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Max-Planck-Projektgruppe Recht der Gemeinschaftsgüter, Poppelsdorfer Alle 45, 53115 Bonn

Trade Neutrality of National Environmental Policy: Some Theoretical Considerations and Simulation Results for Switzerland

by

GEBHARD KIRCHGÄSSNER

UNIVERSITY OF ST. GALLEN

Abstract

According to the traditional theory, for energy taxes uniform rates across sectors are optimal. But wherever attempts are made to 'green' the tax system at least some sectors are treated differently. Exemption regulations for energy-intensive sectors are not the only but perhaps the only practical way to reach trade-neutrality of an ecological tax reform. Besides the influence of political pressure groups and the traditional leakage argument there might be a politico-economic argument which calls for different tax rates in different sectors. Using an applied general equilibrium model of the Swiss economy it is shown that at least for this country such exemptions have no important impacts, neither economically nor environmentally.

Keywords: Ecological Tax Reform, Leakage, Applied General Equilibrium Model

JEL Classification: E47, C53.

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Mailing Address: Prof. Dr. Gebhard Kirchgässner
University of St. Gallen
SIASR, Institutsgebäude
Dufourstr. 48
CH-9000 St. Gallen
Switzerland
Gebhard.Kirchgaessner@.unisg.ch

1 Introduction

Whenever environmental policy measures are to be taken in a modern open economy, and if these measures are more than moral suasion and are not financed by the government, then the argument is brought up that such a policy inhibits the international competitiveness of the economy. This holds especially if ‘ecological incentives’ are to be introduced into the tax system, and it holds in the same way for the U.S., the Federal Republic of Germany or Switzerland.[1)] This argument is usually enforced by the statement that such measures would endanger domestic jobs. Thus, at least internationally co-ordinated measures are called for. Switzerland should wait for the European Union, or the member countries of the European Union should wait for the United States and Japan. International harmonisation or the sacrifice of environmental policy seem to be the only alternatives. If a country – nevertheless – performs such a policy in a ‘solo run’, there are demands for (partial or total) exemptions of those economic sectors which are particularly hurt by this policy: those sectors which are in danger of losing their competitiveness against the corresponding sectors of other economies should not be affected by the environmental policy; the measure should be ‘neutral with respect to international trade’. If a carbon tax is introduced, e.g., the tax rate may be reduced for those sectors which use an especially high share of fossil fuels and/or have a high share of exports.

Despite its political relevance, the question whether some sectors should be exempted from environmental taxation has hardly been discussed in the economic literature.[2)] One reason for this is certainly that there exist famous and well known results that uniform tax rates are economically optimal. Another reason might be that from an environmental point of view, at least at first glance, such exemptions do not make sense at all. If CO_2-emissions are to be reduced, they should be reduced first of all where reduction costs are small, but also where a lot of CO_2 is emitted. An exemption for energy-intensive sectors counteracts this objective. On the other hand, the argument of reduced international competitiveness is not easy to put aside. Even if this concept is somewhat dubious if applied to whole economies,[3)] it is nevertheless true that a policy which increases the cost of the factor ‘environment’ leads to price increases of those products which are using this factor particularly intensive and, thus, reduces – ceteris paribus – the competitiveness of these sectors, if they really act in internationally competitive markets. This leads – again ceteris paribus – with high probability to some (perhaps only transitory) reduction of employment, be it that domestic production is substituted by imports and/or that domestic firms move production to foreign countries. Such an argument is especially strong if there is high (involuntary) unemployment.

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1. See, e.g., the rejection of an ‘ecological tax reform’ by the Swiss Industry (SCHWEIZERISCHER HANDELS- UND INDUSTRIE-VEREIN (1998)).

2. Some of the very few papers are M. HOEL (1996) who discusses whether tradeables should be taxed differently, or W.F. RICHTER and K. SCHNEIDER (1998) who discuss whether the industrial sector should (at least partially) be exempted.

3. For the definition of international or sectoral competitiveness see, e.g., COMMISSION OF THE EUROPEAN COMMUNITY (1992, p. 122), TH. GRIES and C. HENTSCHEL (1994) or H. SIEBERT (1992). – For a critique of this concept if it is applied to a whole economy see, e.g., P. KRUGMAN (1994) oder T. STRAUBHAAR (1994).

The argument becomes even stronger, however, if foreign environmental standards are below current domestic ones. Then, leakage effects may occur, which may cause the environmental situation to become even worse, if the increase in pollution due to the increase of foreign production overcompensates pollution reduction due to the higher domestic standards (and the reduction of domestic production). This is especially important if we deal with global environmental problems like global warming or the shrinking of the ozone layer, since in such cases the origin of the emission is totally irrelevant for the ecological effect. Quite independent of whether a ton of CO_2 is emitted in Switzerland, China, or the United States, the impact on the global climate is the same, and Switzerland is (like any other country) unable to escape, whatever it does.

However, these are all qualitative statements. Whether leakage is an important problem and/or environmental policy measures have a relevant impact on (un-)employment is a quantitative question which can only be answered by empirical research. At least politically, however, the argument seems to be convincing; wherever environmental taxes have been introduced during recent years, exemptions have been granted either for the whole production side, i.e. only (direct) consumption of energy has been taxed, or at least for some sectors of the economy which are energy-intensive. This holds for the Scandinavian countries as well as for the Netherlands, and it is also true for the attempts to 'green' the Swiss and German tax system.[4] However, the only reason for this might be that the exempted sectors of the economy are especially successful in rent-seeking.

In the following we will first ask for the possibilities of a 'trade-neutral' design of environmental policy, especially of an 'ecological tax reform' (*Section 2*). It is shown that exemption regulations for energy-intensive sectors are not the only way, but perhaps the only practical one to reach trade-neutrality (at least approximately). Then, we ask whether there are other reasons besides the influence of political pressure groups which call for different tax rates in different sectors (*Section 3*). It is shown that besides the traditional leakage argument there might be a politico-economic argument which calls for such differences. In *Section 4* we present some simulation results for Switzerland which show that at least for this country such exemptions have no important impacts, neither economically nor environmentally. Finally, we ask whether our results can be applied to other countries as well (*Section 5*).

2 Possibilities for Trade-Neutrality of Indirect Taxes

The most natural trade-neutral indirect tax is a value-added tax based on the destination principle. Taxes are raised in the country of origin, but they are reimbursed if a good is exported. In addition, the same tax is levied on goods which are produced outside the country when they are imported. For such a tax it is quite easy to use different rates for different (categories of) goods, and this is neither discriminatory nor especially difficult to handle. Thus, one might think of an ecological tax reform which uses different (higher) rates of the value-added tax for energy than for other goods.

