Perverse Results of a Greening of the Tax System

Christian Lager

Abstract:

By means of a Classical model of production it is demonstrated, that energy taxation may cause an increase of energy consumption. The reason for these unexpected results is perverse substitution caused by perverse shifts of relative prices. These effects will occur if there is choice of technique and if the energy saving method of production is comparably "capital intensive". If an introduction of an energy tax is complemented by a reduction of the taxation of labour income, then the degree of reduction has no influence on the system of relative prices if the rate of profit is constant.

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1. Introduction

The first and second oil shock and the increasing damage of the spaceship earth created an increasing interest in energy and environmental economics. The roots of environmental economics are, however, much older and may be traced back to the externality theories of Marshall, Pigou and Scitovsky, to the public good theory of Wicksell or even to the rent theories of the classicals[1]. One of the very first instruments of environmental policy were environmental tax and/or subsidy schemes which are designed to internalise the external costs created by polluters. The idea is simple: a tax levied on energy inputs or on damaging activities will increase the cost of energy intensive products or damaging processes. Increasing prices of energy intensive products will cause producers as well as consumers to substitute these products by other goods and induce producers to choose production methods which use less energy and which are more favourable to the environment.

Taxation of energy or emissions is often discussed together with a reduction of the cost of labour. The idea of such a "greening of the tax system" is, that the tax burden is shifted from the use of labour to the utilisation of the environment. It is argued that a reduction of the labour cost and an increase of the cost of energy will induce producers to substitute energy and energy intensive products by labour and labour intensive goods. Hence, such a greening of the tax system will result in a decrease of the unemployment rate and in a reduction of energy use.

The object of this paper is to contradict this widely held view. In particular the following issues are addressed: In section 2 the possibility of „perverse“ substitution is demonstrated. It is shown that an introduction of an energy tax or an increase of the tax rate may increase the use of energy. On the contrary, a subsidy levied on the use of energy may decrease the demand for energy. Sufficient conditions for „perverse“ substitution are presented in section 3. In section 4 it is demonstrated, that the degree of the reduction of the cost of labour has no influence on the system of relative price, if the rate of profit is kept constant. Hence, the

* This paper is based on Gehrke and Lager (1995) and on Lager (1998a).

1 For an application of the Ricardian theory of differential rent to environmental issues see: Ch. Lager (1998b).

reconstruction of the tax system yields the same results as an introduction of an energy tax would do. Finally the reason for perverse substitution, which is s not less perverse, is explored: A energy tax, with or without the reduction of labour cost, may cheapen an energy-intensive product (relative to a less energy-intensive one).

The method of analysis adopted in this paper is classical equilibrium analysis and consists in comparing long run positions[2]. The model used in this paper is, in particular, based on the following assumptions: (i) There are no primary factors other than homogenous labour. (ii) There is no joint production and, therefore, there is no fixed capital. This restrictive assumption is taken for simplicity and could be relaxed by taking simple fixed capital systems into account without rendering any conclusions drawn in that paper. (iii) All products are basic, i.e. the input matrix is indecomposable. (iv) The economy is closed.

2. Is perverse substitution possible?

Given that set assumptions we may characterise a feasible system of production α, or a technique α, by the triplet $\{\mathbf{A}_a, \mathbf{a}_a, \mathbf{l}_a\}$, i.e. by a square semipositive input matrix $\mathbf{A}_a \in R^{n\times n}$, by a semipositive vector of energy inputs, $\mathbf{a}_a \in R^n$, and by a semipositive vector of labour inputs, $\mathbf{l}_a \in R^n$. Denoting the wage rate, the rate of profit and the energy tax rate by w, r, and t, the corresponding system of prices of production, involving a quantity-based tax rate may be written as follows:

