b) taxable	D
Finland	Tax allowance, Price indexed	(a) Linear 24 months; then fixed; (b) taxable	B
France	Tax allowance	(a) Linear 4–60 months; then fixed; (b) taxable, unemployment tax allowance	A/B
Germany	Tax allowance, Nominally fixed	(a) Proportional indefinite; (b) non-taxable[2]	A
Greece	Tax allowance	(a) Proportional 5–12 months; then fixed; (b) taxable	A/B
Ireland	Tax allowance	(a) Linear 15 months; then fixed; (b) taxable	A/B
Italy	Employment tax credit	(a) Proportional 6 months; (b) taxable, unemployment tax allowance	D
Luxembourg	Tax allowance	(a) Proportional 12–18 months; (b) taxable	A/B
Netherlands	Tax allowance	(a) Proportional 9–60 months; then fixed 24 months; (b) taxable	A/B
Portugal	Tax credit	(a) Proportional 10–30 months;[3] then fixed 5–15 months; (b) non-taxable	D
Spain	Tax credit	(a) Proportional 6–18 months; then fixed; (b) taxable	D
Sweden	Tax allowance	(a) Proportional 60 weeks; then fixed; (b) taxable	A/B
United Kingdom	Tax allowance fixed, but regularly adjusted	(a) Fixed, but regularly adjusted; (b) taxable	C

Sources: OECD (1991): Employment Outlook 1991, Tables 7.2 and 7.3; MISSOC (1996), Soziale Sicherheit in den Mitgliedstaaten der Europäischen Union, Chapters 4, 11 and 12; International Bureau of Fiscal Documentation (1995): European Tax Handbook 1995.
Legend: Unemployment benefits: (a) linear: Unemployment benefits increase linearly with gross earnings; proportional: Unemployment benefits increase proportionately with gross earnings; fixed: Unemployment benefits are fixed; (b) Unemployment benefits are subject to income taxation (taxable) or not (non-taxable); comments: (1) duration depending on age; (2) the tax value of the personal allowance is deducted from the amount of tax, i.e. in effect it is a tax credit; (3) benefits are paid proportional to earnings after tax and social security contributions, i.e. as taxes change so does the unemployment benefit.

credit are nominally fixed, we have therefore $b(1-\alpha t_L)+a$.[9] If taxes paid on unemployment benefits are lower than the tax credit, the unemployed do not pay any taxes. This case can be represented by $\alpha = a = 0$.

Column 4 of Table 1 indicates which of the four cases each country belongs to. Dividing the nominal after-tax unemployment benefits by the consumer price index P yields the real net unemployment benefits $\tilde{b}$.

Having analysed the different real income components, we can specify the objective function of the trade union. Utilitarian trade unions are trying to maximize the real income of all N members. Each member is either employed and receives the real net wage $\tilde{w}$, or is unemployed and receives real net unemployment benefits $\tilde{b}$. The objective function of the trade union can be written as[10]

$$\tilde{V} = (\tilde{w} - \tilde{b})L + \tilde{b}N. \tag{3}$$

Within the bargaining process, the fall-back position of the trade union is given by

$$V^0 = \tilde{b}N, \tag{4}$$

i.e. all members remain at their reservation wage. In what follows we define $V \equiv \tilde{V} - V^0$ as part of the maximand under Nash bargaining representing the trade union's objective function. It should be noted, that one may also consider alternative fall-back positions of the trade union. As is shown in Binmore et al. (1986) within a dynamic context of strategic bargaining the fall-back position depends on the source of the incentive of the bargaining parties to reach an agreement. If the consequence of not reaching an immediate agreement is e.g., a delay of the outcome, the trade union's alternative wage includes income sources during the wage dispute. Some of the members may receive unemployment benefits and the rest strike support. For simplicity and in line with the literature we do not distinguish between strike support and unemployment benefits.[11]

2.3. Wage negotiations between trade unions and employer organizations

Usually, wages are determined in a bargaining process between trade unions and employer organizations. Then firms unilaterally determine employment. As

[9] In what follows, it does not matter whether the tax credit is nominally fixed or price indexed. Therefore, we focus on the former case only.

[10] The use of a linear objective function is for analytical convenience. It is often claimed that trade unions do not care about the level of employment if lay-offs follow an inverse seniority rule. In this case the objective function of the trade union would reduce to $\tilde{V} = \tilde{w}$ (cf. Oswald, 1993).

