Green Tax Reform and Competitiveness

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Abstract:

This paper develops a model of a small open economy that produces an export good with domestic labour and imported energy and is stuck in an unemployment situation resulting from an excessive fixed net-of-tax wage rate. We study a revenue-neutral green tax reform that substitutes energy for wage taxes. A moderate green tax reform will boost employment, improve welfare and increase the economy's competitiveness. The driving force behind these results is the technological substitution process that a green tax reform will bring about by inducing the producers to substitute labour for energy as factors of production. The resulting reduction in unemployment is welfare increasing since energy, which the country has to buy at its true national opportunity cost, is replaced with labour, whose price is above its social opportunity cost. As long as the labour tax rate exceeds the resource tax rate, a revenue-neutral green-tax reform will reduce the domestic firms' unit cost of production and hence increase international competitiveness and output of the economy.

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1. Introduction

Western Europe is in a difficult phase today. The increasing speed of globalization and the fall of the Iron Curtain have confronted it with a wave of low-wage competitors that threaten the stability of its labour markets. Just 100 kilometers east of Berlin and Vienna, and south of Helsinki there are new competitors whose labour costs are in the order of one fifth or one tenth of western wages. To preserve the competitiveness of western Europe, the new competition would necessitate wage cuts in the west, but existing labour market institutions do not appear to have the necessary wage flexibility. Insider employees and workers have successfully defended their income positions at the expense of a growing number of unemployed. Unemployment rates in western Europe are on average above 10 % with peaks of 20% and more in disadvantaged regions.

The situation has been exacerbated by the growing labour tax burden that has been a feature of European development in the last two decades.[1] In Germany, for example, since 1975 the revenue from labour income taxes has increased from 32% to 37% of the government tax revenue. Indirect wage costs, such as pension contributions and health insurance premia have also risen because of the ageing population and the new possibilities for medical treatment. Part of the rise in unemployment and falling competitiveness can be attributed to these factors.

The first-best solution to the problem of Europe's fading competitiveness would be wage cuts accompanied by compensation of the insider workers, for example in the form of company shares.[2] However, such a solution may be too radical to gain the approval of unions and employers' organisations. The paper therefore studies a second-best solution.

This second-best solution is a green tax reform that shifts some of the economy's tax burden from labour to energy taxes. Such a reform has long been proposed by economists[3] and has also found some political support. However, it has also been criticized on the grounds that

[1] Cf. OECD (1995).
[2] See Sinn (1998).
[3] The references date back to Binswanger et. al (1983).

it might exacerbate the labour market distortions (Bovenberg and de Mooij 1994), violate the conditions of optimal taxation (Richter and Schneider 1998) or diminish a country's international competitiveness (cf. e.g. Handelsblatt No. 205 October 23/24 1998, p. 1).

This paper supports a green tax reform. We develop a model of an open economy that produces an export good with domestic labour and imported energy and is stuck in an unemployment situation that results from an excessive fixed net-of-tax wage rate. We study a revenue-neutral green tax reform that substitutes energy for wage taxes and induces the producers to substitute labour for energy as factors of production. We show that a moderate reform of this sort will be able to reduce the firms' unit production costs and increase the economy's competitiveness. We also show that employment, national income and national welfare will increase provided only that there is no shortage of labour supply and that the reform is not so radical that it increases the firms' unit costs beyond their original level. We will compare our results with more sceptical ones reached in the literature.

The usual argument in favour of green tax reform is that it internalizes negative externalities and induces private market agents to take properly into account the environmental damage they cause. To sharpen our presentation we fully abstract from this argument. Green considerations in the narrower sense of the word would only strengthen our policy conclusions.

The paper does not use optimal tax arguments, and its results are not based on a monopolistic or monopsonistic exploitation of the rest of the world by using the national tax policy to improve the country's terms of trade. Instead, its driving force is the technological substitution process that a green tax reform will bring about. The substitution is welfare increasing since energy, which the country has to buy at its true national opportunity cost, is replaced with labour, whose price is above its opportunity cost. If the terms of trade will change, they will exacerbate and help improve welfare in the rest of the world in addition to improving the one at home.