(1) $$\mathbf{p}_a = \mathbf{A}\mathbf{p}_a(1+r) + \mathbf{l}_a w + \mathbf{a}_a t = \tilde{\mathbf{l}}_a(r)w + \tilde{\mathbf{a}}_a(r)t$$

where $\tilde{\mathbf{l}}_a(r) \equiv [\mathbf{I} - \mathbf{A}_a(1+r)]^{-1}\mathbf{l}_a = \left(\mathbf{I} + \mathbf{A}_a(1+r) + \mathbf{A}_a^2(1+r)^2 + \cdots\right)\mathbf{l}_a$,

and $\tilde{\mathbf{a}}_a(r) \equiv [\mathbf{I} - \mathbf{A}_a(1+r)]^{-1}\mathbf{a}_a = \left(\mathbf{I} + \mathbf{A}_a(1+r) + \mathbf{A}_a^2(1+r)^2 + \cdots\right)\mathbf{a}_a$

are vectors of sums of dated (and discounted) quantities of labour and energy inputs respectively. Hence, taking a quantity-based tax into account, prices of production are determined by the sum of two value magnitudes, i.e. (i) the sum of discounted cost of labour and (ii) the sum of discounted cost of the energy tax. Note that if there is no energy tax, i.e. at

[2] For a detailed discussion of the concept of long run position or long run equilibrium see: Kurz and Salvadori (1995)

$t = 0$, then the energy content is irrelevant and the prices are, as usual in the prices-of-production theory, proportional to labour commanded price.

It is well known that, if the input matrix is productive, i.e. if the Frobenius-root, l_a, of that matrix is smaller unity, then

(a) for $w = 0$ and $t = 0$ there is a positive *maximal rate of profit*, $R_a = \frac{1}{l_a} - 1$,

(b) for all $r : 0 < r \leq R_a$, the prices defined in (1) are positive, and

(c) the dated quantities of labour and energy, i.e. the elements of vectors $\tilde{\mathbf{l}}_a(r)$, and $\tilde{\mathbf{a}}_a(r)$, are increasing functions of the rate of profit, which

(d) approach infinity as that rate becomes the maximal rate of profit.

The possibility of substitution, i.e. choice of technique, is a precondition for an energy saving effect of energy taxation. Assume first, for simplicity, that there is choice of technique only in a very limited sense: There are two processes for the production of one single product, say commodity k. Hence we have an alternative system of production b: $\{\mathbf{A}_b, \mathbf{a}_b, \mathbf{l}_b\}$ which is *adjacent* to technique a, in the sense that the systems a and b differ only with respect to the two processes producing commodity k.

Assume that the process which produces commodity k in system a requires comparably less direct and indirect energy, i.e.

(2) $$\left[\mathbf{i}_k'(\mathbf{I} - \mathbf{A}_a)^{-1}\mathbf{a}_a\right] < \left[\mathbf{i}_k'(\mathbf{I} - \mathbf{A}_b)^{-1}\mathbf{a}_b\right].$$

Therefore and because of assumption (iii), i.e. all products are basic, it follows that the production of <u>any</u> commodity bundle requires less total energy if technique a is in use:

(3) $$\left[\tilde{\mathbf{a}}_a(0) \equiv (\mathbf{I} - \mathbf{A}_a)^{-1}\mathbf{a}_a\right] < \left[\tilde{\mathbf{a}}_b(0) \equiv (\mathbf{I} - \mathbf{A}_b)^{-1}\mathbf{a}_b\right].$$

Given a rate of profit at $r = \bar{r}$ and expressing all prices in units of labour commanded $(w = 1)$, we obtain prices systems for both feasible techniques where the prices are increasing and linear functions of the tax rate:

(4a) $\mathbf{p}_a = \tilde{\mathbf{l}}_a(\bar{r}) + t\tilde{\mathbf{a}}_a(\bar{r})$ and (4a) $\mathbf{p}_b = \tilde{\mathbf{l}}_b(\bar{r}) + t\tilde{\mathbf{a}}_b(\bar{r})$.

Optimising producers will seek for the cost minimising method of production and will adopt the energy saving method a if and only if

$$(5) \qquad \left(\mathbf{p}_a = \tilde{\mathbf{l}}_a(\bar{r}) + t\tilde{\mathbf{a}}_a(\bar{r})\right) < \left(\mathbf{p}_b = \tilde{\mathbf{l}}_b(\bar{r}) + t\tilde{\mathbf{a}}_b(\bar{r})\right)$$