[11] Trade unions have strike funds which are accumulated by contributions from members in earlier periods. To analyse their determinations, however, would require a dynamic model which lies beyond the scope of the present paper.

we assume a small open economy the model allows us to analyse both wage negotiations which take place at the industry level as e.g., in the Benelux countries, and wage negotiations on a national level as e.g., in the Scandinavian countries.[12] In the following we use a 'right-to manage' model which represents the outcome of the bargaining by an asymmetric Nash bargaining with β representing the bargaining power of the trade union.[13] Assuming that the threat point of the employer organization is zero, the Nash bargaining maximand can be written as

$$\Omega = (\tilde{V} - V^0)^{\beta}\pi^{1-\beta}, \tag{5}$$

where the objective functions are defined by Eqs. (2)–(4).[14] Note that for $\beta = 1$ the model reduces to the case of a monopoly union.[15] Using $V \equiv \tilde{V} - V^0$, the first-order condition with respect to nominal wage is

$$\Omega_w = 0 \Leftrightarrow \beta \frac{V_w}{V} + (1-\beta)\frac{\pi_w}{\pi} = 0, \tag{6}$$

where variables with subscripts refer to partial derivatives (e.g., $V_w = \partial V/\partial w$). Provided that $\Omega_{ww} < 0$, Eq. (6) defines the negotiated nominal wage from Nash bargaining as a function of t_L, a, b, and t_D so that

$$w = w(t_L, a, b, t_D). \tag{7}$$

All these parameters affect Eq. (6) only via the first term of the right-hand side of Eq. (6) so that for parameter $\Psi = t_L, a, b, t_D$

$$\text{sign}\,(w_\Psi) = \text{sign}\,(\Omega_{w\Psi}) = \text{sign}\,(VV_{w\Psi} - V_w V_\Psi). \tag{8}$$

2.4. Comparative statics

In the following we will analyse how the negotiated nominal wage reacts to changes in taxes, the unemployment benefits, and the personal tax exemption. The trade union tries to maximize the rent, i.e. the surplus of real wages over real

[12] For a survey of the wage bargaining situation in the OECD countries, see Layard et al. (1991, p. 517ff).

[13] This approach can be justified either axiomatically (cf. Nash, 1950), or strategically (cf. Binmore et al., 1986).

[14] The following results are not affected if, alternatively, the managers of the firms maximize the real after-tax profit they pay to their share owners. Assuming that the foreign profits π_f the M share owners receive exceed the sum of personal tax allowances, from the viewpoint of a single firm or a centralized employer organization the relevant objective function to be considered in the Nash-bargaining maximand is real after-tax profit $\tilde{\pi} = (1 - t_L)\pi/P$. Of course, as was pointed out by one referee, this is only true for a small open economy as considered here. If wage negotiations affect the output price, the representation of the shareholder preferences becomes important.

[15] Cf. Oswald (1985) or Creedy and McDonald (1991). Note that in the monopoly union case, but not in the 'right-to-manage' model, labour demand elasticity has to exceed unity.

unemployment benefits. The calculations for the comparative statics results, presented in Table 2, are given in Appendix A.

If $\alpha < 1$, an increase in the income tax will lead to an increase in the nominal wage (cf. Eqs. (10-I) in Table 2). The wage surplus, lost by those dismissed, declines at a higher percentage than the benefits for those who remain in employment. It becomes profitable for the union to bargain for a higher nominal wage because the possible increase in labour income of those employed more than outweighs the income loss of those workers who are laid off.

This result holds only if unemployment benefits are taxed at a lower rate than labour income. If unemployment benefits are subject to the same tax rate, as in the limiting cases with $\alpha = 1$, the marginal net real wage income for the trade union and the net real unemployment benefits change by the same amount when the labour tax rate changes. This leaves the first-order condition of the bargaining solution unchanged. The labour tax rate has no effect on the optimal nominal wage.

Result 1. A rise in the labour income tax (i) will increase the nominal wage if the unemployment benefits are taxed at a lower rate than labour income, but (ii) will have no effect when unemployment benefits are taxed at the same rate as labour income.