4. An overview over the regulations in the different countries is given in BAWI (1998).

The relative ease of the handling of the value-added tax depends, however, on the fact that in the end only goods are taxed. Thus, to use a lower rate for food or for books than for other goods (as is done, e.g., in Switzerland and Germany) is relatively simple, even though problems arise whenever a good is used as an input to another one which has a different tax rate. There are, however, tremendous problems if we start taxing production factors and try to reimburse the taxes once a good is exported. If we use a different tax rate for energy the final tax rate of a good depends on its energy content. This is, of course, exactly what we want for ecological reasons. It does not cause any problem as long as we do not try to reimburse such a tax. If the tax burden is, however, to be reimbursed at the border once the good is exported, we must know its energy content to calculate the correct rate.

This might cause a comparatively small problem if a firm is producing just a single product. Most firms, however, are producing quite different goods with rather different energy contents. Thus, it is rather difficult to know the exact energy content of a good and the corresponding tax rate. And it is even more difficult to know about this from outside the firm. If value-added taxes are to be reimbursed in relation to its energy content once a good is exported, this would not only imply high bureaucratic costs but also provide huge manipulation possibilities. Thus, such a solution of the trade neutrality problem fails simply because of practical difficulties.

Of course, this is exactly the same problem as taxing grey energy imbedded in imported goods. There, it would be even more difficult to know the exact energy content. To solve this problem, one might build categories of goods, estimate the average energy content within this category, reimburse the value-added tax in relation to this estimated energy content, and levy a similar tax on imported goods.[5)] Letting aside the practical problems of building such categories, up to this point this procedure might even be compatible with international trade rules. But if the ecological tax reform provides incentives to save energy in the production process the energy intensity will differ between domestic and imported goods. Thus, one should use different tax rates for domestically produced and imported goods.

This causes two further problems. First, it is even more difficult to estimate the energy content of a specific good if it is imported from a foreign country than if it is domestically produced. Second, at least at the moment such differentiated taxes are incompatible with current GATT/WTO rules of international trade. The principle that ‘like products’ are to be treated equally implies that different production processes (in the domestic and foreign countries) do not provide any justification for different treatments of these goods. Taxing the grey energy contained in products is discriminatory if higher tax rates are applied for foreign than for domestically produced goods.[6)] A similar (and for Switzerland quite relevant) problem would

5. The same result could be reached if a tax was only levied on the final product in relation to its energy content.

6. See for this the case between the U.S. and Mexico on U.S.-taxes on petroleum and certain imported substances, GATT, BISD, 34th supplement, 1988, pp. 136ff. – For a detailed discussion of the possibilities of taxing grey energy on the basis of Art. XX GATT see A. ZIEGLER and H. HAUSER (1995).

arise if electricity from nuclear power stations were taxed higher because of its much higher risk than electricity from water power stations.

To evade these difficulties, an alternative proposal is to use a different value-added tax rate for energy but the usual tax rate for all goods, independent of how much energy they incorporate. At a first glance, this seems to be a contradiction in itself, because (just according to its name) the value-added tax should at each stage of the production process tax just the value-added at this stage and nothing else. In fact, however, at least in Switzerland and Germany the 'value-added tax' is not a real value-added tax but a general sales tax to be paid at every stage of the production process, with the possibility of subtracting the tax amount which has been paid at previous stages. Under usual conditions, the result is the same as using a 'true' value-added tax. Problems only arise if at previous stages goods are exempted from taxation or, what would be relevant in the case of ecological taxes, are subject to higher rates. In the latter case these higher rates have no effect at all: in the case of fossil fuels in Switzerland they would be (formally) paid for by the importer, shifted to the next stage, and there subtracted from the amount to be paid. Aside from energy itself all other goods would have the same (common) rate independent of their energy content. Thus, in contrast to the first impression such a tax would be a tax which is only levied on energy directly consumed by private households and by organisations who do not have to pay value-added taxes. The (private) production side of the economy would be exempted.

Thus, the only practical (and with international trade rules compatible) way for ecological taxes using different rates of the value-added tax is a tax only on (private) consumption of energy. This would, of course, ensure trade neutrality, but it would also eliminate all incentives to restructure production processes in order to save energy. This does not only hold for sectors which are energy-intensive and/or export oriented but for all other sectors too. Moreover, there are no incentives for consumers to switch from more to less energy-intensively produced goods.[7)] Thus, many objectives of an ecological tax reform would be missed.

The alternative is to (partially) exempt those sectors from ecological taxation which produce energy-intensively and/or are competitors in international markets. Then, however, besides the question which sectors are to be exempted two additional questions arise. First, should all energy which is directly used by these sectors remain untaxed or should this only hold for process energy? It seems obvious that this should only hold for the latter. There is no reason why, e.g., energy which is used for room heating should be taxed in the banking sector but not in the chemical industry. Second, if these sectors remain untaxed but all others are taxed the untaxed sectors get a competitive advantage compared with the rest of the economy. This should matter for the redistribution of the tax revenue. If the revenue is used to reduce social security contributions, those sectors which are exempted from the energy tax might, e.g., also be exempted from the reduction of (the employers share of) these contributions. It is even

7. The problem is not that the tax burden is shifted to consumers because in an open economy with internationally (perfectly) mobile capital the whole tax burden is ultimately shifted to consumers anyway. The problem is that all incentives vanish to produce and consume less energy-intensive products.

possible to give the firms in the relevant sectors the choice whether they accept to pay the energy tax or whether they sacrifice the reduction of social security contributions.

The disadvantage of this procedure is, first, that for those industries the incentives to save energy are drastically reduced. However, those are the sectors which due to their high share of energy costs already have strong incentives to save energy. The (large) energy saving potentials which are often mentioned in the political debates are found much less in process energy but in room heating and in the traffic sector.[8)] Thus, it is questionable whether there will be much additional reduction induced by an energy price increase. The second and more important disadvantage is, however, that consumer prices of the goods produced in these sectors do at best partially reflect the tax increase and therefore only partially provide incentives for consumers to switch to less energy-intensive goods. This loss of energy saving is the larger the larger (in absolute terms) the price elasticity of these goods. On the other hand, if consumers switch to imported goods with the same high (or even a higher) energy content because of the price increase of domestically produced goods there is in any case no such incentive. In this situation the exemption might have no ecological impact at all.

Thus, whatever procedure is used to preserve trade neutrality of an ecological tax reform, it has at least some disadvantages. However, compared to the problems caused by an complete exemption of the production side and to the problems of taxing grey energy the exemption of process energy in energy-intensive producing sectors might be the procedure with the least disadvantages and, moreover, the only practical one if we do not want to tax consumers only. Thus, in the following we will first investigate in some more detail possible reasons for exempting some sectors and then ask for the economic and ecological consequences.