A energy tax aims at increasing the cost of energy intensive methods of production such that these methods are substituted by processes which use comparably less energy. Hence, an energy tax is successful in reducing energy consumption if and only if it decreases the difference between the cost (or the price) of the energy saving method a and the cost of using method b. This is the case if

$$(6) \qquad \frac{\partial(\mathbf{p}_a - \mathbf{p}_b)}{\partial t} = \left(\tilde{\mathbf{a}}_a(\bar{r}) - \tilde{\mathbf{a}}_b(\bar{r})\right) < 0.$$

By assumption (2) technique a is comparably less energy intensive, i.e. $\tilde{\mathbf{a}}_a(0) < \tilde{\mathbf{a}}_b(0)$. Hence we will first analyse the two cases where $\tilde{\mathbf{a}}_a(\bar{r}) < \tilde{\mathbf{a}}_b(\bar{r})$ at a given rate of profit, $\bar{r}$. Assume first that $\tilde{\mathbf{l}}_b(\bar{r}) < \tilde{\mathbf{l}}_a(\bar{r})$. This case is depicted for an arbitrary commodity in figure 1a.

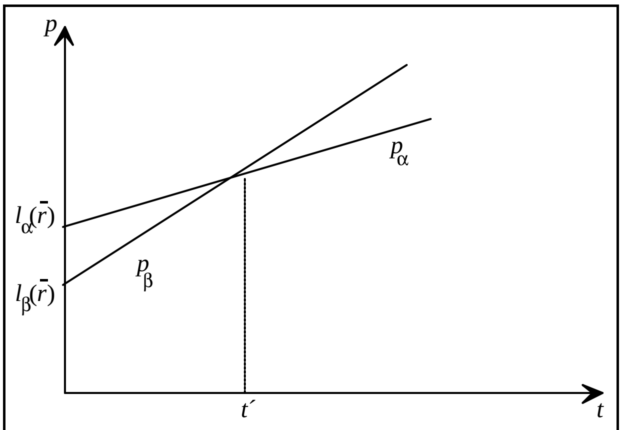

fig. 1a
(normal substitution)

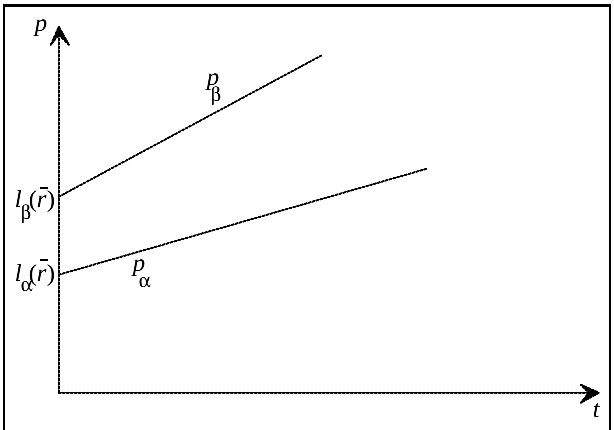

fig. 1b
(no substitution)

If there is no taxation of energy, i.e. at $t = 0$, the energy intensive technique b is cost minimising and will be used. A taxation of energy will increase the cost of method b compared to a. At a tax rate $t = t'$ both techniques are equi-profitable and at a rate $t > t'$ the energy saving method a minimises cost of production and will be used. This will reduce the use of energy and the emission of pollutants. In this case taxation of energy is successful if the tax rate is high enough.

If, on the other hand, $\tilde{\mathbf{l}}_b(\bar{r}) > \tilde{\mathbf{l}}_a(\bar{r})$, then the energy saving method a is cost minimising at any nonnegative tax rate and will be used anyway. Taxation of energy has no effects, except that it increases the differential of cost between methods a b. This case is illustrated in figure 1.b.

Because of assumption (2), which asserts that system b requires more direct and indirect energy, the condition (6) is satisfied if the rate of profit is zero or is close enough to zero. This need not be the case for any positive rate of profit. Hence we will also analyse the case where condition (6) is not satisfied and $\tilde{\mathbf{a}}_a(\bar{r}) > \tilde{\mathbf{a}}_b(\bar{r})$.

If $\tilde{\mathbf{l}}_b(\bar{r}) > \tilde{\mathbf{l}}_a(\bar{r})$ then the energy saving method a is cost minimising if there is no energy tax Taxation will, in this case, reduce the comparative advantage of technique a and will, finally, at a rate $t > t''$, induce a perverse switch from the energy saving method to the energy intensive technique b. This case of a damaging energy taxation is illustrated in figure 2.a.

