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E-mail address: Kurt.Kratena@wifo.ac.at
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E3 IMPACTS OF DOMESTIC EMISSIONS TRADING REGIMES IN LIBERALISED ENERGY MARKETS: CARBON LEAKAGE OR DOUBLE DIVIDEND ?

Daniela Kletzan, Angela Köppl, Kurt Kratena

Austrian Institute of Economic Research

P.O. Box 91 , A-1103 Vienna, AUSTRIA

Tel.: +43 1 7982601 246

Fax: +43 1 7989386

e-mail: Kurt.Kratena@wifo.ac.at

Abstract: This paper analyses the E3 (economy-energy-environment) impacts of a domestic emissions trading regime in Austria for 8 manufacturing industries and the electricity generation sector by 2010. The trading regime leads to compliance with the Austrian Kyoto target of minus 13% until 2010 for these sectors. Due to inter-fuel substitution, fossil energy is crowded out by electricity in manufacturing with a carbon leakage to electricity generation. In liberalised markets, domestic thermal electricity generation is substituted by imports due to higher electricity prices, i.e., carbon leaks abroad. These carbon leakages can be overcome by accompanying measures to stimulate renewable electricity generation. The macroeconomic and sectoral effects of the emissions trading mainly depend on the allocation mechanism applied.

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Introduction

The international discussion on policies to mitigate climate change shows a growing interest in market-based instruments like emissions trading relative to 'command-and-control' regulation. Economic theory as well as practical examples like the US SO_2 trading program demonstrate the cost efficiency and environmental effectiveness of this instrument, as it minimises the overall costs to the economy by equalising the marginal abatement costs across emission sources. Emissions trading offers firms the flexibility to choose – given their individual abatement costs and the market prices for permits – between reducing emissions and buying emission permits on the market. The advantage of economic efficiency has been treated extensively in studies on international emissions trading (see among others: Olivera-Martins, Burniaux, Martin (1992), Conrad, Schmidt (1998)). The rationale in these studies is that different marginal abatement costs across countries are leading to multilateral instead of unilateral CO_2 reduction strategies. The early studies, however, revealed that within Europe the difference between unilateral and multilateral action was not very large (see: Conrad, Schmidt (1998) and also Barker (1999)). Another important issue raised concerning the difference between unilateral and multilateral action was 'carbon leakage' (for a literature overview see: Roson (2001)).

Proposals for attaining national emission targets via domestic emissions trading systems have been developed for different European countries, two such systems are in place in Denmark and the UK (see: Jensen, Rasmussen (1998), Edwards, Hutton (2001)). In the case of domestic emissions trading systems, the differences in marginal abatement costs across industries are the argument for trading emission permits. Two new studies on CO_2 reduction strategies for the European Union (Boehringer (2000), Capros, et al. (2001)) show how the permit price, and therefore the costs for reaching the reduction targets, depend on the countries as well as industries/sectors included in the trading system. An important issue is whether the electricity sector is included in an emissions trading system in addition to manufacturing industries. The overall impact of domestic emissions trading, as well as the special issues of the sensitivity of permit prices to the regulatory environment in energy market systems, have not been evaluated in detail.

The overall economic efficiency of emissions trading is influenced by the allocation mechanism (auctioning or grandfathering) of emission permits to the participants. The free allocation of permits based, for example, on historical emissions represents a 'subsidy' to participating firms. In the case of auctioning, revenues are raised that subsequently can be used to reduce distortionary taxes (e.g., taxes on labour) and can give rise to 'double dividend' effects. The implications of the allocation mechanism in terms of efficiency and distributional effects have been discussed widely in the literature (see, for example, Cramton, Kerr (1998), Jensen, Rasmussen (1998), Zhang (1999), OECD (1999), Kling, Zhao (2000), Edwards, Hutton (2001)). The economic impact of different permit allocation methods with special emphasis on competitiveness has also been analysed recently by Johnstone (1999). Although auctioning is generally regarded as more advantageous due to its efficiency and adherence to the polluter pays principle, grandfathering may be preferable from a policy maker's point of view since it implies less intervention for the regulated industries. This trade-off can be seen more clearly in a direct comparison of the overall economic impact of a trading system, using auctioning and grandfathering.

