ECO - Taxes, CO_2 - Emissions and Structural Change in Germany

by

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1. Introduction

In 1990 the German government announced the target to reduce the CO_2-emissions by 25% in relation to the historical value of that year till 2005.

At the Berlin-conference in 1995 the target was widenend for unified Germany, which meant a reduction of the efforts, because the eastern German industry had had very big CO_2-missions in 1990, but with the break-down of these old structures in the following years, nearly half of the target was already reached in 1995. In 1997 a further target was announced by all EU-countries: Reduction of the CO_2-emissions by 15% in relation to the historical value of 1990 till 2010.

The paper at hand discusses the question wether the 25% target can be reached in Germany and which consequences for growth, employment and structural change this may have.
Different from the official targeting we take as the base year 1991 - the year of the unification. So the numbers to be compared are measured for the same country. As the year of the target we choose 2010, because in the meantime there is no voice in the open debate, which hopes to reach the target in 2005.

The environmental policy under question will be an increasing carbon-tax, which has to be payed by the producers and the importers of fossile energy-carriers. The government will give the tax-income back to the economy reducing the payments of the firms for social security.

Instrument of the analysis is the economic-environmental model PANTA RHEI (greek philosopher Heraklit: “all things flow“). The name is program: PANTA RHEI is the environmentally extended version of the dynamic fully integrated input-output-model with variable structures INFORGE, which is a member of the international INFORUM-family of models (Nyhus, 1991).

With a first version of the model PANTA RHEI the effects of the introduction of pollution rights were discussed for the Western German economy (Meyer/Ewerhart 1997). With a more extended model - PANTA RHEI II - the possibilities of reaching the 25% target for Western Germany by carbon-tax were analyzed (Meyer/Bockermann/Ewerhart/Lutz, 1997). At least PANTA RHEI III was created (Meyer/Bockermann/Ewerhart/Lutz, 1998), which covers unified Germany. With this system a comparing analysis of the effects of an eco-tax-scenario and a pollution-right scenario to reach the EU target of a 15% reduction of CO_2 and different targets for SO_2 and NO_x was prepared (Meyer/Bockermann/Ewerhart/Lutz 1998). The paper at hand summarizes the results of the eco-tax scenario for the CO_2-reduction target.

We will see, that a slowly increasing eco-tax combined with the compensation of social security payments of the firms will yield the double dividend: The environmental target will be reached simultanenously with growing employment.

2. The Model

PANTA RHEI is an ecologically extended version of the 58 sector econometric simulation and forecasting model INFORGE (Interindustry Forecasting Germany). Its performance is founded on the INFORUM philosophy (Almon 1991), what means to build econometric input-output models *bottom up* and *fully integrated*. The construction principle *bottom up* says that each sector of the economy has to be modelled in great detail and that the macroeconomic aggregates have to be calculated by explicit aggregation within the model. The construction principle *fully integrated* means a model structure that takes into account the input-output structure, the complexity and simultaneity of income creation and distibution in the different sectors, its redistribution among the sectors, and its use for the different goods and services the sectors produce in the context of globalizing markets. In this way one succeeds to

describe properly the role of each sector in the interindustry relations, its role in the macroeconomic process as well as its integration into international trade.

These conceptual advantages in comparison to other models end up in a consistent and powerful processing of sectoral and macroeconomic information. The about 30.000 equations of INFORGE describe the interindustry flows between the 58 sectors, their deliveries to personal consumption, government, equipment investment, construction, inventory investment exports as well as prices, wages, output, imports, employment, labour compensation, profits, taxes, etc. for each sector as well as for the macro economy. In addition the model describes the income redistibution in full detail. The model frequency is annual, the model updating frequency is semi-annual.

PANTA RHEI additionally is equipped with a deeply disaggregated energy - and air-pollution-model, which distinguishes 29 energy carriers and their inputs in 58 production sectors and households as well as 8 air pollutants (CO_2, SO_2, NO_x, NMVOC, CH_4, CO, N_2O) and their relations to the 29 energy carriers. The energy demand is fully integrated into the intermediate demand of the firms and the consumption demand of the households.

INFORGE is part of the INFORUM International System (Nyhus 1991) that links 13 national I-O models on the sectoral level via export and import flows as well as the corresponding foreign trade prices. The information gain of this system in comparison to isolated models allows for a reliable analysis of the important contribution of exports for the performance of the German economy. The International System forecasts the economic development of Belgium, Germany, France, Great Britain, Italy, the Netherlands, Austria, Spain, USA, Canada, Mexico, Japan, und South-Korea in full sectoral disaggregation. This world trade model is being developped steadily, in the near future models for China, Taiwan, and Poland will be integrated into the system (Ma 1995, Nyhus/Wang 1997). Besides the goods markets the INFORUM International System also represents the international financial markets, though in a less detailed way: American interest rates as indicators for the international capital

market condition have a weighty influence on German interest rates and by this means once again on the German goods markets.

The degree of endogenization is rather high. On the labour market the supply of labour is an exogenous variable. From the variables representing the rest of the world only the exchange rates between the 14 countries of the INFORUM International System are exogenous. All other variables indicating the development on the global markets, that are necessary for the determination of German exports are endogenous variables of the International System.