An increase in the personal tax allowance a reduces the optimal nominal wage if $\alpha < 1$. Employed workers benefit more than unemployed workers as the differential $(1 - \alpha)t_L a$ can be interpreted as a subsidy on labour. This induces the trade union to accept a lower nominal wage as the marginal worker can now gain more from working than those already employed will lose from the necessary nominal wage reduction. If unemployment benefits are subject to the same tax rate, $\alpha = 1$, the personal tax allowance works like a lump-sum transfer to all members of the trade union. This leaves the arbitrage condition for the bargaining solution unchanged. Formally, both the objective function and the fall-back position of the trade union increase by the same amount.

Result 2. An increase in the personal tax allowance (i) will decrease the nominal wage if the unemployment benefits are taxed at a lower rate than labour income, but (ii) will have no effect when unemployment benefits are taxed at the same level as labour income.

If a represents a tax credit and if the tax payments of an unemployed exceeds the tax credit, a tax credit is also equivalent to a lump-sum transfer granted to all members of the trade union (case D).

Result 3. An increase in the personal tax credit will have no effect on the nominal wage, given that the taxes paid on unemployment benefits exceed the tax credit.

Table 2
Comparative statics of the nominal wage rate with Nash bargaining

	Cases A and A*	Cases B and B*	Cases C and C* $0 \leq \alpha < 1$	Cases D and D*
	Unemployment benefits and the personal tax allowance are nominally fixed $A: 0 \leq \alpha < 1$ $A^*: \alpha = 1$ France, Germany, Greece, Ireland, Luxembourg, Netherlands, Sweden	Unemployment benefits are nominally fixed, the personal tax allowance is price indexed $B: 0 \leq \alpha < 1$ $B^*: \alpha = 1$ Belgium, Finland	Unemployment benefits and personal tax allowances are price indexed $C: 0 \leq \alpha < 1$ $C^*: \alpha = 1$ United Kingdom	Unemployment benefits and the personal tax credit are nominally fixed $D: 0 \leq \alpha < 1$ $D^*: \alpha = 1$ Austria, Denmark, Italy, Portugal, Spain
Objective function for the trade union V (9-I) [(3-I)–(4-I)]	$V = \frac{1}{P}[(1-t_L)w + t_L a]L$ $-\frac{1}{P}[b(1-\alpha t_L P) + \alpha t_L a]L$	$V = \frac{1}{P}[(1-t_L)w + t_L aP]L$ $-\frac{1}{P}[b(1-\alpha t_L) + \alpha t_L aP]L$	$V = \frac{1}{P}[(1-t_L)w + t_L aP]L$ $-\frac{1}{P}[bP(1-\alpha t_L) + \alpha t_L aP]L$	$V = \frac{1}{P}[(1-t_L)w]L$ $-\frac{1}{P}[(1-\alpha t_L)b]L$
(10-I)	$A: w_{t_L} > 0$ $A^*: w_{t_L} = 0$	$B: w_{t_L} > 0$ $B^*: w_{t_L} = 0$	$C: w_{t_L} > 0$ $C^*: w_{t_L} = 0$	$D: w_{t_L} > 0$ $D^*: w_{t_L} = 0$
(11-I)	$w_{t_D} = 0$	$B: w_{t_D} < 0$ $B^*: w_{t_D} = 0$	$w_{t_D} > 0$	$w_{t_D} = 0$
(12-I)	$A: w_a < 0$ $A^*: w_a = 0$	$B: w_a < 0$ $B^*: w_a = 0$	$C: w_a < 0$ $C^*: w_a = 0$	$w_a = 0$

Finally, consider a change in the tax on the dirty good. A higher tax increases the consumer price level – see Eq. (1) – and therefore influences real wages, real unemployment benefits and so on. If both unemployment benefits and the personal tax exemption are nominally fixed (cases A and D), all relevant variables are devalued by an increase in t_D. The arbitrage calculus of the bargaining solution remains unchanged. The same is true if $\alpha < 1$, as in this case the personal tax allowance does not enter the objective function. If unemployment benefits are nominally fixed but the personal tax allowance is price indexed (case B), the personal tax allowance remains constant in real terms while the wage rate devalues. The mechanism works in the same way as an increase in nominal personal tax allowances. If $\alpha < 1$, working becomes more attractive and the trade union will be willing to accept a lower nominal wage. As this is the only effect in case B, we have the paradoxical case that an increase in the consumer price level moderates wages.