In this paper we outline three scenarios for a national CO_2 emissions trading system for Austria using both auctioning and grandfathering as permit allocation mechanisms. Special emphasis is put on the impact of including the electricity generation sector and manufacturing industries in a fully liberalised electricity market as exists in Austria. The three scenarios differ in two aspects: (i) the allocation mechanism and (ii) additional measures in the electricity sector for reducing thermal power generation and emissions. The scenarios are:

- Grandfathering - permits are given to participants for free, and electricity generation from renewables is subsidised in an effort to further reduce emissions in the electricity sector.
- Auctioning with revenue recycling - permits are allocated via auctioning and the revenues are recycled through a reduction of taxes on labour.

- CO_2-leakage - permits are grandfathered but without accompanying measures for renewable electricity generation. This scenario shows the maximum potential for CO_2 leakage to other countries in the case of a national trading system in which the electricity market is liberalised.

The overall economic costs and benefits of the three scenarios are evaluated using an energy model for Austria (*DAEDALUS*) together with a multisectoral model (*MULTIMAC*) of the Austrian economy. The paper is organised as follows: section 1 describes the framework for a national emissions trading system for Austria given by Austria's Kyoto target and the sectoral structure of CO_2 emissions. In section 2 the energy model and the multisectoral model are described in detail with emphasis on the accounting framework for the link between the energy and non-energy commodities, energy demand by industries and modelling of a liberalised electricity market. Section 3 outlines the trading scenarios and their model implementation in detail. In section 4 the model simulation results are presented. Finally, some concluding remarks are offered.

1. Structure and Development of CO_2 Emissions in Austria

Austria has agreed to reduce its greenhouse gas emissions by 13 percent below 1990 levels in order to meet its Kyoto target as negotiated in the European Union's Burden Sharing agreement. To this end, incentive-based instruments are taken into greater consideration, in addition to administrative measures. The conditions for designing and implementing a CO_2 emissions trading system are based on detailed knowledge of the structure of the sectoral CO_2 emissions.

The data used here are based on the energy balance from Statistics Austria, which allows the calculation of CO_2 emissions by 44 sectors, starting from energy consumption by type of energy source and sector.[1] Table 1 shows CO_2 emissions by aggregate sectors. In 1990, 55.6 million tons of CO_2 stemming from the consumption of energy were emitted, compared to 60.5 million tons in 1999. The transport sector contributed 4.5 percent to energy-related CO_2 emissions in Austria in 1999. Other traffic-related emissions are allocated to their respective sectors[2].

Table 1: Energy-related CO_2 emissions by aggregate sectors

Manufacturing (including construction and electricity generation) is the main source of energy-related CO_2 emissions, although its share declined slightly in the period under observation. In 1999, it contributed 58.4 percent of CO_2 emissions. About a quarter of energy-related CO_2 emissions was generated by private households in the late 1990s. Agriculture,

[1] The CO_2-relevant energy consumption by sector and, based on emission factors, CO_2 emissions by sector, for the period of 1990-1999 were calculated, including CO_2 emissions caused by the use of fossil fuels for energy generation. Process emissions (e.g., by the cement industry) are not accounted for in this analysis.

[2] This deviates from the coverage of transport related CO_2-emissions in the model (section 2) as well as the simulations (sections 3 and following).

forestry and fishery produced some 3.5 percent of energy-related CO_2 emissions in 1999. The six sectors with the highest emission intensity and highest emission level in 1999 (Table 2) emitted 25.2 million tons of CO_2 or about 71 percent of the emissions generated by the manufacturing sector in that year. These emissions originated from 5.4 percent (692 operations) of the companies included in the Statistics Austria business statistics. Electric utilities alone contributed 8.9 million tons of CO_2 or 25.3 percent of the emissions generated by the manufacturing sector (to the equivalent of 14.8 percent of overall energy-related CO_2 emissions).

Table 2: Sectors with the highest emission intensities in 1999

This analysis of sectoral CO_2 emissions provides a starting point for designing a national emissions trading system and indicates its potential for Austria. The data clearly show that energy-related CO_2 emissions in the manufacturing sector are concentrated in a small number of industries and operations. However, it is important to note that the manufacturing sector produces less than 60 percent of total CO_2 emissions.