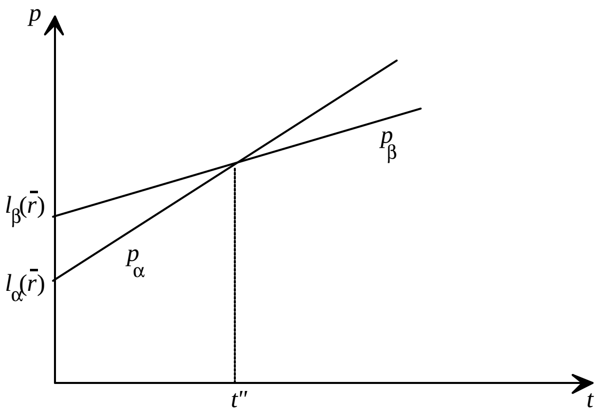

fig. 2a
(perverse substitution
caused by energy taxes)

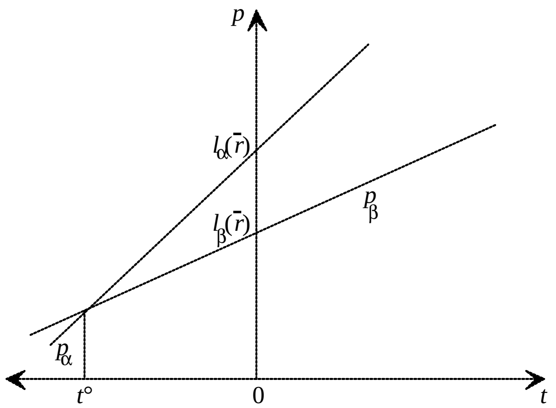

fig. 2b
(perverse substitution
caused by subsidies on energy use)

However, even in the case that a taxation of energy reduces the cost advantage of the energy saving process, there is the possibility of a successful energy policy. But the mechanism of that policy also involves perverse substitution. If $\tilde{\mathbf{l}}_b(\bar{r}) < \tilde{\mathbf{l}}_a(\bar{r})$, then a negative energy tax, i.e. a subsidy on the energy use, will decrease the comparative advantage of the energy intensive method b and will result in a perverse switch to the energy saving technique a at a rate $t < t^{\circ} < 0$. This case of perverse substitution is illustrated in figure 2.b.

The analysis presented above carries over to the general case with choice among a finite number of processes available for the production of more than one commodity. This case is illustrated by figure 3 in which the choice of technique among four processes is accounted for.

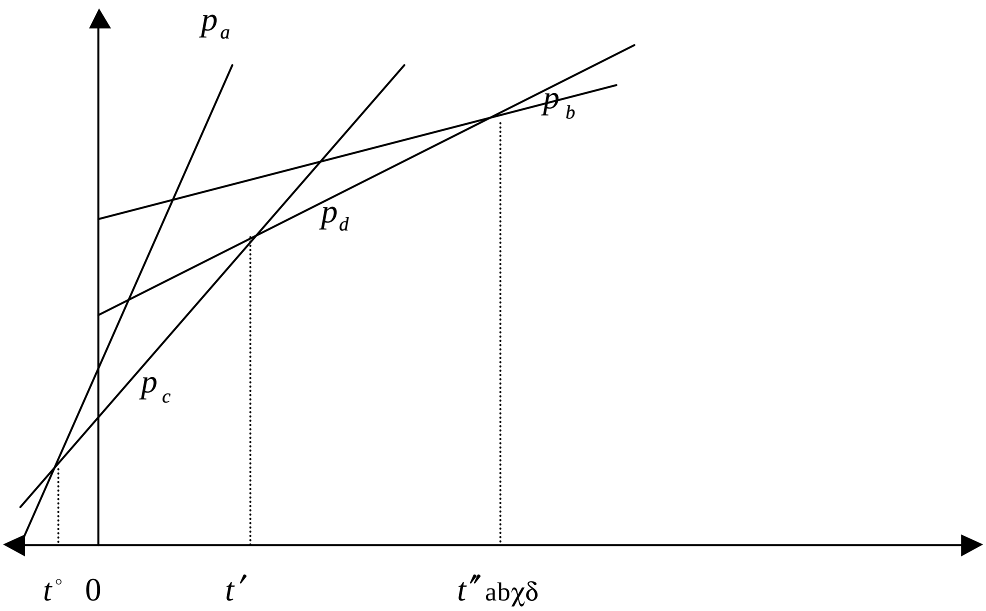

fig. 3
(The general case: More than two systems of production)