2. The Model

Our model satisfies the usual resource constraint of an open economy

$$Y = C + G + pX - M \tag{1}$$

where Y, C, G, X and M denote income, private consumption, public consumption, exports, and imports, and p is the price of export goods in terms of a produced import good which serves for public and private consumption. We will identify p with the economy's "terms of trade". There is another import good R, a "natural resource", called "energy", which is available at a fixed price q, again defined in terms of the imported consumption good, so that

$$M = C + G + qR. \tag{2}$$

The economy is perfectly specialized in the production of X which is carried out with labour L and energy R according to a well-behaved linear homogeneous production function:

$$X = f(L, R).$$

The terms of trade are a declining isoelastic function of the economy's output volume

$$p(X) = kX^{-1/\varepsilon}, \tag{3}$$

where ε is the absolute value of the price elasticity of demand and k is a shift parameter; ε and k may depend on the preferences of foreign consumers and the prices charged by (imperfect) foreign competitors.

Inside the economy there is perfect competition in all markets, but not necessarily price flexibility. The representative firm adjusts to given wage and energy costs $\tilde{w}$ and $\tilde{q}$ so as to maximize its profits. In equilibrium it will therefore be true that the factor costs equal the respective marginal value products,

$$pf_L = \tilde{w}, \quad pf_R = \tilde{q},$$

with f_i denoting the partial derivative of $f(L,R)$, and that the factor rewards exhaust the value of output,

$$pX = \tilde{w}L + \tilde{q}R. \tag{4}$$

The wage and energy costs are defined gross of ad-valorem labour and resource tax rates t_w and t_q such that

$$\tilde{w} = w(1+t_w) \tag{5}$$

and

$$\tilde{q} = (1+t_q)q, \tag{6}$$

where w is the net-of-tax wage rate and q is the fixed world price of energy as introduced above. The government budget constraint satisfies the equation

$$G = t_w wL + t_q qR. \tag{7}$$

Throughout the analysis we will confine our attention to revenue-neutral tax reforms so that G is a constant.

We will focus the analysis on the impact of a green tax reform on employment, national income, welfare, and competitiveness. The notion of employment is straightforward: it is measured by L. The definition of national income, Y, is given by equation (1). It follows from (1), (2), and (4)-(7) that national income equals net-of-tax labour income plus the government tax revenue which is equal to public consumption:

$$Y = wL + G.$$

Income is not welfare because work absorbs leisure. We assume that welfare is given by the representative household's quasi-linear utility function

$$U(Y,L) = Y - v(L) \tag{8}$$

where $v(L)$, $v' > 0$, $v'' > 0$ is the utility of leisure lost when working. A cleared labour market would be characterized by $v' = w$. However, for the reasons explained in the introduction we assume throughout the analysis that there is involuntary unemployment in the sense that

$$w = const. > v'(L),$$

because the labour markets are unable to adjust to an exogenous shock that has produced this unemployment.[4] In the model, the shock may have been a sudden and irrevocable increase in the shift parameter k in the country's demand curve (3) which would have required an accommodating wage cut to reach a new equilibrium.

The final definition refers to the notion of competitiveness. Competitiveness is not an end in itself but is a useful notion for understanding the reaction to a country's policy moves. In line with Alesina and Perotti (1997), we measure competitiveness by the negative of the unit production cost of its exports. In general the production cost is a function of the gross-of-tax factor prices and the output level, $C(\tilde{w}, \tilde{q}, X)$. With our linear-homogeneous production function we have

$$C(\tilde{w}, \tilde{q}, X) = c(\tilde{w}, \tilde{q})X. \tag{9}$$

where c is the unit production cost. The lower c, the more can the country sell in the world market for X, and the higher is its competitiveness.