3 Some Theoretical Considerations

If an ecological tax reform intends to reduce the usage of energy and/or CO_2-emissions traditional economic theory tells us that a uniform tax rate (in relation to units of energy content or CO_2-emissions) is optimal. The reason for this is quite simple: If total emissions are to be reduced and if this is costly, than (increasing) marginal avoidance costs should be identical for all emitting sources. This holds if we have a uniform tax rate which provides incentives to emission reductions up to the point where the avoidance costs of the last not-emitted unit are equal to the tax rate. The tax rate should be equal to the marginal damage caused by the last emitted unit, i.e.

(1) $\quad t_i = \lambda e_i = \lambda E_i/x_i,$

with t_i being the tax rate with respect to good x_i, E_i the emissions connected with the production (and/or consumption) of this good, e_i its emission intensity and λ the shadow price of the emission.[9)] This uniform tax rate is, however, only optimal if the marginal damage is equal for

8. See for this, e.g., E.U. V. WEIZSÄCKER, A.B. LOVINS and L.H. Lovins (1995).

9. See, e.g., H. SIEBERT (1978), pp. 39ff.

all emission sources. This really holds for CO_2. For other emissions like SO_2 or NO_x the marginal damage depends on the regional concentration. Thus, different tax rates are optimal between regions, but within regions the rates should again be uniform.[10)]

Apart from political considerations, there are, nevertheless, (at least) two reasons why differing tax rates for different sectors of the economy might make sense. Both reasons play some role in the public debate about the tax reform. The first reason is the endeavour to limit the tax burden. Traditional economists, especially those from the optimal taxation tradition usually only consider the excess burden of taxation. Political economists as well as ordinary people, however, often consider the total tax burden as being relevant. Then, we have the problem of maximising the environmental effect subject to a given tax revenue, or to minimise the tax revenue subject to a given environmental standard. Thus, the elasticity of the emission with respect to the tax revenue is important. Second, as mentioned above, at least in a small open economy the existence of leakage effects make it possible that the introduction of a CO_2 tax might even increase total CO_2 emissions. Both cases shall be discussed in the following.

3.1 Minimal Tax Revenue Subject to a Given Environmental Standard

First, we consider the problem of minimising total tax revenue T from an emission tax,

(2) $$T = \sum_{i=1}^{n} T_i = \sum_{i=1}^{n} t_i\, e_i\, x_i\,,$$

where t_i, i = 1, ..., n, are the tax rates for the different goods x_i with respect to their emission intensities e_i, subject to the constraint

(3) $$E^* = \sum_{i=1}^{n} E_i = \sum_{i=1}^{n} e_i\, x_i\,,$$

where E* is the maximal acceptable emission, and the non-negativity constraints $t_i \geq 0$, which implies that we only consider taxes but exclude subsidies. Thus, we get the Lagrange-function

(4) $$Min: \;\; L = \sum_{i=1}^{n} t_i\, e_i\, x_i - l\left[\sum_{i=1}^{n} e_i\, x_i - E^*\right] - \sum_{i=1}^{n} m_i\, t_i\,,$$

with μ_i and $\lambda \geq 0$. For constant e_i we get the first order conditions:

(5) $$x_i\, e_i + \sum_{j=1}^{n}\left(t_j \cdot e_j \cdot \frac{\partial x_j}{\partial p_i} \cdot \frac{\partial p_i}{\partial t_i}\right) - l\left[\sum_{j=1}^{n}\left(e_j \cdot \frac{\partial x_j}{\partial p_i} \cdot \frac{\partial p_i}{\partial t_i}\right)\right] - m_i = 0\,,$$

10. For a model with regionally differing tax rates see H. SIEBERT (1978, pp. 123ff.).

i = 1, ..., n, where p_i is the consumer price of good i. For the most simple case that all cross price elasticities are zero, and if (under perfect competition) long-run marginal costs are constant, because of $\partial p_i/\partial t_i = e_i$ we get:

$$(5') \qquad x_i\, e_i \;+\; t_i \cdot e_i^2 \cdot \frac{\partial x_i}{\partial p_i} \;-\; l \cdot e_i^2 \cdot \frac{\partial x_i}{\partial p_i} \;-\; m_i \;=\; 0\;,$$

i = 1, ..., n. If the tax rate is positive than due to the Kuhn-Tucker-conditions it holds that μ_i = 0. Thus, (5') can be transformed to

$$(6) \qquad t_i \;=\; \frac{l\, h_i - r_i / e_i}{(1 + h_i)}\;,$$

where r_i is the producer price of good x_i and η_i its demand elasticity. Because the denominator is always negative, we get positive taxes only for $\eta_i < -1$, i.e. for those goods where the demand is elastic. Moreover, it holds that

$$(7) \qquad \frac{\partial t_i}{\partial e_i} \;=\; \frac{1}{1 + h_i} \cdot \frac{r_i}{e_i^2} \;<\; 0, \qquad \frac{\partial t_i}{\partial h_i} \;=\; \frac{l + r_i / e_i}{(1 + h_i)^2} \;>\; 0\,.$$

i.e., the tax rate is the higher, the lower the energy intensity is, and it is – as in the famous Ramsey rule – the higher, the lower the absolute value of the demand elasticity is. The second derivative of the Lagrange function is

$$(8) \qquad \frac{\partial^2 L}{\partial t_i^2} \;=\; e_i^2 \left[2 \cdot \frac{\partial x_i}{\partial p_i} \;+\; e_i\,(t_i \;-\; l)\, \frac{\partial^2 x_i}{\partial p_i^2} \right],$$

which might be positive or negative depending on the size of the second derivative of x_i with respect to p_i. Thus, relation (6) might give the conditions of minimal but also of maximal tax revenue. In the latter case, corner solutions might be optimal, i.e. if tax rates are restricted to be non-negative some sectors might become totally exempted from taxation.[11)]

If no energy is used in some sector, i.e. if $e_i = 0$, than according to (6) the tax rate goes to infinity, while the tax rate with respect to one unit of good x_i,

$$(9) \qquad t_i\, e_i \;=\; \frac{-r}{1 + h} \;>\; 0$$

is positive. In this situation, however, the objective function would require zero taxes. Thus, for goods which are produced without energy and – due to relation (7) – also for goods with very low energy intensities relation (6) is the condition for a maximum.

A similar argument holds if the constraint is not binding. Then, because of $\lambda = 0$, also (9) holds, i.e. tax rates are positive despite the fact that no taxes are needed to reach the environ-

11. An example for such a corner solution is given in the Appendix.

mental objective and, therefore, the optimal solution would require zero taxes. Starting from the given emission level and reducing it gradually, i.e. increasing the shadow price of the emission, λ, tax rates are increasing and relation (6) still gives the condition of a maximum. As for the energy intensity, it can, however, not be excluded that for high levels of e and/or λ relation (6) is the condition for a minimum.