Assume that the available techniques a, b, c and d are ranked according to energy intensity such that system a involves the less energy intensive processes and d requires most energy, i.e. $\tilde{\mathbf{a}}_a(0) < \tilde{\mathbf{a}}_b(0) < \tilde{\mathbf{a}}_c(0) < \tilde{\mathbf{a}}_d(0)$. At a given positive rate of profit, $\bar{r}$, it may be the case that $\tilde{\mathbf{a}}_b(\bar{r}) < \tilde{\mathbf{a}}_d(\bar{r}) < \tilde{\mathbf{a}}_c(\bar{r}) < \tilde{\mathbf{a}}_a(\bar{r})$ and that, without taxation, system c minimises cost of production. A energy tax will decrease the comparative advantage of that system in use and, at a positive rate t: $t' < t < t''$, producers will adopt technique d. The taxation induced a perverse switch to the most energy intensive system of production. A further increase of the tax rate will induce the intended result, i.e. a switch to the energy saving technique b. This is, however, from an environmental point of view, just the second best solution. The least energy intensive system of production, a, is dominated at any positive tax rate. A subsidy of the use of energy will bring about the most wished-for result which, again, involves a perverse switch.

Summarising that section we must conclude that we may exclude perverse substitution effects if and only if the sums of discounted energy contents of the energy saving technique is smaller than that of the adjacent method which comes into use if the tax rate is increased.

3. Sufficient conditions for "perverse" substitution.

Up to now it was simply postulated, that for two adjacent systems of production $\tilde{\mathbf{a}}_a(0) < \tilde{\mathbf{a}}_b(0)$ is compatible with $\tilde{\mathbf{a}}_b(\bar{r}) < \tilde{\mathbf{a}}_a(\bar{r})$ at a positive rate of profit, and that, therefore, perverse substitution is possible and cannot be neglected. We may proof the existence of such perverse results by means of an example. However, it is much more interesting to provide sufficient conditions for perverse substitution and assess whether these conditions are quite likely and may exist in real life.

It is well known that for any viable and basic technique e the associated prices of production (without energy taxation), valued in terms of commanded labour, given by vector $\mathbf{p}_e = \mathbf{l}_e(r) = (\mathbf{I} - \mathbf{A}_e(1+r))^{-1}\mathbf{l}_e$, are (i) increasing functions of the rate of profit r: $0 < r < R_e$, and that (ii) these prices tend to infinity as the rate of profit approaches the maximal feasible rate R_e.[3]

[3] The proof is straightforward if one accepts two simple facts: (i) the elements of the matrix $(\mathbf{I} - \mathbf{A}_e(1+r))^{-1}$ are increasing functions of r. (ii) the maximal rate of profit is attained if the real wage rate, measured in terms of an arbitrary bundle of goods, is equal to zero and hence, the reciprocal of that wage rate, i.e. the price of that arbitrary bundle, is equal to infinity.

Because of the formal equivalence between labour commanded prices and the sums of discounted energy content, given by $\mathbf{a}_e(r) = (\mathbf{I} - \mathbf{A}_e(1+r))^{-1}\mathbf{a}_e$, of products, these results obtained for the former can be carried over to the latter. Hence,

(7) $$\frac{\partial \mathbf{a}_e(r)}{\partial r} > 0 \text{, and}$$

(8) $$\lim_{r \to R_e} \mathbf{a}_e(r) = \infty .$$

The possible shapes of two functions representing the sum of the discounted energy content for an arbitrary commodity produced by two adjacent techniques are depicted in figures 4a and 4b.