If, however, unemployment benefits are also price indexed, there is a countervailing effect. As the latter effect dominates the former, the trade union will go for a higher nominal wage (case C).

Result 4. If the unemployment benefits are taxed at a lower rate than labour income, an increase in the tax on the dirty good will (i) increase the nominal wage if the unemployment benefits are price indexed, (ii) leave the nominal wage unchanged if unemployment benefits and personal tax allowances are nominally fixed, (iii) lower the nominal wage if the unemployment benefits are nominal fixed while the personal tax allowance is price indexed.

Note that the results hold even if the trade union is not interested in the level of employment, i.e. if its objective function is given by $\tilde{V} = \tilde{w}$ and hence $V = \tilde{w} - \tilde{b}$ (cf. Appendix B). As is shown in Oswald (1993), this may represent a trade union's objective function when lay-offs will be by inverse seniority within the firm.

Finally, note that an increase in the unemployment benefits, which increases the benefit–replacement ratio, makes the outside option for the trade union members more attractive. It becomes more profitable to bargain for a higher nominal wage. In all cases we have $w_b > 0$ (cf. Oswald, 1985).

In the next sections we will use the comparative static results to analyse revenue-neutral green tax reforms. Section 3 considers the case where additional revenues from increasing green taxes are recycled by reducing taxes on labour income. Section 4 will analyse the case where the additional tax revenues are used to increase the personal tax allowance or the personal tax credit, respectively.

3. Revenue-neutral green tax reform I: Reducing the income tax

We can now analyse a revenue-neutral green tax reform which increases the tax on the dirty good and reduces the income tax correspondingly. The focus is on a comprehensive income tax t_L levied on both labour income and profit income. Revenue neutrality means that the government keeps the public good provision G constant. For case A, e.g., the government budget is given by

$$G = t_L(wL + \pi_f + \pi) + t_D D - (1 - \alpha t_L)b(N - L) - t_L a[M + L + \alpha(N - L)]. \tag{13A}$$

In general, a revenue-neutral green tax reform is described by

$$\mathrm{d}G = G_{t_L}\,\mathrm{d}t_L + G_{t_D}\,\mathrm{d}t_D + G_w\,\mathrm{d}w = 0, \tag{14}$$

where $\mathrm{d}w$ is determined by the reaction of the Nash bargaining solution to the tax rate changes. From the analysis of wage negotiation we know that the reaction of the nominal wage to a green tax reform is given by

$$\mathrm{d}w = w_{t_L}\,\mathrm{d}t_L + w_{t_D}\,\mathrm{d}t_D. \tag{15}$$

Substituting the RHS of Eq. (15) into Eq. (14) yields

$$\mathrm{d}G = G^*_{t_L}\,dt_L + G^*_{t_D}\,\mathrm{d}t_D = 0. \tag{16}$$

Here $G^*_{t_L}$ and $G^*_{t_D}$ denote the marginal tax revenues from the income tax and the tax on the dirty good, respectively, taking account of the impact tax rate changes have on the wage bargaining. Assuming that we are on the Laffer-efficient side of both tax revenue curves is equivalent to assuming that the marginal tax revenues of both taxes are positive, i.e.[16]

$$G^*_{t_L} > 0, \quad G^*_{t_D} > 0. \tag{17}$$

Using conditions (16) and (17), we have $\mathrm{sign}(\mathrm{d}t_L) = -\,\mathrm{sign}(\mathrm{d}t_D)$ for a revenue-neutral green tax reform. For the cases A, B, D, and in all limiting cases, the employment effects can easily be worked out from Eq. (15), see Table 3.

Proposition 1. A revenue-neutral green tax reform, which reduces the income tax rate, will increase employment if unemployment benefits are nominally fixed and taxed at a lower rate than labour income ($\alpha < 1$).

[16] While the first condition is quite reasonable as the income tax is imposed in order to raise tax revenues, we should point out that the second condition might not hold. If the environmental damage caused by the consumption of the dirty good is high, the government may be forced to levy such a high green tax that marginal tax revenues may actually become negative. Except for case B, a revenue-neutral green tax reform will never boost employment if the marginal tax revenue of a green tax is negative.