Let us now turn to a more detailed description of intermediate demand, final demand, labour input and prices.

The input coefficients are in general variable and depending on relative prices and time trends. Material inputs are assumed to be limitational at the non observable level of the different products (Georgescu-Roegen 1990). In input-output tables we can only observe product groups. Their input coefficients are price dependent due to of changes in the product mix of the sector and to technical progress, which is induced by price changes

The model distinguishes three vectors for investment demand: equipment, construction and inventory investment. For the equipment functions and construction functions real profits and real interest rates are the main explaining variables. Inventory investment is modelled by accelerator assumptions.

Behavioural equations for real personal consumption are estimated for 58 product groups. Real disposable income of private households and the relative price of the category defined as the relation between product groups index and a macro consumer price index are the main explaining variables next to the interest rate for consumer

durables and some special influences like the annual average temperature for heating expenses.

Sectoral exports are linked to the INFORUM International System. The export of a sector is explained by the world import demand of the particular product and the relation of the export price of that sector and the particular world market price.

Imports of a product group are devided into intermediate imports and finished product imports. The last are determined by real disposable income and the relation between the domestic price of the product and its import price. Intermediate imports are observed for each of the 58 inputs in each of the 58 sectors. We define a matrix of import ratios, in which each element is variable and depending upon the relation of the domestic price and the particular import price. Multiplying the import shares with total intermediate inputs in that cell yields intermediate imports.

Prices are determined by the mark-up hypothesis: Unit costs, competing import prices and the degree of capacity utilization explain the price of a product, so that the relation between price and unit costs is variable.

Labour demand of every sector (measured in hours) is explained by its output, the real wage rate and a time trend. The nominal wage rate of every sector is depending from the basic wage - which is realized in the automotive industry - and specific sectoral variables. The basic wage rate is explained by macro-variables like productivity and a macro price-index.

Our way of modelling is far away from the neoclassical approach, which is used in the typical general equilibrium models like the OECD GREEN-model (Lee/Olivera-Martins/Van der Mensbrugghe 1994) or the model of Walley/Wigle (1991).

3. The Scenarios

In this chapter we give a short description of the assumptions, which define our Business-as-usual (Bau) and the eco-tax-scenario and the short overview of the results of the Bau-scenario.

3.1 The Business-as-usual-scenario and its results

We assume , that the exchange rates and the American interest rate remain on the level, which they just have. The world-market prices and the world import demand of the different product groups are taken from a linked run of the international INFORUM-system. The german fiscal and monetary policy are endogenous parts of INFORGE. The environmental and energy policy remain unchanged till 2010. This means especially, that the market shares of nuclear energy and alternative energy carriers like wind and solar energy do not change. We further assume, that the subsidies for coal will be paid further on.

Table 1:
The base solution

- average growth rates p. a. between 1998 and 2010 in prices of 1991 -

Gross domestic product	1.7
Personal consumption expenditures	1.4
Public consumption expenditures	1.6
Investment in equipment	2.3
Construction	0.7
Exports	4.0
Imports	3.2
Producer Prices	1.8

CO_2 emissions in 2010 in Mt	855
Unemployment rate in 2010	9.0

Table 2:
Effects of CO_2 Reduction Strategies

- percentage differences relative to the base solution in 2010 in v. H. -

	Tax solution
Gross domestic product	- 5.8
Private consumption expenditures	- 7.7
Public consumption expenditures	- 8.6
Investment in equipment	- 9.2
Construction	- 1.1
Exports	- 1.2
Imports	- 4.4
Producer Prices	+ 3.4
CO_2	-16.9

Price of CO_2 in DM/t in 2010	277.2
Unemployment rate in 2010	6.92

Table 1 gives the averages of the growth rates for important macro-variables over the whole period till 2010. Real gdp will grow with 1,7% a little bit slowlier than in the eighties (2,2%). Most dynamic variables will be the exports with an average growth rate of 4,0%, whereas private consumption limps with only 1,4%.

The rate of unemployment in 2010 (9,0%) will be lower than today, but remain to be unacceptabel. The CO_2-emissions in 2010 (855 Mio t) will be a little bit higher than today and miss the target by 140 Mio t.

3.2 The eco-tax-scenario

We now add to the just mentioned assumption of the Bau-scenario the following points:

- Every producer and importer of fossile energy carriers has to pay taxes in relation to the CO2-emissions, which are set free when the specific energy carrier is burned

- Producers and importers of fossile energy carriers raise their prices due to the tax-payment.

- The government uses the eco-taxes-income to reduce the social security costs for the firms.

- The government starts with a taxe rate of 10 DM/t CO_2 in 1999 and raises the tax rate to 277 DM/t CO_2 in 2010.

- The import price for electricity follows the domestic price.

The last assumption allows two interpretations. The first is, that there is a parallel eco-tax-policy in the other countries of the EU. This is resonable, since all EU countries have formulated the target of a 15% reduction of CO_2-emissions based on the 1991 figur till 2010. A second interpretation is, that germany tries a separate eco-tax-policy

and raises a tarif on imported electricity. Of course this is a more theoretical interpretation, because this would violate the existing EU-law.