3. A Comparison of Two Tax Systems

European tax systems are characterized by high taxes on labour and low ones on energy. Let t_w^A and t_q^A, $t_w^A > t_q^A$, be the respective model tax rates. Given the net-of-tax factor prices w and q, these tax rates establish an equilibrium that is characterized by unique values of employment

[4] We assume throughout that the net-of-tax wage is constant. See Koskela, Schöb and Sinn (1998) for its justification in the union bargaining context.

L^A, energy input R^A, and output X^A. We call this equilibrium a "labour-tax regime". Similarly we call an equilibrium with $t_w^B < t_q^B$ a "green-tax regime".

Our analysis focuses on reforms that move the economy from a labour-tax regime to a green-tax one. While the next section will analyze piecemeal reforms of this type, this section considers a radical reform that replaces one system by the other. The question is whether it is possible to design a green-tax system that does not affect the economy's competitiveness and will therefore result in the same production cost and the same output as the labour-tax system, but generates higher employment.

It is easy to show by means of Figure 1 why the answer to this question is affirmative. The right-hand part of the diagram contains an isoquant and various isocost lines. In general, the slope of an isoquant equals the negative of the ratio of the tax-inclusive factor prices $-\tilde{q}/\tilde{w}$. Let the isoquant through A reflect the initial factor price ratio $-(1+t_q^A)q/(1+t_w^A)w$. Since A is a point of tangency between the isocost and the isoquant, it characterizes a cost minimum. Given q, w, t_q^A, t_w^A, there are many such cost minima on a ray from the origin through A all of which have the same unit production cost. However, because of the endogeneity of the terms of trade [equation (3)], there is only one where the factor rewards exhaust the value of output according to equation (4) or, equivalently, where the terms of trade equal the unit production cost,

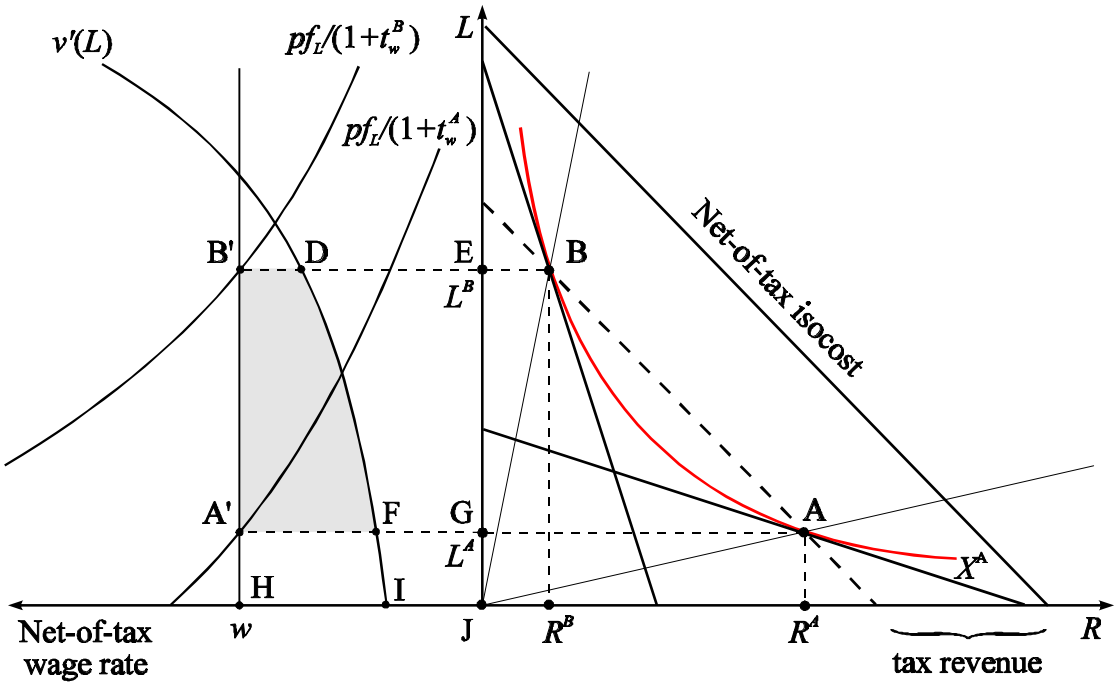
$$p(X) = c(\tilde{w}, \tilde{q}) \tag{10}$$

with $\tilde{w} = w(1+t_w)$ and $\tilde{q} = q(1+t_q)$ according to (5) and (6). We assume that A is that cost minimum where condition (10) is satisfied.