Table 3
Employment effects of a revenue-neutral green tax reform which reduces the income tax rate

Case	Changes in nominal wage	Employment effect
A, D	$dw = \underset{+}{w_{t_L}}\,\underset{-}{dt_L} < 0$	$dL > 0$
B	$dw = \underset{+}{w_{t_L}}\,\underset{-}{dt_L} + \underset{-}{w_{t_D}}\,\underset{+}{dt_D} < 0$	$dL > 0$
C	$dw = \underset{+}{w_{t_L}}\,\underset{-}{dt_L} + \underset{+}{w_{t_D}}\,\underset{+}{dt_D} \{\gtreqless\} 0$	?
A*, B*, D*	$dw = 0$	$dL = 0$
C*	$dw = \underset{+}{w_{t_D}}\,\underset{+}{dt_D} > 0$	$dL < 0$

Due to the reduction in the income tax, net wage income increases while net unemployment benefits remain constant. Hence it becomes profitable for the trade union to bargain for a lower nominal wage because the loss in wage income for all workers is more than outweighed by the gain from hiring more workers. As the nominal wage is not affected by changes in t_D, there is no countervailing effect in cases A and B.

In the limiting cases, where unemployment benefits are taxed at the same rate, the real after-tax wage for the trade union and the real after-tax unemployment benefits change proportionately, leaving the first-order conditions for the bargaining solution unchanged. Hence, an income tax cut has no effect on the optimal nominal wage or on employment and the results depend on the effect the green tax has on the wage negotiations only (for an interpretation see Section 2.4).

Proposition 2. If unemployment benefits are taxed at the same rate as labour income ($\alpha = 1$), *a revenue-neutral green tax reform, which reduces the income tax rate, will have no effect on employment if unemployment benefits are nominally fixed. It will reduce employment, if unemployment benefits are price indexed.*

The result for the case C is not that clear-cut. The reason for this ambiguity result lies in the fact that both the income tax and the green tax have a positive effect on nominal wages and thus a negative effect on employment. The revenue-neutral effects of a tax shift therefore depend upon their relative magnitudes. After some calculations, given in Appendix C, we obtain the following condition for case C:

$$\left.\frac{dL}{dt_D}\right|_{dG=0} \{\gtreqless\}\, 0 \Leftrightarrow \frac{\tau_{t_D}}{\tau_{t_L}} \{\gtreqless\} \frac{\varepsilon_{t_D}}{\varepsilon_{t_L}}, \tag{18}$$

where $\varepsilon_{t_L} = w_{t_L} t_L / w$ and $\varepsilon_{t_D} = w_{t_D} t_D / w$ denote the income tax elasticity and green tax elasticity of nominal wages, respectively; $\tau_{t_L} = (\partial G / \partial t_L) t_L / G$, and

$\tau_{t_D} = (\partial G/\partial t_D)t_D/G$ denote the income tax elasticity and green tax elasticity of tax revenues, respectively.

The ratio of the left-hand side indicates at what percentage the income tax has to decrease so that the public good provision G remains constant. The ratio of the right-hand side denotes the percentage the income tax has to decline to keep the nominal wage constant. If the revenue-neutrality requirement allows the government to cut the income tax at a higher (lower) rate than necessary to sustain the nominal wage, wage negotiations will lead to lower (higher) wages and will increase (decrease) employment accordingly.

Proposition 3. If unemployment benefits are price indexed, a revenue-neutral green tax reform, which reduces the income tax rate, will boost employment if the ratio of the tax revenue elasticities as given in Eq. (18), is larger than the ratio of the nominal wage elasticities.

Given the stylized facts presented in Table 1, Proposition 3 is relevant for the U.K. only. To some extent, however, it may also be relevant for other countries because the long-term unemployment benefits are often price indexed as they are determined by the minimum existence level to be sustained.