Starting out from economic theory, and the framework as set out above, one can develop design options for a national CO_2 emissions trading system. The proposed options are limited to CO_2 emissions for two reasons: (i) the sheer quantitative importance of this greenhouse gas and (ii) the uncertainties of monitoring other greenhouse gas emissions. The limitation to CO_2 means that reduction potentials for other greenhouse gases, which may be highly cost-effective, are not considered here. Nevertheless, limiting the system to CO_2 emissions can be justified by the experience to be gained in handling a new instrument.

2. The E3 Model

For the model simulations, we used an E3 model (economy-energy-environment) that integrates the detailed energy system model *DAEDALUS* and the multisectoral macroeconomic model for Austria *MULTIMAC*[3]. The E3 links provide information about the overall benefits and costs of the different energy/CO_2 paths in different scenarios. The E3 link modelling requires a clear-cut treatment of energy and non-energy flows in the economy. The most important example of a fully linked E3 model for Europe based on input-output definitions and a set of econometric equations for 32 industries and 17 energy users is E3ME (Barker, et al. (1999)). Meyer, Uno (1999) also describe the building blocks of a large multisectoral model with special emphasis on energy.

In the model used here the E3 links are embedded in a partitioned input-output accounting framework (s.: Kratena, Schleicher (1999)) that integrates the DAEDALUS energy model and the MULTIMAC multisectoral macroeconomic model. *DAEDALUS* consists of an econometric model for final energy demand of 13 sectors of the Austrian economy and an input-output model of energy transformation with varying technical coefficients. *DAEDALUS* determines the energy sector variables that constitute the energy/economy link. The output of the *MULTIMAC* model (GDP, output by 36 industries, capital stock for different energy relevant purposes), together with exogenous influences (energy prices, technology diffusion for renewables and district heating, transport equipment, demography, etc.), determines energy use and CO_2 emissions, which constitute the other E3 link.[4] The *MULTIMAC model* combines the advantages of econometric techniques with consistent microeconomic functional forms and uses specifications derived from well known microeconomic concepts. The current version, *MULTIMAC IV,* is described in detail in Kratena, Zakarias (2001) (s.:

[3] For details on the structure of both models, see the Appendix.

[4] As the industry structure of DAEDALUS (13 industries) is less detailed than the structure of MULTIMAC (36 industries), MULTIMAC industries are aggregated, these results then enter the economy-energy link.

Appendix). The accounting framework considers the E3 links via the input-output definitions of the commodity balance:

(1) $\mathbf{Q} = \mathbf{QA} + \mathbf{M} = \mathbf{QH} + \mathbf{F}.$

The total goods demand vector **Q** is made up of the imports vector **M** and the vector of domestic output **QA**[5]**,** where **QH** is the intermediate demand vector and **F** is the final demand vector. Introducing the technical coefficients matrix **A** (the sum of domestic and imported elements), **QH** can be substituted by the product of **A** and **QA**:

(2) $\mathbf{Q} = \mathbf{A} * \mathbf{QA} + \mathbf{F}.$

MULTIMAC treats energy transactions in a separate way, so that all matrices and vectors can be split into an energy (e) and a non-energy (ne) part. The commodity balance for non-energy therefore becomes:

(3) $\mathbf{Q_{ne}} = \mathbf{A_{ne}} * \mathbf{QA} + \mathbf{F_{ne}}.$

The technical coefficients matrix $\mathbf{A_{ne}}$ comprises the non-energy input in non-energy sectors as well as the non-energy input in energy sectors; **QA** is the total output vector (energy and non-energy). The original matrix of technical coefficients in the current version of *MULTIMAC* stems from the 1990 input–output table of Austria, thus the issue of technical change in

[5] MULTIMAC IV makes no distinction between industries and commodities (although Austrian input-output statistics do), but includes a row for transfers to take into account non-characteristic production by industries.

matrix **A** has to be considered. In *MULTIMAC* the input coefficient **V/QA** (with **V** as intermediates) is explained in factor demand functions derived from Generalized Leontief cost functions (for details s.: *Appendix*). Once the total input coefficient **V/QA** is determined, the sum of non-energy inputs (along the column) is given by:

(4) $$\sum a_{ne} = V / QA - \sum a_e ,$$

where technical change in the sum of energy inputs $\sum a_e$ is described in the energy model DAEDALUS and is fit exogenously into MULTIMAC.