The isocost through A reflects the factor cost including the burden of factor taxes. The diagram also shows the corresponding net-of-tax isocost curve. This curve is defined as the geometrical locus of factor combinations that would be attainable at a given expense if there were no taxes. The net-of-tax isocost curve is flatter than the tax-inclusive isocost because $t_w^A > t_q^A$ and it is lying in a more outward position because $t_w^A, t_q^A > 0$.

The horizontal distance between A and the net-of-tax isocost equals the government's tax revenue in terms of R (and the vertical distance the tax revenue in terms of L). The broken parallel to the net-of-tax isocost through A therefore defines the geometrical locus of potential equilibria, where the tax revenue and the net-of-tax factor expenses are the same as in the labour-tax regime A. Assume that the isoquant is well-behaved in the sense that it does not touch the axes and is strictly concave. Then it is obviously possible, with an appropriate choice of the tax rates t_w and t_q, to transpose the economy from A to B, keeping output, tax-inclusive factor expenses and unit production cost constant while preserving the conditions for a cost minimum. Since neither the unit production cost nor the terms of trade alter with this transposition, B is an equilibrium. It is a green-tax equilibrium since the isocost curve through B is steeper than the net-of-tax isocost which indicates that $t_q^B > t_w^B$. As is to be expected, the green-tax equilibrium is characterized by more employment and less energy consumption than the labour-tax equilibrium, i.e. $L^B > L^A$, $R^B < R^A$.

Figure 1: Labour-tax regime versus green tax regime



PROPOSITION 1: There exists a green-tax equilibrium with higher tax rates on energy than on labour which yields the same level of output and same tax revenue as, but a higher level of employment than, the existing labour-tax equilibrium. The move from the labour-tax equilibrium to a green-tax equilibrium maintains the economy's international competitiveness in the sense of keeping the unit production cost, the terms of trade, and exports constant.

The reform will not only increase employment but will also improve national welfare. The left part of Figure 1 illustrates why this is so. The upward sloping curve $v'(L)$ is the disutility from working or the opportunity cost of labour. The downward sloping curves are the graphs of the market labour demand curves for alternative levels of the labour tax rate and of the energy input where this input is fixed at R^A and R^B, respectively. The vertical intercept of the labour demand curves is the net-of-tax marginal value product of labour, $pf_L/(1+t_w)$, given the energy input. The demand curves are downward sloping because the marginal physical productivity of labour decreases with L and the output price decreases with output. In both types of equilibrium the net-of-tax wage rate is fixed at the level w. In the labour-tax equilibrium the labour market is in the situation A' where private income is equal to A'GJH, disutility from working is FGJI, and welfare is A'FIH (plus constant government expenditure). The green tax reform increases income by B'EGA' and disutility from working by DEGF. Welfare increases by the shaded area B'DFA'. This can be summarized as follows.

PROPOSITION 2: A radical output-preserving green tax reform will increase national income and national welfare because it substitutes domestic labour income for the revenue of foreign resource owners.

Note that the reform may even be Pareto-improving with regard to the whole world. If the rest of the world is in equilibrium, q measures the true opportunity cost of energy in terms of withdrawing it from other resources. The domestic wage rate, on the other hand, is above the opportunity cost of labour. This asymmetry explains why the domestic economy may gain from the green-tax reform while no one in the world loses.