A theoretical foundation for minimising tax revenue subject to a given environmental standard can be found in Constitutional Economics as represented, e.g., by J.M. BUCHANAN (1987, 1987a). The question of an – from this perspective – optimal tax system is thoroughly discussed in G. BRENNAN and J.M. BUCHANAN (1980). Traditional (optimal) taxation theory assumes that the government behaves like a benevolent dictator. Even with respect to democratic governments, there is hardly any assumption in economics which is empirically that wrong. Governments, as all other agents too, aim to maximise their (subjective expected) utility according to their (perceived) restrictions. This does not necessarily lead to a Leviathan government, but certainly not to the maximisation of social welfare either, whatever this might be. Appropriate political institutions might force a government to behave more or less according to the preferences of the citizens, but there is certainly not a one-to-one correspondence. Moreover, it is debatable whether the minimisation of the excess burden of taxation is really the main objective of the citizens with respect to taxation.

Just opposite to the traditional approach, G. BRENNAN and J.M. BUCHANAN (1980) explicitly assume that the government behaves like a Leviathan who tries to exploit the citizens. A general energy and/or carbon tax which – due to the inelastic demand – might generate a large revenue might be rather well suited for such an exploitation, especially as there is an additional 'green' justification for such a tax.[12] CH.B. BLANKART (1987) has shown that (under specific conditions) the structure of a revenue maximising indirect tax corresponds to a structure which minimises the excess burden of taxation.[13] Thus, it is no surprise that at least some of the tax proposals of G. BRENNAN and J.M. BUCHANAN (1980) are just the opposite of what the theory of optimal taxation tells us. It is in line with this reasoning that a tax system which minimises the revenue (subject to some other objectives) leads to results which contradict the results of optimal taxation theory. In our case this implies that uniform tax rates are no longer optimal.

But even if we do not assume that the government behaves like a Leviathan it can hardly be denied that there are real burdens of taxation besides the excess burden. Administrative costs connected with rising (and redistributing) taxes play an important role in this respect. If it is assumed that such 'political excess burdens' differ between taxes, but are more or less pro-

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12. Sometimes, the opposite argument is brought about against an ecological tax reform: if an ecological tax was ecologically successful, the tax base erosion effect would lead to a tax revenue which is too small to substitute other (income) taxes. Because, especially for fossil fuels, demand is (presumably also in the long-run) inelastic and because of its large base this does not hold for a general energy and/or CO_2-tax. See for this G. KIRCHGÄSSNER (1998, pp. 304ff).

13. For the theory of optimal taxation and its critique from a politico-economic perspective see the discussion between W.R. RICHTER and W. WIEGARD (1993, 1994) and CH.B. BLANKART (1994); especially with respect to an ecological tax reform see G. KIRCHGÄSSNER (1998a).

portional to total tax revenue for specific taxes it makes sense to keep this revenue as small as possible without, of course, impairing the other objectives. This is also an argument to reach the ecological objective of such a tax with a minimal revenue.

3.2 Leakage Effects

The second argument in favour of different tax rates for different sector is the possibility of leakage effects. Let us consider a carbon tax levied on fossil fuels. If we consider the reaction of the energy usage on a change of the tax rate we get

$$(10) \qquad \frac{\partial E_i}{\partial t_i} = \frac{E_i}{x_i} \cdot \frac{\partial x_i}{\partial t_i} + x_i \cdot \frac{\partial (E_i / x_i)}{\partial t_i} .$$

From this we get after some transformations:

$$(11) \qquad h_{E_i, t_i} = (h_{x_i, p_i} \cdot h_{p_i, p_e} + h_{E_i / x_i, p_e}) h_{p_e, t_i} < 0,$$

with (always related to the sector (good) i):

$h_{E_i, t_i} < 0$:	the elasticity of energy usage on the tax rate,
$h_{x_i, p_i} < 0$:	the price-elasticity of demand,
$h_{p_i, p_e} > 0$:	the elasticity of the product price on the energy price,
$h_{E_i / x_i, p_e} < 0$:	the elasticity of the energy intensity on the energy price,
$h_{p_e, t_i} > 0$:	the elasticity of the energy price on the tax rate.

Thus, the saving of energy is – ceteris paribus –larger the stronger the demand for good x reacts to a price change, the stronger the product price and the energy intensity react to the energy price changes, and the stronger the energy price reacts to a change of the tax rate.

The crucial relation is the reaction of the energy intensity to the energy tax rate. As long as we only consider domestically produced goods this relation is clearly negative. As soon, however, as we consider total demand of this good we have to split up total energy demand in

$$(12) \qquad E_i = e_i^d \left(x_i^{dd} + x_i^{df}\right) + e_i^f \left(x_i^{fd} + x_i^{ff}\right),$$

with x_i^{jk}, j, k = d, f,, being goods produced (j) and consumed (k) in the domestic (d) or foreign (f) country and e_i^j being the corresponding energy elasticities. The effect of an domestic tax increase on total energy usage is given by

$$(13) \quad \frac{\partial E_i}{\partial t_i^d} = \frac{\partial}{\partial t_i^d}\left(e_i^d x_i\right) + (x_i^{fd} + x_i^{ff}) \cdot \left[\frac{\partial}{\partial t_i^d}\left(e_i^f - e_i^d\right)\right] + \left(e_i^f - e_i^d\right) \cdot \left[\frac{\partial}{\partial t_i^d}(x_i^{fd} + x_i^{ff})\right],$$

with x_i being total for good x_i (at home and abroad). While according to (11) the first part of this expression is negative, as long as the foreign goods are produced with more energy than domestic goods the two latter parts will be positive. Thus, the probability that an increase of the domestic energy price leads to an increase of total energy demand is the higher the larger the difference between the two energy intensities and the higher (in absolute terms) the substitution elasticities between foreign and domestically produced goods are. From an environmental point of view it would be optimal to tax, corresponding to (1), foreign and domestically produced goods in relation to their energy content. However, this is, if at all, only possible if the policy is internationally co-ordinated, because the domestic country (trivially) is unable to tax goods which are produced and consumed in foreign countries.

Besides practical (and legal) problems, the question whether the different components should be taxed depends (besides other things) on the objective function of the government. If we consider CO_2-emissions where the environmental effect is independent of the location of the emission, and if only the ecological objective is relevant, then the total amount of emitted CO_2 should be minimised. Starting from a situation where energy intensities (and prices) are identical between the domestic and foreign countries, for any constant elasticity of substitution σ, as long as it is not - 8 , i.e. as long as the demand is not perfectly elastic, any increase in the price of the domestically produced good will reduce total emissions. The assumption of an infinite substitution elasticity makes, however, hardly sense in this context, because in this case the good would be produced either domestically or in a foreign country but not in both places, at least as long as there are some differences in production costs. Thus, domestically produced goods should be taxed, and there should be no re-imbursement at the border if these goods are exported, whether the imported goods can be taxed or not. Production might be shifted to a foreign country, but even in this case, as long as $\sigma > -\infty$ and $e_i^f = e_i^d$, total emission will be lower than if the corresponding sector is exempted. This does, however, no longer hold as soon as the energy intensity is higher in the foreign than in the domestic production. Then, as (13) shows, the reduction of the domestic energy consumption may be overcompensated by an increase of foreign energy consumption.