Total Energy Demand of Industries

Total energy demand is treated in the model as follows. The typical firm in each of the eight manufacturing industries (see, e.g. Table 3) faces a (short term) variable cost function for energy, which depends on given prices of the total energy bundle, the output level and other variables. In a first step technical change is specified by an adjustment mechanism to price changes, that represents the adjustment via changes in equipment with embodied technologies. The second step splits an industry's total energy demand into electricity and other energy types (non–electric). Electricity's share of total energy demand in a typical production sector is modelled along the lines of an 'AIDS' (Almost Ideal Demand System) model with an 'income elasticity' with respect to total energy demand and a price elasticity with respect to the price of electricity relative to fossil fuels. The own and cross price elasticities for electricity and non-electricity are below unity in all industries. Induced changes in the price of fossil fuels for manufacturing through an emissions trading system shift energy demand towards electricity, resulting in a 'carbon leakage' from manufacturing to electricity generation. The fossil fuel input bundle comprises coal input, derived oil input and gas input and is split up into these fuels using relative prices and a deterministic trend.

As *Table 3* shows, own and cross price elasticities differ for the three fossil fuels across industries. Own price elasticities all have the expected negative sign (except for 'textiles' and 'other industries', where coal input is negligible). It is worth noting that cross price elasticities between coal (the most CO_2-intensive fuel), and oil products and gas are all positive. That indicates considerable potential for inter-fuel substitution in an emissions trading system (where energy indirectly becomes costly according to the CO_2 content of fuels). The permit price has a twofold influence on energy demand: (i) the implicit relative prices of coal, oil and gas change and reduce fossil fuel demand, and (ii) the price of the fossil fuel bundle rises and makes electricity cheaper relative to fossil fuels.

Table 3: Own and cross price elasticities of fossil energy demand in manufacturing

Primary Energy Demand of Electricity Generation

The energy conversion processes are treated in the framework of an input-output model with a flexible matrix of technical coefficients for the processes of energy conversion. For electricity and heat generation by the manufacturing sector, the electricity, the heat and oil refining sectors, technical change is taken into account at least in the form of a deterministic trend. Power generation in the electricity sector is the process modelled in most detail, taking into account technical change as well as the influence of prices on inter-fuel substitution. As Ko, Dahl (2001) have shown for the US, reforms in electricity markets can have a significant impact on the magnitude of price responsiveness in fuel choice. From their results and from our 'econometric experiments' we derive a reasonable interval for elasticities of substitution for the Austrian electricity sector in a liberalised market, that allow us to calculate parameter values for fuel input functions and to calibrate these functions for the historical period. The cross price elasticities chosen for input demand in the electricity sector are:

	Coal	Oil	Gas
Coal	-0,3	0,2	0,1
Oil	0,3	-0,2	-0,1
Gas	0,05	-0,03	-0,02

The price of thermal generation (calculated from the price for the fossil fuel bundle taking into account conversion efficiency) is entered together with the import price and the price of other generation sources (hydropower, wind) to give the overall electricity price for consumers, given as the weighted price index (s.: *Appendix*). The import price in a fully liberalised market such as in Austria is assumed to follow an exogenous path mainly determined by the European wholesale price in a liberalised market. This price was assumed to follow the path described in Haas, et al. (2000), where short term price reductions are followed by larger price increases in the mid term due to changes in the electricity market and firm strategies (mergers and acquisitions).

The role of foreign trade of electricity in a liberalised market significantly changes when compared to a closed regulated market. In the latter, imports and exports mainly mirror the difference between domestic demand and power generation. These elements play a minor role in the liberalised market, where foreign and domestic suppliers compete and changes in relative prices might have significant effects on foreign trade of electricity. In a full opening of the market, this mechanism leads (in the 'baseline' scenario) to a considerable increase in imports and exports, resulting in an increase in the net import share. The relevant domestic price for imports is the price of thermal generation in the electricity sector relative to the import price, because imports mainly compete with thermal power generation during the winter season, when demand peaks coincide with low hydropower generation (s.: *Appendix*).

3. Scenarios of an Emissions Trading System

Different simulation scenarios reveal the influence of various design elements of an emissions trading system compared to a 'baseline' scenario (Kratena (2001)) without emissions trading. This baseline scenario assumes a continuation of current developments in the energy sector taking into account the structural break of electricity market liberalisation. Aggregate energy-related CO_2 emissions rise by almost 10 percent until 2010 in the 'baseline' scenario. Half of the aggregate increase in emissions stems from the electricity sector, whereas the emissions from manufacturing remain almost constant.