4. Revenue-neutral green tax reform II: Increasing the personal tax allowance or the personal tax credit

Instead of reducing the income tax, the government may also increase the tax exemption. Proceeding as in Section 3, we can derive the condition for the revenue-neutral green tax reform, where the personal tax allowance or the personal tax credit are increased:

$$\mathrm{d}G = G_a^* \mathrm{d}a + G_{t_D}^* \,\mathrm{d}t_D = 0. \tag{19}$$

G_a^* and $G_{t_D}^*$ now denote the marginal tax revenues from increasing the personal tax allowance and the tax on the dirty good, respectively. The assumption that we are on the Laffer-efficient side implies that the marginal tax revenue of an increase in the personal allowance is negative, while the marginal tax revenue of the tax on the dirty good is positive, i.e.

$$G_a^* < 0, \quad G_{t_D}^* > 0. \tag{20}$$

Using conditions (19) and (20) a revenue-neutral green tax reform has the property $\mathrm{sign}(\mathrm{d}t_D) = \mathrm{sign}(\mathrm{d}a)$. Table 4 summarizes the employment effects for the various institutional arrangements.

As the comparison of Tables 3 and 4 shows, a revenue-neutral green tax reform which increases the personal tax allowance yields the same qualitative results as a reduction of the income tax (cases A, B, C) so that we can formulate

Table 4
Employment effects of a revenue-neutral green tax reform which increases the personal tax allowance or the personal tax credit

Case	Changes in nominal wage	Employment effect
A	$\underset{-}{dw} = \underset{-}{w_a}\ \underset{+}{da} < 0$	$dL > 0$
B	$\underset{-}{dw} = \underset{-}{w_{t_D}}\ \underset{+}{dt_D} + \underset{-}{w_a}\ \underset{+}{da} < 0$	$dL > 0$
C	$\underset{+}{dw} = \underset{+}{w_{t_D}}\ \underset{+}{dt_D} + \underset{-}{w_a}\ \underset{+}{da}\ \{\gtrless\} 0$	?
D	$dw = 0$	$dL = 0$
A*, B*, D*	$dw = 0$	$dL = 0$
C*	$\underset{+}{dw} = \underset{+}{w_{t_D}}\ \underset{+}{dt_D} > 0$	$dL < 0$

Proposition 4. A revenue-neutral green tax reform which increases the personal tax allowance will affect employment qualitatively in the same way as a revenue-neutral green tax reform which reduces the income tax rate.

Though the results are qualitatively the same as in the case of reducing the income tax, they differ quantitatively. To see this, we will split a green tax reform that increases the personal tax allowance into two succeeding tax reforms. First, we increase the green tax and reduce the income tax accordingly. Then, in a second step, we undo the reduction of the income tax and increase the personal tax allowance accordingly. This can be interpreted as an increase in the progressivity of the tax system. As Koskela and Vilmunen (1996) have shown, increasing progressivity in a revenue-neutral way will increase employment in popular models of trade union behaviour including the 'right-to manage' model (see also Holm and Koskela, 1997). An increase in progression moderates wages because it acts as a tax on wage increases. This result is not only a theoretical possibility but has also received an increasing amount of supporting empirical evidence.[17]

[17] This result cannot be seen directly from the calculations presented here. A revenue-neutral increase in progression will affect the nominal wage via the negative substitution effect so that the nominal wage falls and employment is boosted. For empirical evidence in Italy, see Malcomson and Sartor (1987); for the U.K., Lockwood and Manning (1993); for Sweden, Holmlund and Kolm (1995); and for Finland, Tyrväinen (1995).

Corollary 4. A revenue-neutral green tax reform will generally be more successful with respect to reducing unemployment if it rebates green tax revenues via increasing the personal tax allowance instead of reducing the income tax.

For countries where a personal tax credit is granted, Proposition 4 does not hold. As has been pointed out in Section 2, the nominal wage is not affected by a change in the tax credit as a tax credit is equivalent to a lump-sum transfer to all members of the trade union (given that $b\alpha t_L > a$). Hence, as unemployment benefits are nominally fixed in all countries that grant a tax credit instead of a tax allowance, employment remains constant as both the change in the tax credit and the change in the green tax do not affect wage negotiations.

Proposition 5. A revenue-neutral green tax reform which increases the personal tax credit will never have a positive effect on employment. It will be negative if unemployment benefits are price indexed.

Proposition 5 is important in showing that the question of how green tax revenues are rebated matters in countries such as Austria, Denmark, Italy, Portugal and Spain. If the decision is whether to rebate green tax revenues via a cut in the income tax or via an increase in the tax credit, only the former policy increases employment.