However, the assumption that the reduction of the emissions is the single objective of environmental taxation makes sense, if at all, in a full employment equilibrium situation only. In this situation, the possible increase in 'voluntary' unemployment should cause no significant social problem. The situation is quite different if there is involuntary unemployment and if the reduction of domestically produced goods further increases unemployment. Then, the employment is likely be more important than the environmental objective. There would be winning and losing sectors as a result of the tax reform, but the gross effect on employment should be positive as long as the tax revenue is used to reduce gross labour costs. Thus, unemployment could be reduced by such a reform.[14] Nevertheless, since it can be expected that the energy-intensive sectors would lose most, this might be a reason to exempt them from taxation or at least to use reduced rates.

If there is involuntary unemployment, the economic and ecological impacts of exemptions depend on many more parameters than just the demand elasticities for the respective goods

14. See for this E. KOSKELA, R. SCHÖB and H.-W. SINN (1999) or, with special reference to Switzerland, G. KIRCHGÄSSNER, U. MÜLLER and M. SAVIOZ (1998).

and the substitutions elasticities of domestically and foreign produced goods. To provide at least tentative answers simulations can be made. This is done for Switzerland in the next section.

4 Simulation Results for Switzerland

Whatever the reason for exempting some sectors from a general energy or carbon tax might be, the question remains whether such exemptions have a measurable economic or environmental impact. As has been stated above, this is an empirical question. One way to give (at least tentative) answers to such questions is to perform simulations. In this paper, we do this for a carbon tax for Switzerland. The analysis is based on a static applied general equilibrium model of the Swiss economy for the year 1990, and we ask for the economic and environmental consequences of a tax of 36 Sfr per ton CO_2. Such a tax has been proposed by the Swiss government (Bundesrat) in 1993. We use two different versions of the simulation model. In the first version we assume the existence of a Walrasian equilibrium with only voluntary unemployment, in the second version we assume that involuntary unemployment exists. In both cases we compare situations without exemptions with a situation where the three most energy-intensive sectors are exempted from the CO_2 tax. The model corresponds in its broad characteristics to the one developed by A. MEYER ZU HIMMERN (1997).

4.1 Description of the Model

There are three (primary) production factors: capital, labour, and energy. Energy is assumed to be internationally perfectly mobile, i.e. its market price is internationally determined. Labour is assumed to be internationally immobile. The critical assumption concerns capital. Taking the Swiss situation of a small open economy into account, it makes sense to assume that capital is also internationally (perfectly) mobile. Thus, we use this assumption if we run simulations with a Walrasian labour market. But under these assumptions any wage rate which is above its equilibrium level would immediately reduce domestic production to zero. Thus, to embed involuntary unemployment which is caused by too high a gross wage rate in our model we need one fixed factor of production besides labour. Therefore, to allow for involuntary unemployment we assume that capital is (quasi) fixed. To make comparisons possible, we also perform simulations for a Walrasian labour market and fixed capital. However, this assumption is not only due to methodical reasons, it can also be justified by substantial arguments: Involuntary unemployment is – at least hopefully – a short or medium term phenomenon, and, as the studies of M. FELDSTEIN and PH. BACHETTA (1991) and others show, the FELDSTEIN-HORIOKA-Paradox (1980) still holds: Real capital is much less mobile than economic theory suggests.[15)]

15. See, e.g., K.R. FRENCH and J.M. POTERBA (1990), M. FELDSTEIN and T. SINAI (1994) or A.M. TAYLOR (1996).

Thus, the structure of the model is as follows:

(i) *Producer behaviour:* The supply-side of the model is disaggregated into twenty industrial sectors which are listed in *Table A1* in the Appendix. Producers are assumed to maximise profits subject to their production technology. Nested linear homogeneous constant-elasticity-of-substitution (CES) production functions are assumed. The arguments of the production functions are the intermediate inputs and the primary inputs, labour, capital and energy. The latter input is disaggregated in electricity, gas and fuels. The substitution elasticities and the nesting structure are described in *Figure 1*. These elasticities, together with the Input-Output Table of the year 1990, are used to calibrate the production functions of the twenty industrial sectors.

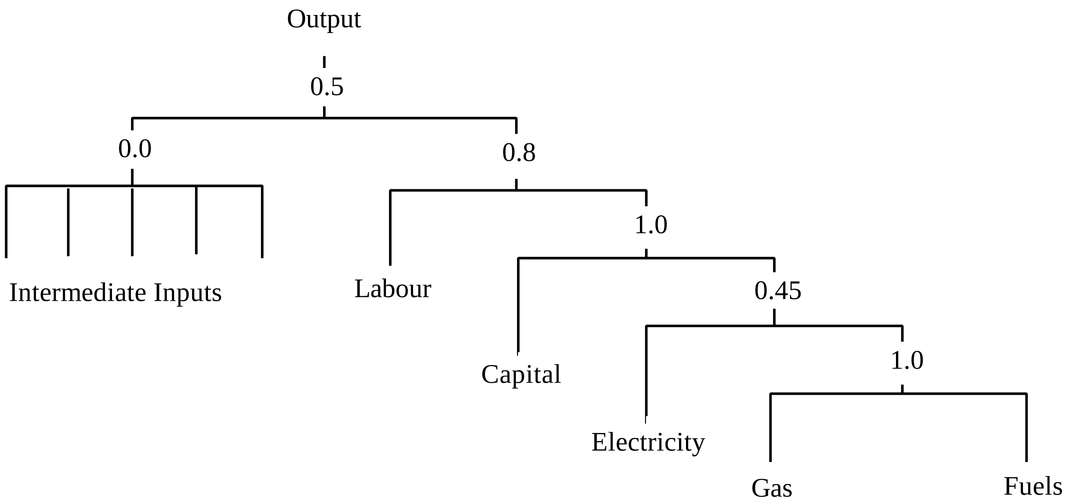

Figure 1: The nested CES production functions.

(ii) *Household behaviour:* The demand-side of the model is disaggregated into four types of households: workers, unemployed, retired people living from social security transfers and retired people living from the return of their capital. The whole capital is owned by the latter. Households are assumed to be utility-maximisers. The utility functions are of the nested linear homogenous constant-elasticity of substitution (CES) type. The arguments of the utility functions are the twenty consumer goods and – in the equilibrium version – also leisure. There, the elasticity of substitution between leisure and consumption is assumed to be 2.1.[16)] In an economy with involuntary unemployment, however, leisure has no opportunity cost for workers and unemployed. The same is true for retired households, because it is assumed that they do not have the opportunity to work. Therefore leisure does not enter the utility functions. *Figure 2* gives the nesting structure and the elasticities of the utility function for the model with involuntary unemployment.