Figure 1:
CO_2 emissions

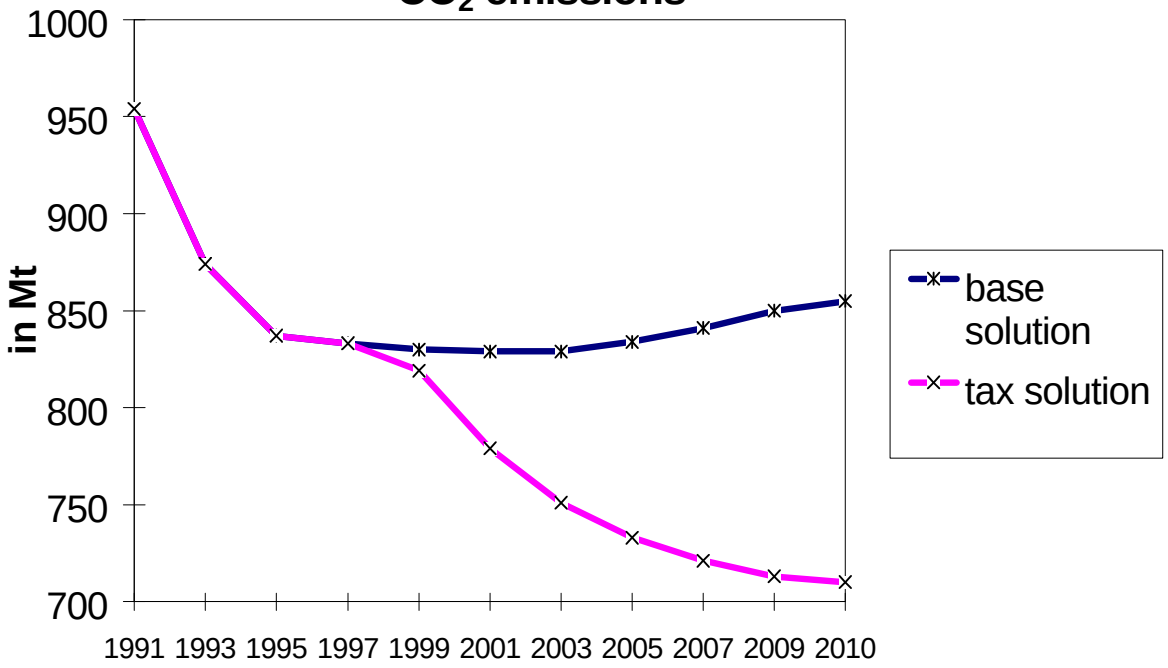
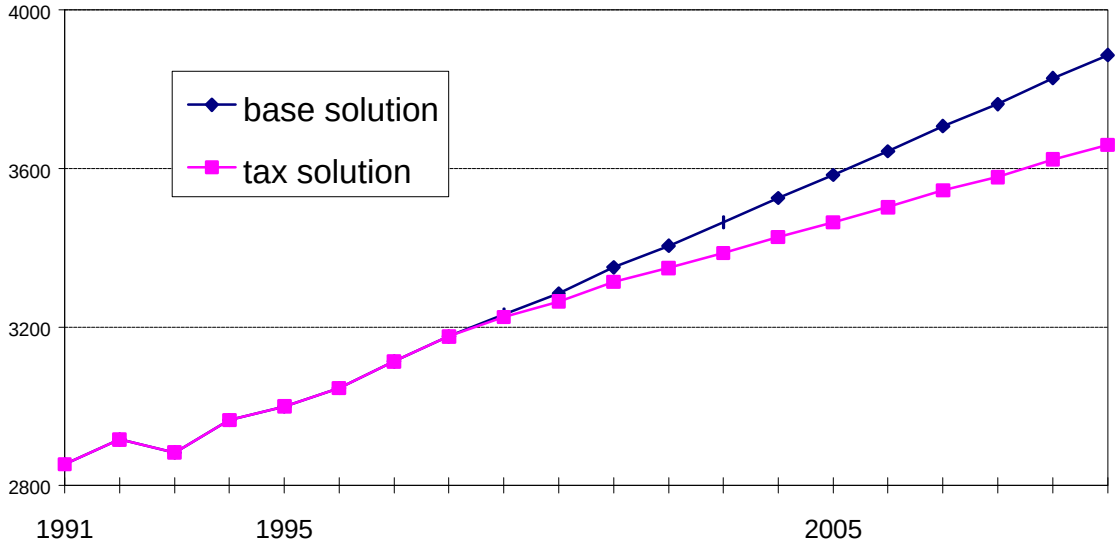


Figure 2: GDP in prices of 1991
in the base- and in the tax solution



4. The macroeconomic results of an eco-tax-policy

Let us first have a look at the CO_2-emissions in figure 1. We see, that the historical development at the beginning of the nineties is characterized by the slow-down of the old industry-
structures in East-Germany, which strongly reduced CO_2-emissions. Till the year 2000 there will be a further slow reduction, because economic growth will still be relatively weak. After 2000 we expect for the bau-scenario growth rates, which lie above the productivity gains of energy consumption. This will raise CO_2-emissions after 2000.