5. Concluding remarks

The paper analyses the employment effects of a green tax reform in a unionized labour market by focusing on the revenue-recycling effect. The model contains three important features which have not received enough attention in the literature. First, there is involuntary unemployment in equilibrium. Second, wages are endogenously determined in a bargain between trade unions and employers. Third, a distinction is made between various institutional arrangements concerning taxation of unemployment benefits, the type of tax exemption, price indexation of unemployment benefits and tax exemptions. Using the 'right-to-manage' model as the framework of analysis we have considered two different revenue-neutral green tax reforms: a rebate of green tax revenues via a reduction in labour taxes and a rebate via an increase in personal tax allowance or personal tax credit, respectively.

The main findings are as follows. First, the qualitative results are sensitive to institutional arrangements concerning taxation and indexation of unemployment benefits and the personal tax allowance. A revenue-neutral green tax reform will boost employment if unemployment benefits are nominally fixed and taxed at a lower rate than labour income. If unemployment benefits are price

indexed, however, there is a negative effect on employment as a higher consumer price level increases nominal wages. Employment effects are indeterminate if unemployment benefits are price indexed and taxed at a lower rate than labour income. Employment actually falls if unemployment benefits are price indexed and taxed at the same rate as labour income.

Second, the employment effects of a revenue-neutral green tax reform are not sensitive to the question of whether green tax revenues are rebated via a cut in income taxes or an increase in the personal tax allowance – though the increase in personal tax allowances will increase employment more than the reduction in income taxes does. They are sensitive, however, in countries where tax credits are granted. In these countries, only a cut in the income tax lowers unemployment.

When employment is boosted, the tax burden is shifted away from labour income towards other income groups. In particular, if the indirect taxes increase, income from capital gains, savings or rents as well as income from social transfers bear a larger share of the tax burden.[18] More fundamentally, however, the change in the benefit–replacement ratio – the ratio between the after-tax real unemployment benefits and the after-tax real wage rate – rules the roost. It is the benefit–replacement ratio which decreases if the green tax reform succeeds in boosting employment.

Often it is stated that a green tax reform reaps a double dividend in the form of alleviating unemployment and improving environmental quality. Environmental quality, however, is affected by such a tax reform in two ways. First, an increase in the tax rate of the dirty good will affect the consumption of the dirty good negatively. Second, an increase in nominal income will lead to higher consumption, provided that the dirty good is a normal good. Intuitively, the environment improves if the substitution effect due to the change in relative consumer prices more than outweighs the positive income effect. The larger the employment effect is, however, the larger is the output change and the income effect, respectively. Thus these might be a trade-off between the environmental dividend and the employment dividend (cf. Schöb, 1996). This indicates that there is no free lunch, as obtaining a higher level of environmental quality goes along with a smaller employment effect.

[18] This effect is also pointed out in Bovenberg and van der Ploeg (1995). In their approach, however, the tax burden is shifted to transfer income only while in our model the burden of the green tax is also borne by profit income. The shift of the tax burden away from labour will become even stronger if the tax reduction is restricted to labour specific charges (e.g., unemployment insurance contributions) or labour specific tax allowances.

Concluding in terms of policy recommendations, our analysis suggests that there are good reasons for arguing that green tax reforms can alleviate unemployment by shifting the tax burden away from labour towards other income groups, or to put it in a more fundamental way, by decreasing the benefit-replacement ratio. However, as we have stressed, in order to be successful, green tax reforms require certain institutional arrangements concerning the taxation and price-indexation of unemployment benefits and the type of tax exemption granted.

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Appendix A. Some comparative statics of Nash bargaining

The following appendix shows some calculations which are necessary to understand the results of the comparative statics presented in Table 2. We proceed case by case.

*Cases A and A**: The partial derivative of the objective function (9-A), presented in Table 2, with respect to the nominal wage is given by

$$V_w = \frac{1}{P}\frac{L}{w}\left[(1-t_L)w(1-\delta) + [(1-\alpha t_L)b - (1-\alpha)t_L a)]\delta\right] \tag{A.1}$$

with δ being the wage elasticity of labour demand. Straightforward calculations utilizing Eq. (8) yield the partial derivatives as given in Table 2. In particular,

we obtain

$$\text{sign}\,(w_{t_L}) = \text{sign}\,(VV_{wt_L} - V_w V_{t_L}) = \text{sign}\,[(1-\alpha)(b-a)] \tag{A.2}$$

and

$$\text{sign}\,(w_a) = \text{sign}\,(VV_{wa} - V_w V_a) = -\,\text{sign}\,[(1-t_L)t_L(1-\alpha)]. \tag{A.3}$$

*Cases B and B**: The partial derivative with respect to the nominal wage is given by

$$V_w = \frac{1}{P}\frac{L}{w}[(1-t_L)w(1-\delta) + (1-\alpha t_L)b\delta]. \tag{A.4}$$

Straightforward calculations, similar to case A, yield the results presented in Table 2.