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16. This corresponds to an elasticity of labour supply with respect to real wage of 0.15. See A. MEYER ZU HIMMERN (1997, pp. 208ff.) for a description of the derivation of these values.

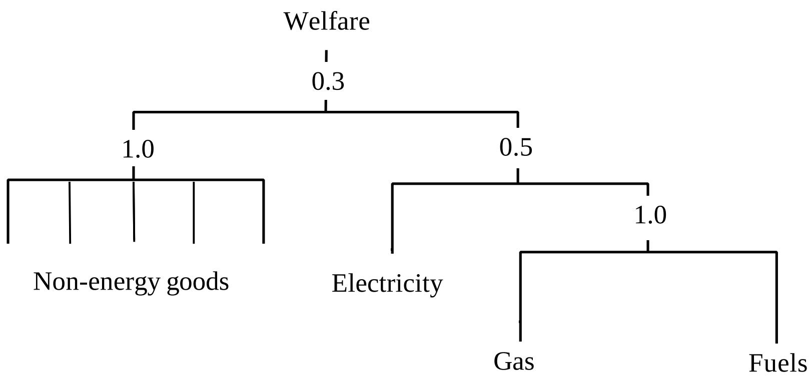

Figure 4: The nested CES utility functions.

The four types of households differ with respect to their budget constraints. The income of the workers is the product of the after-tax wage and the number of employed. An increase in employment may increase the income of this sector even if the after-tax wage falls. The income of the unemployed sector is the product of the insurance benefits and the number of unemployed. The numbers of employed and unemployed workers add up to the total working population which is assumed to be constant. The income of the (retired) capital owners is the product of the rate of return and the capital stock. The retired transfer earners get a pension fixed in real terms. The purpose of disaggregating the household sector in workers and capital owners is to display the effects of the energy tax on the functional distribution of incomes. The assumed elasticities together with the assumptions about the endowments of the households with labour and capital and their benchmark consumptions are sufficient to calibrate the utility functions.

(iii) *Government and social security*: The public sector is composed of the government sector and the social security sector, which pays retirement and unemployment insurance benefits. The revenues of this sector are a proportional income tax of 10 percent levied on labour and paid by the workers, the social security contributions which are also levied on labour but paid in equal shares by employers and employees, a tax of 15 percent on capital income, duties and indirect taxes as they were present in the Swiss 1990 economy, and the carbon tax levied on energy which is used for private consumption and as production input. The public sector spends these expenditures on government consumption (and government investment), transfers to retired people, and transfers to the unemployed. The per capita benefits to the unemployed are 75 percent of the real wage paid to the workers.

Tax revenue are adjusted so that the budget of the public sector remains balanced. In particular the introduction of the carbon tax is revenue neutral: It is compensated for by a decrease of the social security contributions. The transfers to the unemployed decrease with unemployment, while the transfers to the retired remain constant in real terms. The consumption expenditures of the public sector are assumed to be constant in relation to private activities, i.e. they are a constant share of GDP.

(iv) *Labour Market*: In the benchmark we assume that the unemployment rate is 5 percent, be it voluntary or involuntary.[17] The real wage is assumed to be the result of negotiations. In the equilibrium version the negotiated real wage is fixed in a way that we have a Walrasian equilibrium with voluntary unemployment of 5 percent. In the disequilibrium model the negotiated real wage is fixed above the Walrasian equilibrium wage so that a level of involuntary unemployment of 5 percent results. The labour cost (gross wage) is the negotiated wage with half of the social security contributions added, while the net wage is the negotiated wage minus the other half of the social security contributions and the labour tax. The price index used in the negotiations is an implicit deflator of consumption expenditure, where the prices of the energy goods enter the index *before* the energy tax. Thus, it is assumed that workers accept that with the introduction of an carbon tax the negotiated nominal wage remains constant, i.e. they accept a decrease of the negotiated real wage, because they are (at least partially) compensated by a reduction of their social security payments (in addition to the higher environmental quality). This is the crucial behavioural assumption of the model. The negotiated wage is kept fixed in nominal terms with respect to this price index. Other price changes than the introduction of an energy tax levied on the direct consumption of energy by households influence the nominal wage but leave it unchanged in real terms.[18]

(v) *Foreign trade*: It is assumed that a foreign household demands the exports and represents the 'rest of the world'. The elasticities of substitution between the exported goods and a single 'multifunctional' good that the foreign household is endowed with, are given in the second column of *Table A1* in the Appendix. The terms of trade adjust so that the balance of trade remains in equilibrium. The imports of the foreign good are a substitute to the intermediate goods produced in the domestic economy. The elasticities of substitution are found in the first column of *Table A1*.

(vi) *The environmental tax*: This tax is assumed to be a CO_2 tax. It is levied on the (direct) consumption of energy goods (fuels and gas) by private households as well as on energy goods utilised as inputs in the production sectors.[19] Thus, electricity is not taxed.

4.2 Simulation Results

The model is calibrated with Input-Output data for the year 1990.[20] The assumed elasticities of substitution and the input-output data fully specify the utility and production functions.

17. This was approximately the average Swiss unemployment rate in 1996.

18. This implies that workers are compensated for price increases of consumer goods as a result of energy price increases, but they also do not gain from price decreases following the reduction of unit labour costs.

19. Because practically all fossil energy is imported, this corresponds to a tax which is levied on imports of fossil energy. The export of energy goods are, with the exception of electricity, of a small order of magnitude, and they are not taxed in the model.

20. This was the latest available Input-Output data for Switzerland when we started this project. A description of the data is given in G. ANTILLE (1995).

Parametrised in this way, the model is solved for equilibrium prices and quantities.[21)] This represents the benchmark relative to which the results of the simulations are compared. Under these assumptions an income tax of 22 percent (including social security contributions) balances the budget of the public sector.

Six scenarios, as listed in *Table 1*, are computed. In *Scenario I* the labour market is modelled in the usual Walrasian way. This implies that employment (and leisure or unemployment, respectively) are endogenous. Unemployment benefits are paid to five percent of the workers. A carbon tax of 36 Sfr per ton CO_2 is levied. In *Scenario II* the three most energy-intensive sectors, paper industry, mining and iron industry, and chemical industry, are exempted from the CO_2 tax. However, the share of the social security contributions paid by the firms in these sectors is not reduced either when the CO_2 tax is introduced; only social security contributions owed by the workers in these sectors are decreased. In *Scenario III* the Walrasian labour market is combined with the assumption of internationally mobile capital. In *Scenario IV* we employ the same assumptions but again exclude the three most energy-intensive sectors from the CO_2-tax. Finally, *Scenarios V and VI* corresponds to *Scenarios I and II* but with involuntary unemployment.