In the eco-tax-scenario we will have strong reductions of CO_2-emissions so that the figure for 2010 (710 Mio t) will be 25% below the historical value of 1991. This means, that the target of the german government would be reached.

Figure 2 compares the development of the real gdp in both scenarios: The growth-path of the economy will be a little bit steeper in the bau-scenario than in the eco-tax-scenario.

In table 2 we look at the results for the target year 2010. We find deviations between the bau-scenario and the eco-tax-scenario in percent for important macroeconomic variables. The domestic demand variables investment and consumption are hit stronger than the exports, which nearly do not react at all. Prices will be about 3% higher in the tax-scenario than in the bau scenario.

The slight reduction of final demand does not penetrate employment. The rate of unemployment will be 6,9% in the eco-tax-scenario against 9,0% in the bau-scenario. This means, that the number of employment in the eco-tax-scenario will be 867 thousand (2,4%) above that figure in the bau-scenario.

Figure 3: Relative change of selected prices for fuels in 2010: Tax solution against base solution

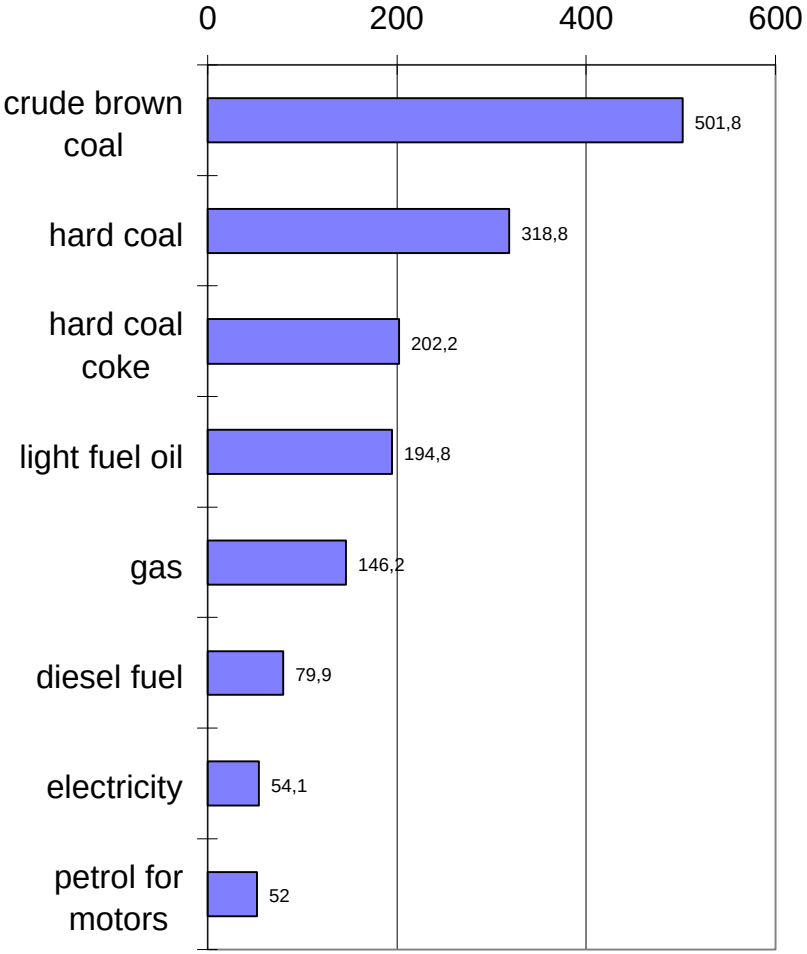


Figure 4: Relative change of selected prices for gross production in 2010: Tax solution against base solution