4. Marginal Green Tax Reforms

In this section we allow for a change in the output level so that we can study the effects of a piecemeal green tax reform on output, unit cost of production, and hence the competitiveness of the country. From the government budget condition (7) we get

$$dG = \left[wL + t_w wL_{\tilde{w}} w + t_q qR_{\tilde{w}} w\right]dt_w + \left[qR + t_q qR_{\tilde{q}} q + t_w wL_{\tilde{q}} q\right]dt_q . \tag{11}$$

The elasticities of factor demands are given by $\eta_{R,\tilde{q}} \equiv R_{\tilde{q}} q/R = -\sigma + (1-s)(\sigma - \varepsilon)$, $\eta_{R,\tilde{w}} \equiv R_{\tilde{w}} \cdot \tilde{w}/R = s(\sigma - \varepsilon)$, $\eta_{L,\tilde{w}} \equiv L_{\tilde{w}} \tilde{w}/L = -\sigma + s(\sigma - \varepsilon)$, $\eta_{L,\tilde{q}} \equiv L_{\tilde{q}} \cdot \tilde{q}/L = (1-s)(\sigma - \varepsilon)$ where $s \equiv \tilde{w}L/pX$ denotes the share of labour and $(1-s) \equiv 1 - \tilde{w}L/pX = \tilde{q}R/pX$ denotes the cost share of energy, and σ denotes the constant elasticity of substitution (see Allen 1938). Substituting these in equation (11) gives

$$dG = wL\left[1 + \frac{t_w}{(1+t_w)}\eta_{L,\tilde{w}} + \frac{t_q}{(1+t_q)}\frac{(1-s)}{s}\eta_{R,\tilde{w}}\right]dt_w + qR\left[1 + \frac{t_q}{(1+t_q)}\eta_{R,\tilde{q}} + \frac{t_w}{(1+t_w)}\frac{s}{(1-s)}\eta_{R,\tilde{w}}\right]dt_q$$

Setting $dG = 0$ in the above equation gives an expression showing how the labour tax rate changes due to a marginal increase of the energy (using the fact that $\eta_{R,\tilde{w}} = (1-s)\eta_{L,\tilde{q}}/s$)

$$\left.\frac{dt_w}{dt_q}\right|_{dG=0} = -\frac{qR\left[1 + \frac{t_q}{(1+t_q)}\eta_{R,\tilde{q}} + \frac{t_w}{(1+t_w)}\eta_{R,\tilde{w}}\right]}{wL\left[1 + \frac{t_w}{(1+t_w)}\eta_{L,\tilde{w}} + \frac{t_q}{(1+t_q)}\eta_{L,\tilde{q}}\right]}. \tag{12}$$

How does such a marginal revenue-neutral green tax reform affect unit cost of production which is used in (9)? The impact of a revenue-neutral green tax reform on the unit cost of production is given by

$$dc(\tilde{w}, \tilde{q}) = c_{\tilde{w}} w dt_w + c_{\tilde{q}} q dt_q .$$

Applying Shephard's lemma

$$C_{\tilde{w}} = c_{\tilde{w}} X = L,\ C_{\tilde{q}} = c_{\tilde{q}} X = R.$$

and using equation (12) allows us to determine the change in the unit cost of production:

$$\left.\frac{dc}{dt_q}\right|_{dG=0} = c_{\tilde{w}} w \left.\frac{dt_w}{dt_q}\right|_{dG=0} + c_{\tilde{q}} q = \frac{qR\left[\frac{t_q(\eta_{L,\tilde{q}} - \eta_{R,\tilde{q}})}{(1+t_q)} + \frac{t_w(\eta_{L,\tilde{w}} - \eta_{R,\tilde{w}})}{(1+t_w)}\right]}{X\left[1 + \frac{t_w}{(1+t_w)}\eta_{L,\tilde{w}} + \frac{t_q}{(1+t_q)}\eta_{L,\tilde{q}}\right]}$$

Substituting in the definitions of the (cross-)price elasticities yields

$$sign\left(\left.\frac{dc}{dt_q}\right|_{dG=0}\right) = sign\left(t_q - t_w\right). \tag{13}$$

Recalling our definition of competitiveness as given in Section 2, this can be interpreted as follows.