Table 1: The Scenarios

Scenario	Crucial assumption	Change in GDP
I	Walrasian labour market; no exemptions	0.0
II	Walrasian labour market; three sectors exempted	0.0
III	Walrasian labour market; no exemptions, mobile capital	0.1
IV	Walrasian labour market; three sectors exempted, mobile capital	0.1
V	Involuntary unemployment; no exemptions	0.5
VI	Involuntary unemployment; three sectors exempted	0.5

Table 1 also gives the general economic impact for the different scenarios, i.e. the change in GDP. As long as there is only voluntary unemployment, there is nearly no change at all. As soon as involuntary unemployment exists, we get a positive impact on GDP. An exemption of the energy-intensive sectors from the CO_2 tax has no measurable impact on the change in GDP.

Table 2 presents the effects on the emissions of CO_2 (second column) and energy consumption (third column). The results are presented in percentage changes relative to the benchmark value which is given by 44 million tons, the amount of CO_2 which was emitted in 1990 in Switzerland. The reference scenario shows that a CO_2 tax of 36.- Sfr per ton leads to a reduction of these emission of 8.7 percent. We get nearly the same figure in Szenario III if we as-

21. As it is (still) the usual practice in the applied general equilibrium literature, the computed relative prices are not compared with the actual relative prices in order to validate the model.

sume capital to be mobile. The Scenario V with involuntary unemployment predicts a somewhat lower reduction of the emissions (- 8.3 percent). This is a consequence of the fact that in this scenario economic activity is changed contrary to the scenarios with only voluntary unemployment. The exemption of the energy-intensive sectors from the obligation to pay the CO_2 tax does only slightly reduce the environmental effects (Scenarios II, IV and VI), the reductions of the CO_2-emission is 0.6 percentage points lower than without this exemption.

Table 2: Emissions of CO_2, Use of Energy, and Revenue of the Ecological Tax

Scenario	CO_2-Emissions*)	Energy-Consumption*)	Tax Revenue
I	- 8.7	- 7.6	1.43 Mrd
II	- 8.1	- 7.1	1.34 Mrd
III	-8.6	- 7.6	1.43 Mrd
IV	-8.0	- 7.0	1.34 Mrd
V	- 8.3	- 7.3	1.43 Mrd
VI	- 7.7	- 6.8	1.35 Mrd

*) These results are given in percentage changes relative to the benchmark

The third column of *Table 2* shows the results for total energy consumption. There the reduction is almost proportional to the reduction in CO_2-emissions. This holds for all scenarios. The last column shows the revenue of the carbon or energy tax which corresponds to the reduction of the social security contributions. With 1.4 Mrd. Sfr its amount is nearly the same in all four scenarios. This corresponds to 1.4 percent of total government revenue (and expenditure), and 5.25 percent of the contributions for the public social security system with the ‘first pillar’ of the old age pension system (AHV), unemployment insurance (ALV) and the insurance for invalidity (IV).

Table 3: Gross Production of the Energy-intensive Sectors

Scenario	Mining and Iron Industry*)	Paper Products*)	Chemical Products*)
I	- 0.159	- 0.236	- 0.297
II	- 0.044	- 0.171	- 0.249
III	- 0.081	- 0.218	- 0.218
IV	0.039	- 0.166	- 0.166
V	0.390	0.311	0.172
VI	0.498	0.368	0.213

*) These results are given in percentage changes relative to the benchmark

Table 3 shows the gross production of the three sectors with the highest energy intensities, which are subject to exemptions of the carbon tax. If we assume a Walrasian labour market gross production of those sectors is declining. This also holds if we exempt those sectors from the carbon tax, but also from the corresponding reductions in the social security contributions, but to a lesser extent. But in the case of involuntary unemployment even for those three sectors the production reduction due to higher energy prices is overcompensated by the increased production due to higher demand: the increase in gross production of those sectors is lower than the one of the total economy (of GDP) but still positive, whether or not exemptions are assumed.

It is assumed that the negotiated nominal wage remains constant. Thus, the real wage does not fully adjust to changes of the prices of the energy goods consumed. The introduction of the CO_2 tax therefore causes a decrease of the negotiated wage in real terms. Because the green tax reform is assumed to be revenue neutral, the introduction of the CO_2 tax is also followed by a reduction of the social security contributions. Furthermore, as the base of the CO_2 tax is smaller than the base of the labour tax (or the social security contributions, respectively), the green tax reform implies a distortion effect which lowers the marginal product of labour.

Table 4: Tax Rates and Unemployment

	Tax rate on labour income *)	**Unemployment Rate**
Status quo	22.0	5.0
I	21.2	4.9
II	21.3	4.9
III	21.2	4.9
IV	21.3	4.9
V	20.1	4.0
VI	20.2	4.0

The tax rate on labour income is given in percent. The rate of unemployment is the percentage of unemployed relative to the total number of (potential) workers.

*) This is the total tax on labour which includes social security contributions of employers and employees

Because of the reduction in the employers' part of the social security contributions, in our model the gross wage rate and, therefore, real labour costs fall even more than the negotiated real wage. In the scenarios with the Walrasian labour market this has, however, nearly no effect on employment, as this is determined by labour supply. As the real wage is nearly unchanged, (un-)employment remains nearly constant. This does not change if the energy-intensive sectors are exempted. In the version with involuntary unemployment, however, the reduction of the gross wage rate leads to an increase in production and also in employment. This reduces the amount of revenues which are needed for unemployment compensations. Thus, an additional reduction of social security contributions is possible, which again increases the real net wage. Thus, as is shown in *Table 4*, the social security contributions are lower (the real net wage is higher) in the model with involuntary unemployment compared to the model with a Walrasian labour market. Again, the exemption of the energy-intensive sectors has hardly any impact on these results, neither on the tax nor on the unemployment rate.

Table 5: Terms of trade effects

	Exports	**Terms of trade**[*)]
I	- 0.3	0.2
II	- 0.3	0.2
III	- 0.3	0.2
IV	- 0.2	0.2
V	0.1	- 0.1
VI	0.1	- 0.1

The results are given in percentage changes relative to the benchmark.

*) The terms of trade are defined here as the average price of the goods exported, weighted with their export shares, relative to the price of foreign domestic goods. The terms of trade adjust so that the balance of trade constraint is fulfilled.

The impact on the competitiveness of the Swiss economy is described in *Table 5*. In the models with a Walrasian labour market, the terms of trade improve, and exports and imports decline. Contrary to this, in the model with involuntary unemployment, a carbon tax is followed by a reduction in the terms of trade and an increase in exports and imports. But in all cases these effects are small, and they do not change if the energy-intensive sectors are exempted.