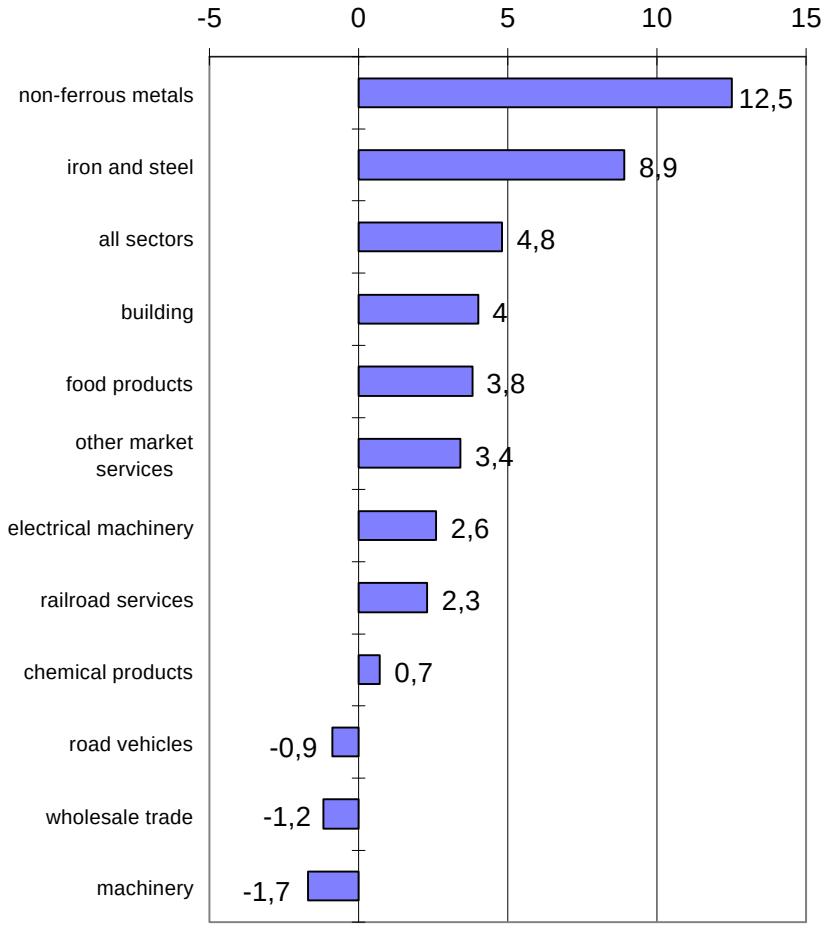


Figure 5: Relative change of energy-inputs in petajoule for different fuels in 2010: Tax solution against base solution

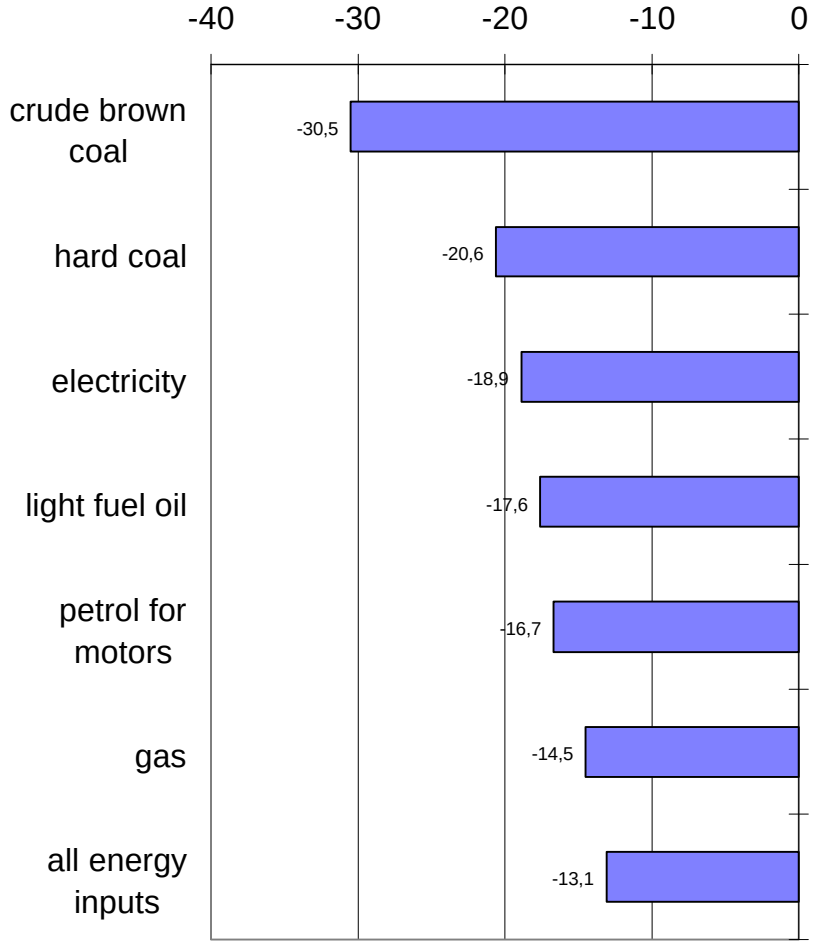
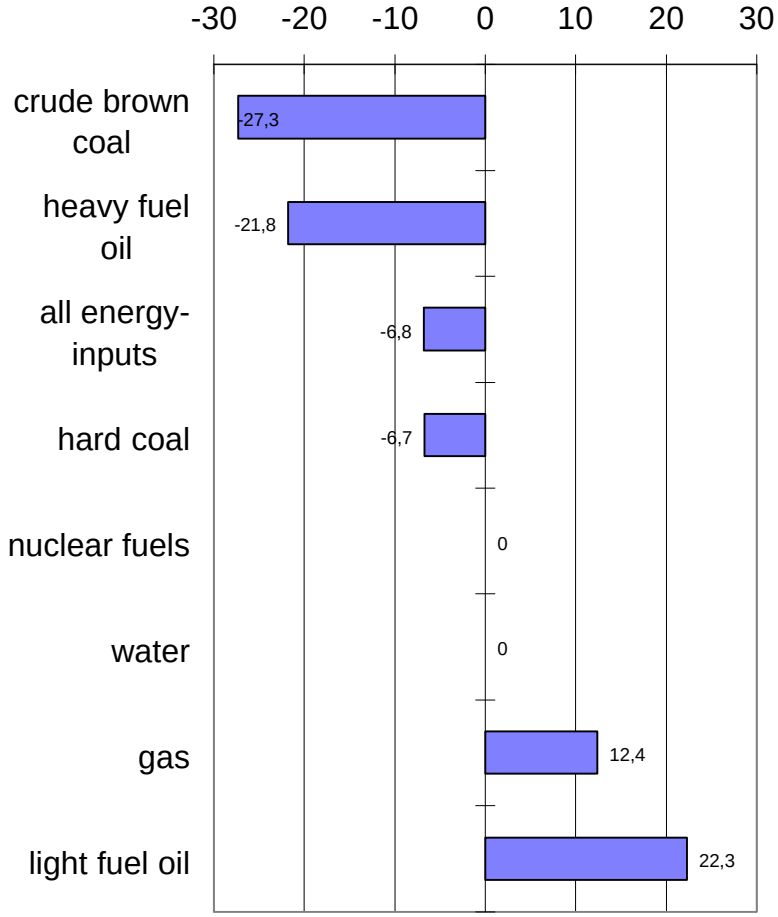