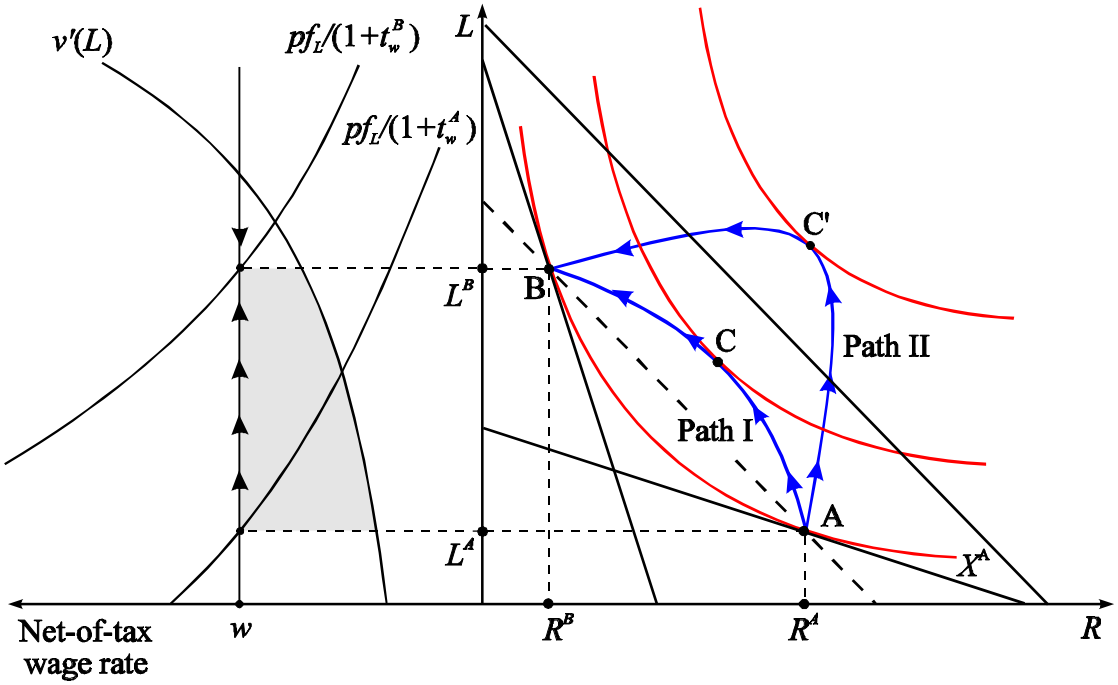
PROPOSITION 3: As long as the labour tax rate exceeds the energy tax rate, a piecemeal revenue-neutral green-tax reform will increase the international competitiveness and the output of the economy.

Furthermore, condition (13) also indicates that an economy is most competitive when it applies equiproportional taxes on factor inputs:

PROPOSITION 4: A country's competitiveness is maximized when the energy tax rate equals the labour tax rate.

To interpret and understand these results it is useful to inspect Figure 2. The right-hand side of that figure shows two conceivable paths of consecutive marginal tax reforms starting in the labour tax system A and ending in the green tax system B. Up to points C or C' where $t_w = t_q$, output will increase. A further increase in t_q will result in marginal output reductions.

Figure 2: Consecutive marginal green tax reforms



The marginal reaction of employment is also ambiguous. Up to point C or C' employment will definitely increase. However, an increase of t_q sufficiently far beyond the point where $t_q = t_w$ will not necessarily increase employment further because there is a countervailing output effect. A green tax reform will definitely create the incentive to substitute employment for energy consumption. However, the output decline such a reform induces in the range where $t_q > t_w$ will, in itself, reduce the factor demands. If t_q is sufficiently far above t_w, the output effect may dominate the substitution effect such that employment declines at the margin.

With paths I and II, Figure 2 distinguishes two different possibilities that depend on the price elasticity of the demand curve for the economy's products. If the demand elasticity is small, the initial rise and subsequent fall in output will be small and the substitution effect will dominate the output effect. This case is represented by path I. Moving from C to B further increases employment while output is falling. If output demand is very elastic, however, as

represented by path II, there will be an interval on the path II from C' to B where output and employment are falling simultaneously.[5]

The ambiguity translates to the country's welfare and international competitiveness. Recall that, according to (8), welfare is the difference between income and the disutility from working, and that we measure competitiveness by the negative of the country's unit production cost which, because of (10), in turn equals the economy's terms of trade.