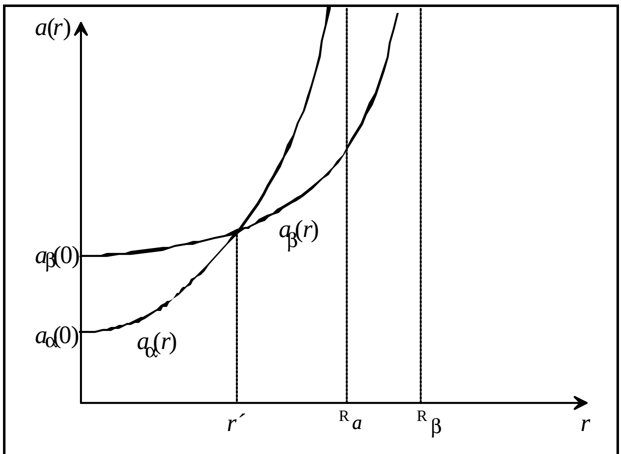

fig. 4a

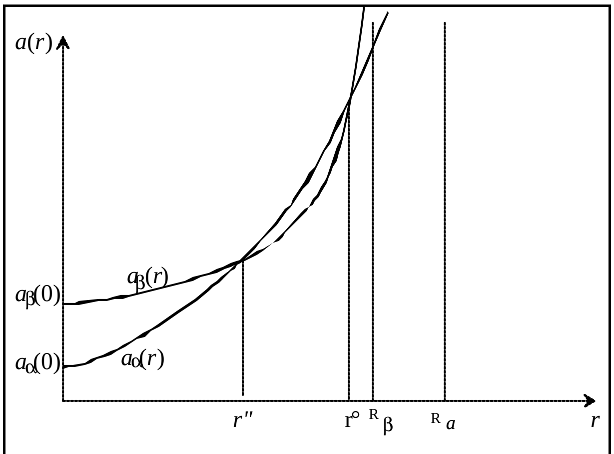

fig. 4b

It is again assumed that technique a requires less energy than technique b, i.e. $\mathbf{a}_a(0) < \mathbf{a}_b(0)$. Hence, for small rates of profit we can exclude the possibility of perverse substitution. But if $R_a < R_b$, i.e. if the maximal rate of profit of the energy intensive method b exceeds the maximal attainable profit rate of the energy saving method a, then functions $\mathbf{a}_a(r)$ and $\mathbf{a}_b(r)$ have at least one switch point. Hence there exists (at least one) range of the rate of profit, depicted in figure 4a as $\bar{r} : r' < \bar{r} < R_a$, at which $\mathbf{a}_a(\bar{r}) > \mathbf{a}_b(\bar{r})$ and at which perverse substitution effects will happen.

Even in the case that $R_b < R_a$, we cannot preclude that the functions $\mathbf{a}_a(r)$ and $\mathbf{a}_b(r)$ will not switch. This case is illustrated by fig. 4b where perverse substitution effects will happen for rates of profit at $\bar{r} : r'' < \bar{r} < r^{\circ}$.

Hence the condition that the technique which requires comparably more direct and indirect energy has the larger maximal rate of profit, is a sufficient but not a necessary condition for the existence of intervals of the rate of profit at which perverse substitution will occur.

The maximal rate of profit is a central concept for the existence of perverse substitution effects. In order to understand the economic meaning of the sufficient condition specified above one must explore the sense of the concept of a maximal rate of profit.

The eigenwert problem which brings about the maximal rate of profit is usually specified in terms of the direct capital input matrix **A**:

(9) $$(\mathbf{I} - \mathbf{A}(1+R))\mathbf{p} = 0,$$

but may be equivalently defined in terms of Pasinetti´s matrix of vertically integrated capital inputs $(\mathbf{I} - \mathbf{A})^{-1}\mathbf{A} = \mathbf{H}$ which shows the total, i.e. direct and indirect capital inputs:

(10) $$(\mathbf{I} - \mathbf{H}R)\mathbf{p} = 0$$

A is indecomposable by assumption. It follows that $\mathbf{H} > 0$ and indecomposable. Hence the maximal rate of profit feasible for the system with respect to **A** is a decreasing function of the elements of **H**[4]. If there are two systems of production, a and b, then following implication holds:

(10) $$\lfloor \mathbf{H}_a \geq \mathbf{H}_b \rfloor \Rightarrow \lfloor R_a < R_b \rfloor.$$

If technique a is comparably “capital intensive”, in the sense that it requires in general not less but at least in one respect more direct and indirect capital goods than the other technique b, has the smaller maximal feasible rate of profit.