Figure 6: Relative change of energy-inputs in petajoule in the sector electricity in 2010: Tax solution against base solution



5. The effects on prices and energy demand

The tax burden for the energy carriers is very different, because their contents of CO_2-varies very much. Figure 3 shows, that the price for crude brown coal will be in 2010 500% above its value of the bau-scenario, whereas gas will be only 150% more expensive.

Secondary energy like electricity and mineral oils are not taxed. They get higher prices because their production costs rise with the prices of the fossile energy-carriers. Of course then we
have a lower increase of prices, because the other factors of production have relatively stable prices and labour will be cheaper because the social security costs for the firms fall.

The effects on some selected output prices are shown in figure 4. The strongest effects are of course to be found in the energy-intensive sectors like steel and nonferrous metals. But we have to take in account, that a deviation of + 8,9% in 2010 means, the growth rate of the price for steel is 0,7% higher per year if there is an eco-tax-policy. In the average of all sectors the deviation in 2010 is only 4,8% or in other words: The rate of inflation will be 0,35% higher in the eco-tax-scenario than in the bau-scenario.

It is remarkable, that the sectors chemical products, electrical machinery, machinery and road vehicles, which together represent more than 60% of the german exports, we have nearly no rising prices but in two cases falling prices. Here the higher energy-costs are more than compensated by falling labour costs.

In figure 5 the effects of the eco-taxes on some important energy-carriers are summarized. According to our expectations the demand for crude brown coal reduces most and the demand for gas has the lowest losses.

In figure 6 we look at the inputs of different energy-carriers in the production of electricity. In this very important energy-sector we watch on the one side growing efficiency: All energy-inputs reduce by 6,8%. On the other side we recognize

substitution of the „dirty“ crude brown coal by the „clean“ energy carriers gas and light mineral oil. Nuclear energy and water do not change.

Figure 7: Relative change of real gross production in selected sectors in 2010: Tax solution against base solution