*Cases C and C**: The partial derivative with respect to the nominal wage is given by

$$V_w = \frac{1}{P}\frac{L}{w}[(1-t_L)w(1-\delta) + [(1-\alpha t_L)bP - (1-\alpha)t_L aP)]\delta]. \tag{A.5}$$

Comparative statics is similar to the cases A and A* with the exception that

$$\begin{aligned}\text{sign}\,(w_{t_D}) &= \text{sign}\,(VV_{wt_D} - V_w V_{t_D}) \\ &= \text{sign}\,[P_{t_D}[b(1-\alpha t_L) - (1-\alpha)t_L a]\,] > 0.\end{aligned} \tag{A.6}$$

*Cases D and D**: The partial derivative with respect to the nominal wage is given by

$$V_w = \frac{1}{P}\frac{L}{w}[(1-t_L)w(1-\delta) + (1-\alpha t_L)b\delta]. \tag{A.7}$$

Comparative statics are similar to the case A with the exception that

$$\text{sign}\,(w_a) = \text{sign}\,(VV_{wa} - V_w V_a) = 0 \quad \forall \alpha \in [0;1]. \tag{A.8}$$

Appendix B. Comparative statics in a seniority model

If lay-offs follow some type of seniority rule, the trade union will act as though it were locally indifferent to the level of employment (cf. Oswald, 1993, p. 87). In our model the Nash maximand for case A then becomes

$$\Omega = \left[\frac{(1-t_L)w + (1-\alpha)t_L a - b(1-\alpha t_L)}{P}\right]^{\beta}\pi^{1-\beta}. \tag{B.1}$$

Using Eq. (8), straightforward calculations show that

$$VV_{wt_L} - V_w V_{t_L} = (1-\alpha)(b-a)/P^2 > 0 \Leftrightarrow w_{t_L} > 0, \tag{B.2}$$

$$VV_{wt_D} - V_w V_{t_D} = 0 \Leftrightarrow w_{t_D} = 0, \tag{B.3}$$

$$VV_{wa} - V_w V_a = (1-t_L)(1-\alpha)t_L/P^2 > 0 \Leftrightarrow w_a > 0. \tag{B.4}$$

The other cases can be proved analogously. A complete set of results is available from the authors upon request.

Appendix C. Derivation of the change in nominal wage for case C

Appendix C gives the calculations for deriving condition (18). Extending the revenue-neutrality condition (16) yields

$$\frac{\mathrm{d}G}{G} = \frac{G^*_{t_D} t_D}{G}\frac{\mathrm{d}t_D}{t_D} + \frac{G^*_{t_L} t_L}{G}\frac{\mathrm{d}t_L}{t_L} = 0 \tag{C.1}$$

and, by rearranging and using the definition given in Section 3, we obtain the following condition:

$$\frac{\mathrm{d}G/G}{\mathrm{d}t_D} = 0 \Leftrightarrow -\frac{\mathrm{d}t_L/t_L}{\mathrm{d}t_D/t_D} = \frac{\tau_{t_D}}{\tau_{t_L}}. \tag{C.2}$$

Condition (C.2) shows for a 1% increase in the green tax, at which percentage the income tax has to decrease to meet the revenue-neutrality requirement.

Analogously, we can derive the following condition for changes of the nominal wage [from Eq. (16)]:

$$\frac{\mathrm{d}w/w}{\mathrm{d}t_D} \left\{\gtreqless\right\} 0 \Leftrightarrow \frac{\mathrm{d}t_L/t_L}{\mathrm{d}t_D/t_D} \left\{\gtreqless\right\} -\frac{\varepsilon_{t_D}}{\varepsilon_{t_L}}. \tag{C.3}$$

Substituting condition Eq. (C.2) in Eq. (C.3) and using $L_w < 0$ yields condition (18).

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