4 See: Horn and Johnson (1996, S. 515)

Considering the comparably high capital intensity of some, if not most, methods designed to reduce energy consumption, we can conclude that perverse switches to energy intensive techniques induced by the introduction of an energy tax system may not be exceptional.

4. A socio-ecological greening of tax system

For two reasons the greening of the tax system, i.e. introducing taxes on energy or on emissions, is usually discussed in connection with a reduction of the tax on labour. First, it seems to be generally agreed that the governmental share in total income is close to its acceptable limit, and it is therefore hardly possible to increase overall taxation. An introduction of a new tax must therefore be accompanied by a reduction of other taxes. Since labour is, by far, the most taxed factor of production, it is a natural candidate for a reduction of taxation. Second, most European countries suffer from unemployment. It is argued that a redistribution of the burden of taxation by an introduction of environmental or energy taxes accompanied by a reduction of taxes levied on labour will raise the cost of the use of energy and will, simultaneously, decrease the cost of labour. Hence, cost minimising producers will not only use less energy and create less pollutants but will also employ more labour.

Let s denote the share of the reduction of the cost of labour caused by a reduced taxation of that factor. Hence we obtain a system of prices of production which accounts for energy taxes as well as for a reduction of the taxation levied on wages and salaries:

(11) $$\mathbf{p} = \mathbf{Ap}(1+r) + \mathbf{l}\, w(1-s) + \mathbf{a}\, t = \tilde{\mathbf{l}}(r)\, w(1-s) + \tilde{\mathbf{a}}(r)\, t$$

where $\tilde{\mathbf{l}}(r)$ and $\tilde{\mathbf{a}}(r)$ are the sums of discounted labour and energy respectively as defined in section 2.

Assume that the economy produces the net output bundle $\mathbf{d}$. Hence gross outputs are determined by $\mathbf{x}' = \mathbf{d}'(\mathbf{I}-\mathbf{A})^{-1}$. The yield of the energy tax is $T = \mathbf{x}'\mathbf{a}\, t = \mathbf{d}'\tilde{\mathbf{a}}(0)\, t$ and the sum required to finance the reduction of taxes levied on labour income is $S = \mathbf{x}'\mathbf{l}\, s = \mathbf{d}'\tilde{\mathbf{l}}(0)\, w\, s$.

Define the degree of (budget) neutrality of the greening of the tax system

(12) $$m = \frac{S}{T} = \frac{\mathbf{d}'\tilde{\mathbf{l}}(0)\, w\, s}{\mathbf{d}'\tilde{\mathbf{a}}(0)\, t},$$

i.e. the share of total reduction of taxes levied on labour in per cent of the additional yield by taxation of energy. Obviously, $m = 1$ means that the reconstruction of the tax system is budget neutral and, $m = 0$, is the special case which has been analysed in section 2 and 3, i.e. an introduction of an energy tax without any reduction of taxes levied on wages.

The rate of the reduction of taxes on labour (*s*), may be expressed as a function of the tax rate (*t*), the wage rate (*w*), the degree of neutrality of the tax system (m), and the aggregate energy/labour ratio denoted by $e = \frac{\mathbf{d}'\tilde{\mathbf{a}}(0)}{\mathbf{d}'\tilde{\mathbf{l}}(0)}$:

(12) $$s = \frac{e\, m\, t}{w}$$

Substitution of (12) into (11) gives

(13) $$\mathbf{p} = \tilde{\mathbf{l}}(r)\, w + \tilde{\mathbf{a}}(r)\, t - \tilde{\mathbf{l}}(r)\, e\, m\, t\,.$$

Expressing all prices, the wage rate and the tax rate in terms of a numeraire good j, i.e. $p_j = 1$, we obtain for the price of an arbitrary commodity *i*:

(14) $$\frac{p_i}{p_j} \equiv p_i^{(j)} = \tilde{l}_i(\bar{r}) w^{(j)} + \tilde{a}_i(\bar{r})\, t^{(j)} - \tilde{l}_i(\bar{r}) e\, m\; t^{(j)},$$

where $w^{(j)} = \frac{w}{p_j}$ and $t^{(j)} = \frac{t}{p_j}$ are the wage rate and the tax rate respectively expressed in terms of the numeraire commodity j. Note that

Considering that the price of the numeraire commodity j is set equal to one we obtain a relation between the wage rate and the tax rate.