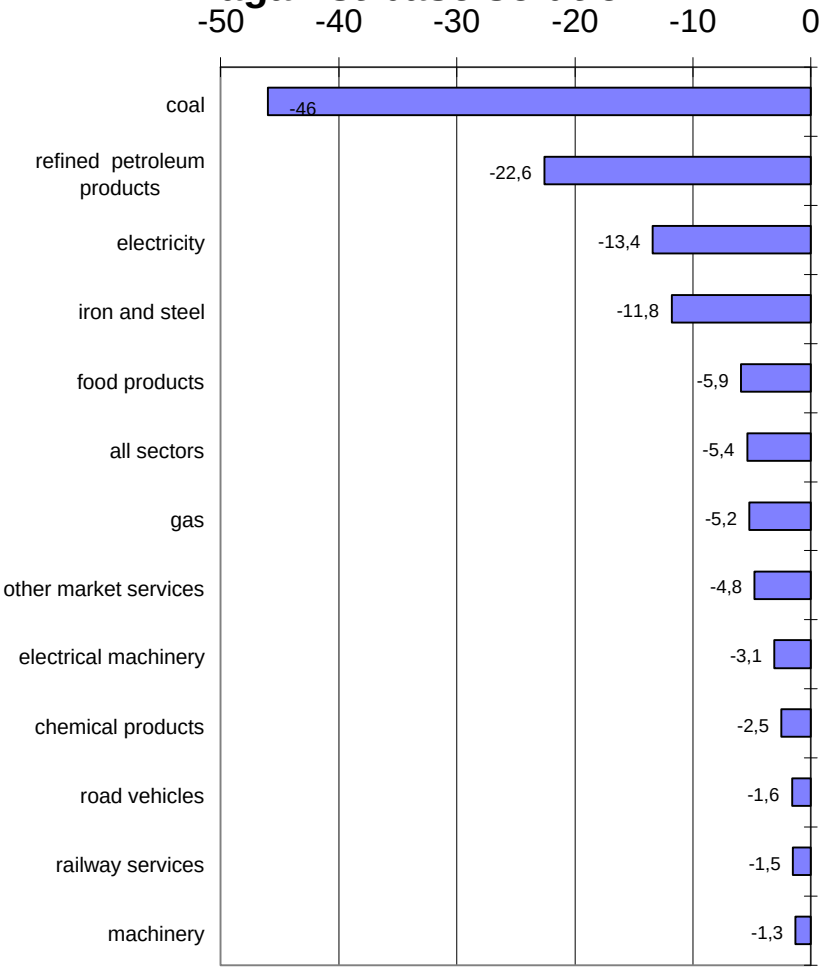
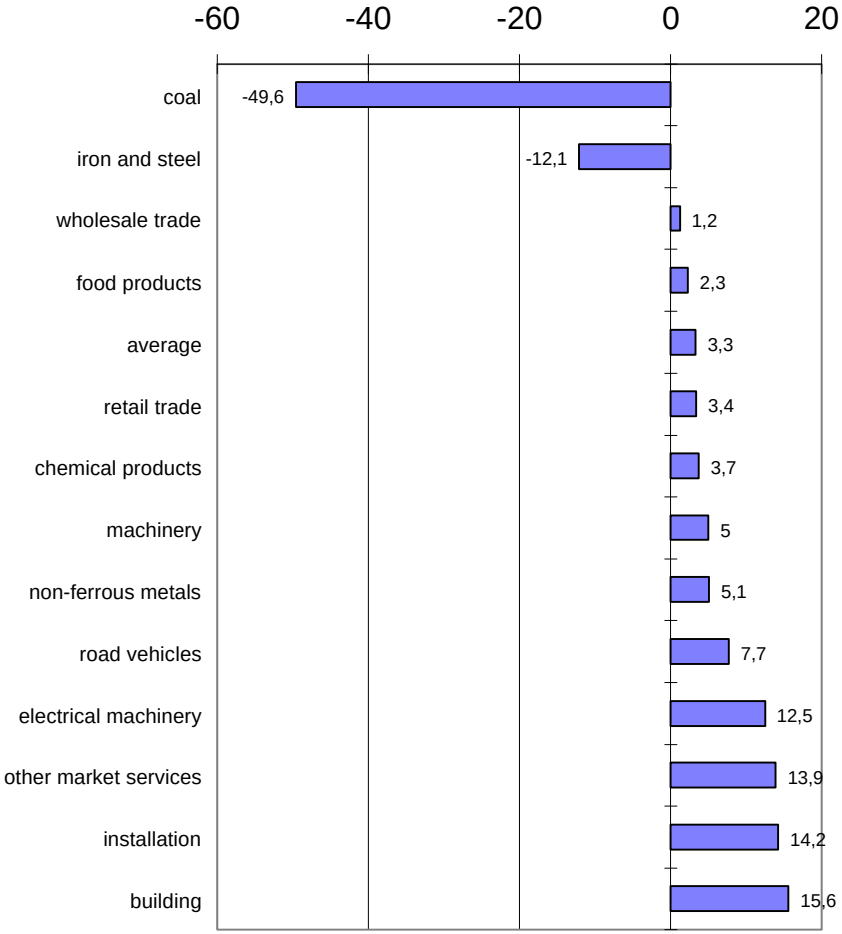


Figure 8: Relative change of working hours in selected sectors in 2010: Tax solution against base solution



6. The effects on production and employment

Figure 7 shows, that the production effects concentrate on the energy-sector and - in a weaker form - the energy-intensive sectors steel and nonferrous metals. Coal mining would lose the half of its production, which hits this sector in his existence.

All the other sectors are nearly inaffected: Over all sectors (the energy-sectors are included) the reduction of the outputs in 2010 against the bau-scenario would be only 5,4%. The average growth rate per year would be only 0,4% lower than in the bau-scenario. Really neglectable are the effects in the industrial heart of Germany, which consists of the sectors road vehicles, machinery, electrical machinery and chemical products.

In figure 8 we look at the relative change of working hours in selected sectors on 2010. The break down of employment in coal mining and the losses of working hours in steel and in nonferrous metals have to be compared with the gains in all other mentioned sectors. Summarizing over all sectors employment grows by 3,3%. So the fall of the wage rate overcompensates the negative effects resulting from the reduction of production.

What does this mean in absolute terms? Figure 9 gives the answer: The labour intensive sector other market services has the strongest expansion of employment, which is nearly six times the fall of employment in coal mining. But we have also growing employment in many manufacturing sectors.

7. The burden for private households

Without an eco-tax the price for gasoline would rise up to 2,15 DM/l in 2010 (see table 3).
If we choose the eco-tax-scenario, we would get a price for gasoline of 3,27 DM/l in 2010, which gives a deviation of 52,1%. The effect on the consumer-price for electricity would be like that, whereas the energy-carriers, which are used for heating-light mineral oil and gas - would rise with 203% and 140% much stronger.