Since (3) says that the terms of trade are a declining function of output, the economy's competitiveness increases with a piecemeal green tax reform as long as $t_q < t_w$ (right of C and C') and declines when $t_q > t_w$ (left of C and C').

National welfare, on the other hand, will always move along with employment. Thus, whenever $t_q < t_w$, a piecemeal green tax reform will increase welfare. It will also increase welfare in the situation of path I when $t_q > t_w$. If the conditions of path II apply and $t_q > t_w$, welfare will increase with a piecemeal green tax reform provided that the energy tax does not exceed the wage tax by too much. However, if t_q is sufficiently larger than t_w, a piecemeal green tax reform will reduce national welfare, notwithstanding the fact, of course, that national welfare will under all circumstances be higher than in the initial equilibrium. When output is not smaller than in the initial equilibrium, as assumed by comparing two points on the same isoquant, the total net effect on welfare along a path will definitely be positive.

5. Conclusion and Comparison with other Results

Basically we have found that the effects of a green tax reform that substitutes an energy tax for a labour income tax are very favourable. Such a tax reform will induce a technical substitution in the production process that replaces energy consumption with employment. Since energy is priced at its true national opportunity cost, but the price of labour is above its opportunity

[5] For the same reason, moving form A to C' increases resource demand. In the context of a wage bargaining model a similar result has been shown by Koskela, Schöb and Sinn (1998).

cost, there is a strong presumption that the reform will boost employment and bring about a national income increase and a welfare improvement.

As mentioned in the introduction, this counters the more pessimistic views expressed by other authors. However, the differences in opinion are easily explained. Bovenberg and de Mooij (1994) have a market clearing model where people chose between a dirty and a clean good. A labour tax is an equal tax on both goods. Replacing this tax with a green tax shifts the labour tax burden effectively on only one of the goods and creates an excess burden that operates like a general increase in the labour tax and exacerbates the distortion in the labour supply decision. Our approach differs from theirs by considering dirty and clean factors instead of goods and by allowing for involuntary unemployment.[6]

Richter and Schneider (1998) study an optimal tax system in a model with unionized labour markets, unemployment and a hidden fixed factor whose return can be taxed. Due to the effective assumption of lump-sum taxation there is no need in their model to introduce additional factor taxes. By way of contrast, we have assumed that such an easy solution to the tax problem is not available and that both energy and labour taxes are potentially useful sources of government revenue.

It seems to us that Europe's current labour market difficulties, which have resulted from a significant increase in low wage competition due to globalization and the fall of the Iron Curtain, require a well-tailored policy response that takes account of the precise nature of the current difficulties. From that perspective, classical, involuntary unemployment due to overdrawn wages is a necessary ingredient of any model that wants to give advice on how to solve the unemployment problem. A green tax reform may not be the first best policy tool, but it certainly deserves attention and careful scrutiny in the debate. We therefore hesitate to dismiss such a reform as useless, or even dangerous, as some authors apparently do.

Finally in the German press it is currently popular to fight green tax reform on the grounds that it would hit the manufacturing industry where energy input is relatively high. This

[6] Our analysis is complementary to Koskela and Schöb (1996) who using a model with green output taxes have shown that Bovenberg and de Mooij's analysis cannot be generalized to the case of unemployment.

argument cannot be rejected on the basis of our very aggregate model. Certainly, in a more complicated setting with sectors whose labour-energy intensities differ, there will be sectors that shrink and others that grow in situations where our model predicts constant output. Before we explicitly analyse the multi-sector problem, we can only suspect that the gains of the rising sectors will outweigh the losses of the shrinking ones in particular in the cases studied in our model where a green tax reform increases output and welfare and improves the country's competitiveness. We believe that strange things would have to happen in a multi-sector model before our results could be stood on their heads.

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