(15) $$w^{(j)} = \frac{1 - \tilde{a}_j(\bar{r})\, t^{(j)}}{\tilde{l}_j(\bar{r})} + e\, m\, t^{(j)}.$$

The wage rate consists on two additive components. The first is the wage rate which would occur if $m = 0$, i.e. if there is taxation of energy without any reduction of taxes on labour. The second, $e\,m\,t^{(j)}$, indicates the effect of that tax reduction. Since the rate of profit is taken as given this tax reduction must necessarily raise the wage rate.

Substitution of (15) into (14) gives:

$$(16)\qquad p_i^{(j)} = \frac{\tilde{l}_i(\bar{r})}{\tilde{l}_j(\bar{r})} + \frac{\tilde{a}_i(\bar{r})\tilde{l}_j(\bar{r}) - \tilde{a}_j(\bar{r})\tilde{l}_i(\bar{r})}{\tilde{l}_j(\bar{r})}\, t^{(j)},$$

where prices of production depend on the rate of the energy tax but do not depend on the degree of (budget) neutrality of the greening of the tax system. Hence, if the rate of profit is given, the system of relative prices is completely invariant with respect to the degree of reduction of the tax burden on labour. It is only the wage rate (and not the profit rate) which benefits from the reduction of taxes on labour. Hence, a decrease of taxes on labour income will not cause any change of the cost and, therefore, we cannot reasonably expect that there are any substitution effects which will create jobs.

5. Perverse movement of relative prices.

Assume that product i is comparably energy intensive in the sense that its production requires more total energy per unit of total labour than another product j:

$$(17)\qquad \frac{\tilde{a}_i(0)}{\tilde{l}_i(0)} > \frac{\tilde{a}_j(0)}{\tilde{l}_j(0)},$$

Can we expect that the price of the energy intensive product i relative to the price of the labour intensive product j will rise with a rising tax rate? From 16 it follows, that this is the case if

$$(18)\qquad \frac{\partial\left(p_i/p_j\right)}{\partial t} = \frac{\partial p_i^{(j)}}{\partial t} = \left(\frac{\tilde{a}_i(\bar{r})}{\tilde{l}_i(\bar{r})} - \frac{\tilde{a}_i(\bar{r})}{\tilde{l}_j(\bar{r})}\right)\tilde{l}_i(\bar{r}) > 0\,.$$

By definition (17) this must hold true if the profit rate is equal to zero. For positive rates of profit we can, however, not ensure that condition (18) is satisfied. Even if (17), i.e. the relation of energy intensities in terms of total energy and total labour content holds it might happen that this relation is reversed if it is defined in terms of "discounted" energy and labour and that the "discounted" energy intensities of good j exceed the "discounted" energy intensities of good i, i.e.

(19) $$\frac{\tilde{a}_i(\bar{r})}{\tilde{l}_i(\bar{r})} < \frac{\tilde{a}_j(\bar{r})}{\tilde{l}_j(\bar{r})}.$$

This could be the case if the energy saving product j requires more energy and less labour on earlier stages of production.

Whether commodity i becomes cheaper or dearer (relative to commodity j) with an increase in the tax rate depends on the production characteristics of the economic system as a whole and on the distribution of income.

6. Summary and conclusions

In this paper it has been demonstrated by means of a Classical model of production that energy taxation may cause an increase of energy consumption. The reason for these unexpected results is perverse substitution caused by perverse shifts of relative prices. A sufficient condition for these effects to occur is that there is choice of technique and that the energy saving method of production is comparably "capital intensive". If an introduction of an energy tax is complemented by a reduction of the taxation of labour income, then the degree of that reduction has no influence on the system of relative prices if the rate of profit is constant.

These unexpected and seemingly perverse findings are some of many examples which demonstrate that we should be careful in relying on results found by partial analysis or by models which are based on regular economies.

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