Figure 9: Change of million working hours in selected sectors in 2010: Tax solution against base solution

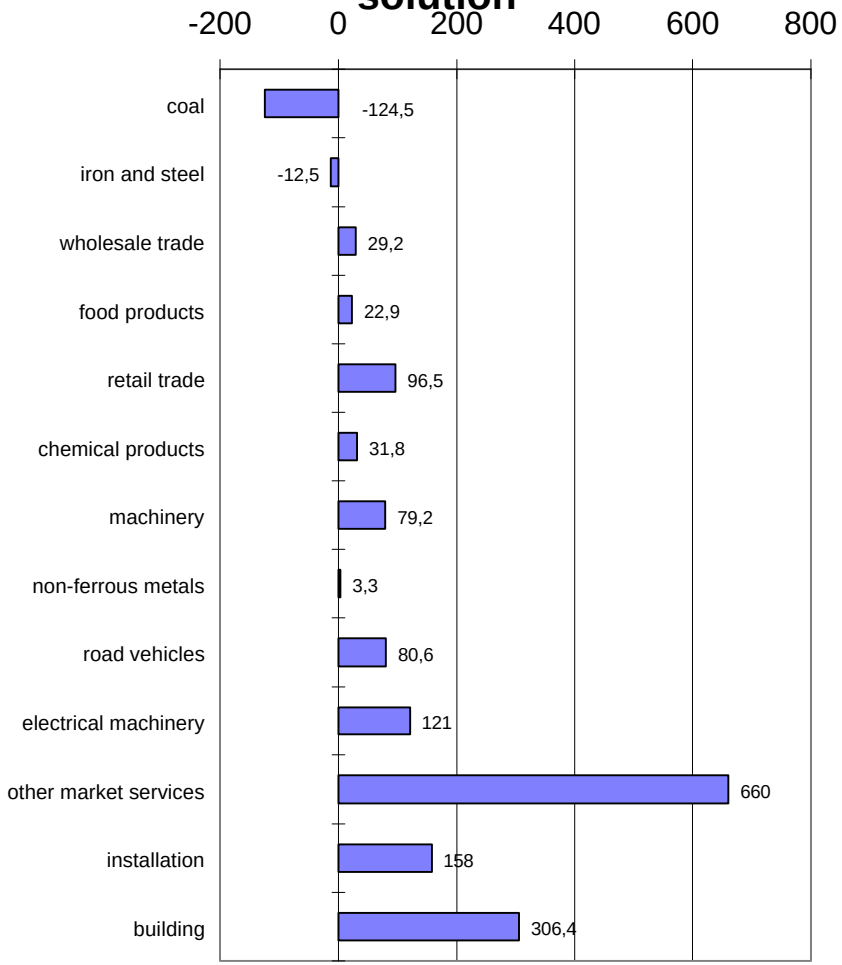


Table 3:

The effects of the tax solution on selected energy prices of private consumption in 2010

	base solution	tax solution	relative deviation
prices of gasoline	2,15 DM/l	3,27 DM/l	+ 52,1 %
price of light fuel oil	0,82 DM/l	2,49 DM/l	+ 203,6 %
price of electricity	29,9 Pf/kWh	46,2 Pf/kWh	+ 54,2 %
price of gas	7,5 Pf/kWh	18,0 Pf/kWh	+ 140,5 %

Table 4: Share of different consumption categories in total expenditures of private households

	1991 (for comparison)	base solution in 2010	CO_2-Tax in 2010
gasoline	2,8	2,7	3,6
heating	1,4	1,4	3,3
electricity	1,9	1,9	2,2
Σ	6,1	5,8	9,1

The nominal share of the three energy-consumption-categories gasoline heating and electricity on whole consumption was 6,1% in 1991 (table 4). In the bau-scenario we will have a short reduction of this figure till 2010 to 5,8%, because there will be technical progress especially in the consumption of gasoline.

After the introduction of the eco-tax households will not be able to compensate the rising energy prices by reduction of the demand volumes completely. So the nominal share of energy consumption will rise to 9,1% in 2010. This refers especially to rising expenditures for heating. Nevertheless we should not be afraid, that the end of all times is coming. The expenditures for energy remain in an acceptable area.

8. Conclusions

The simulations show, that an eco-tax is not necessarily combined with a break down of the economy. But further model runs, which can not be discussed here, have made clear, that this really can be the case. So the kind of compensation is of great importance for the results. If the compensation would be paid to the households, employment would fall and gdp would reduce three times stronger than in our scenario. Households would have to reduce their consumption by 4,5%. So the on the first view „better" position in the distribution of income would generate a lower level of income and consumption than in our scenario.

The special kind of our eco-tax proposal, which is directed to the producers and importers of fossile energy carriers is to be recommended also in respect to its practicability: The administrative costs will be very low, because there are only some firms, which have to be taxed. The dynamic character of the eco-tax will need the installation of an autonomous institution like the „Bundesbank", which would have to rise the tax-rates from year to year following the target of sustainability.

The presented results are not too optimistic, because the further development of alternative energies is not considered. But we can be shure, that with rising prices of fossile energy-carriers the production of solar-energy will be profitable, so that after „half of the way" the full result of CO_2-reduction may be realized. The most important

point is, that a political sign in the right direction will be given. In this case investment in alternative energies will be induced.

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