5 Summary and Concluding Remarks

Using traditional economic arguments energy taxes should be uniform across sectors. This holds especially if carbon taxes are considered as policy measures against global environmental problems like global warming.[22)] But wherever attempts are made to 'green' the tax system at least some sectors are treated differently. In this paper it has been shown that there can be valid reasons for doing so: There are not only political considerations due to the influence of strong pressure groups which can justify lower rates or even exemptions for energy-intensive sectors, but also politico-economic considerations to limit the tax revenue or to avoid job losses if significant leakage effects are to be expected. Moreover, our simulation results for Switzerland where we compare the effects of a carbon tax without exemption with policies where the three most energy-intensive sectors are exempted from the carbon tax show that such exemptions may have minor economic and ecological consequences.

22. For such a use of carbon taxes see the seminal paper of D.A. PEARCE (1991).

The problem is, of course, how far these results can be generalised. The argument of limiting the share of the government is, of course, independent of the size or openness of a country and of its share of energy-intensive industries. The importance of leakage effects depends, however, (i) on the size (and openness) of the country and (ii) on the share of energy-intensive production of GDP. Ceteris paribus, it seems plausible to assume that the smaller a country is the higher will be the potential negative economic effect due to leakages and the smaller the (overall) environmental effect of exemptions. Thus, it is no surprise that the small European countries which started with 'greening' their tax system all used differing tax rates. Moreover, the higher the share of energy-intensive sectors is the stronger will be the economic argument for such exemptions. But the larger the country is (and the higher its share of energy-intensive industries) the higher will be the environmental costs of such exemptions. We can imagine two extreme cases: For small countries with a small share of energy-intensive sectors such exemptions will have neither economically nor environmentally strong effects. This is what our simulations for Switzerland show. Large countries with a high share of energy-intensive industries are in a difficult situation. On the one hand, the possibility of leakage effects is of minor importance. On the other hand, there might be real economic losses. To avoid such losses one might strongly strive for internationally co-ordinated policies.

What may be said about Germany in this respect? Compared to Switzerland, it is certainly not a *small* open economy, and it has a much higher share of energy-intensive industries. Thus, the international co-ordination of possible carbon tax policies is of much higher relevance. But being the economically most important member of the European Union it also has (compared to Switzerland, e.g.) much better possibilities to push for such a co-ordinated policy, at least within Europe.

The new German government which has been elected in September 1998 nevertheless undertakes some (rather modest) steps to green its tax system in a solo-run. It considers Germany as a small open economy (compared, e.g., to the U.S.) and proposes exemptions for energy-intensive industries. This might be necessary for political reasons, but it does not seem to be necessary for economic reasons: H. WELSCH and others show that a German solo-run should have positive employment effects as long as the revenue of the ecological tax is redistributed so as to reduce gross labour costs.[23)] This holds even if there are no exemptions for energy-intensive industries.

23. See, e. g., H. WELSCH (1996, 1996a), H. WELSCH and F. HOSTER (1995) as well as the overview in M. KOHLHAAS and H. WELSCH (1995).

Appendix: A) A Small Theoretical Model of Optimal Tax Revenue

There are two goods in the economy, x_1 and x_2. The two (linear) demand functions are:

(A.1) $x_1 = 12 - p_1, \quad x_2 = 5 - 0.5\,p_2,$

where p_1 and p_2 are the two consumer prices. With each produced unit of x_1 and x_2 one unit of E is emitted. Tax rates are t_1 and t_2, which are levied on the producer prices $r_1 = 1$ and $r_2 = 2$. Total emissions shall not exceed 10 units. We optimise the tax revenue

(A.2) $T = t_1(11 - t_1) + t_2(4 - 0.5\,t_2),$

subject to the constraint

(A.3) $E^* = 10 = 15 - t_1 - 0.5\,t_2.$

Thus, we get the Lagrange-function

(A.4) $L = t_1(11 - t_1) + t_2(4 - 0.5\,t_2) + \lambda(5 - t_1 - 0.5\,t_2).$

From this we get the first order conditions

(A.5a) $\partial L/\partial t_1 = 11 - 2\,t_1 - \lambda = 0,$

(A.5b) $\partial L/\partial t_2 = 4 - t_2 - 0.5\,\lambda = 0,$

which have to hold together with the restriction (A.3). From this we get the optimal solution

(i) $t_1 = 3.83, \quad p_1 = 4.83, \quad x_1 = E_1 = 7.17,$

$t_2 = 2.33, \quad p_2 = 4.33, \quad x_2 = E_2 = 2.83,$

$T = 34.1.$

Due to (A.5) the second derivatives are negative and the cross terms zero. This implies that solution (i) is a maximum and the only interior optimum. Thus, tax revenue is the lower the further away (in different directions) the two tax rates from their optimal values are. The two possible corner solutions are:

(ii) $t_1 = 5, \quad p_1 = 6, \quad x_1 = E_1 = 6,$

$t_2 = 0, \quad p_2 = 2, \quad x_2 = E_2 = 4,$

$T = 30,$

and

(iii) $t_1 = 1, \quad p_1 = 2, \quad x_1 = E_1 = 10,$

$t_2 = 8, \quad p_2 = 10, \quad x_2 = E_2 = 0,$

$T = 10,$

Thus, solution (iii) is the one with minimal tax revenue. The optimal solution with a uniform tax rate is, however,

(iv) $t_1 = 3.3, \ p_1 = 4.3, \ x_1 = E_1 = 7.7,$

$t_2 = 3.3, \ p_2 = 5.3, \ x_2 = E_2 = 2.3,$

$T = 33.3,$

This is quite near to the maximal tax revenue. It is, moreover, the only uniform tax rate for which the restriction exactly holds.

B) Sectoral Disaggregation

Table A1: Elasticity of substitution between imports and exports *)

Sectors	home country	foreign country
1) Electricity	1.5	2.0
2) Gas	4.0	4.0
3) Oil products	4.0	4.0
4) Agriculture and forestry	1.5	2.0
5) Water supply	0.0	0.0
6) Food and beverages	1.5	2.0
7) Textile and clothing products	2.0	2.0
8) Paper products	2.5	1.5
9) Chemical products	2.0	2.0
10) Mining and iron industry	5.0	1.3
11) Non-ferrous metal products	1.5	1.5
12) Products of the machine industry	3.0	0.5
13) Rest of industry	1.5	2.0
14) Construction	0.0	0.0
15) Wholesale and retail trade	1.5	2.0
16) Tourism and gastronomy	0.0	0.0
17) Transportation	1.5	2.0
18) Finance and Insurance	1.5	2.0
19) Education and health	0.0	0.0
20) Government and social security	0.0	0.0

*) The elasticites of substitution are the ones between the corresponding home produced good and imports and the exports and the (unique good) produced in the foreign country. The elasticities are taken from A.-C. MEYER ZU HIMMERN (1997 p. 110), who refers to G. ANTILLE et al. (1993).

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