The emissions trading scenarios are evaluated for Austria using the models described above and in the *Appendix*. Underlying the simulation scenarios is the assumption that Austria implements a national 'cap and trade'-emissions trading system before the first Kyoto commitment period (2008-2012). The target is a reduction of Austrian CO_2 emissions by 13 percent compared to 1990 in the manufacturing and electricity sectors. This corresponds to the Austrian Kyoto commitment for these sectors. The emissions trading system would cover about 58 percent of Austrian CO_2 emissions (see section 1). The caps are distributed across sectors based on historical emissions (base year 2000). This 'flat rate' distribution of caps does not account for differences in adjustment flexibility across industries in energy use and therefore has important implications for the simulation results.

The simulated scenarios are:

Scenario 1: 'Grandfathering'

Scenario 2: 'Auctioning with revenue recycling'

Scenario 3: 'CO_2-Leakage'

The results of the simulations are 'winners' and 'losers' in terms of costs resulting from compliance on the sectoral level, prices for the emission permits, and differing sectoral abatement costs. See Table 4 for the basic design elements of the three trading scenarios.

Table 4: Design elements of the three scenarios of a national emissions trading system

Scenario 1: 'Grandfathering'

For this scenario we assume that emission permits are allocated via grandfathering to the participating sectors. The economic implications of grandfathering have been discussed thoroughly (see, e.g., Kletzan, Köppl (2001) for an overview of pros and cons). Compared to auctioning, grandfathering implies a transfer of wealth to private firms. As Johnstone (1999) has pointed out, the core difference for firms between grandfathering and auctioning is that auctioning with revenue recycling has an impact on costs, whereas grandfathering represents a windfall profit, which has to be compared to overall abatement costs and the net position of a firm concerning its cap. As described above, energy demand by industries and by the electricity sector reacts to energy prices, which in the case of permit trading comprise 'pure' energy costs and implicit energy costs through the price of emission permits. From the perspective of opportunity costs, *all* permits needed by a firm to cover its emissions can be treated as costs, whereas the market value of grandfathered permits (= permit price times emission cap) represents extra revenue. Due to demand reactions at the total energy level, substitution between electricity and non-electricity, as well as inter-fuel substitution within the fossil fuel bundle, the pure energy costs of a firm also change. The total relevant cost/benefit situation for firms in the case of grandfathering is therefore dependent on the following factors:

- 'abatement costs': difference in 'pure' energy costs
- revenues: market value of grandfathered permits
- net revenues/costs due to selling/buying permits to cover the difference between actual emissions and the emission cap.

The magnitude of the abatement costs depends on price elasticities at different levels of energy demand. Slow adjustment due to (necessary) switches to new technologies embodied in new capital stock generally affects the level of total energy demand and electricity/non-electricity substitution. Inter-fuel substitution between fossil fuels takes place without additional capital costs and shows the flexibility of the industrial processes involved. Due to considerable substitution effects between fuels with different emission factors, abatement costs may not be equal to revenues from grandfathering, which would be the case in a single-fuel model. For the implementation in *MULTIMAC,* all costs and revenues are treated as net costs, with the corresponding pass-through on product prices according to the Generalized Leontief cost functions integrated in *MULTIMAC*. That means that an industry with negative net costs from emissions trading would decrease output prices by the same amount as it would pass on higher net costs to output prices. This crucial assumption was made (in contradiction to Johnstone (1999))in order to treat 'winner' and 'loser' industries from emissions trading uniformly and symmetrically. Applying the assumption often referred to in the literature -that windfall profits from grandfathering enter profit income without price effects - would have introduced a bias towards less direct positive income effects from grandfathering due to profit income distribution to firm headquarters abroad.

Another design element of scenario 1 concerns the share of electricity supply from renewable energy. We assume an additional increase of electricity from renewables of 2250 gigaWatt hours cumulated until 2010. This assumption stems from research on the potential of electricity generation from renewables in Austria as well as respective measures to realise this increase. In this scenario the share of renewable electricity is therefore increasing over time and exceeds the 'baseline' by approximately one third in 2010 (5.6 percent (without hydropower) instead of 4.2 percent in the 'baseline' scenario). To realise this increase we assume direct financial support to electricity producers to cover the higher costs of electricity generation using renewables. We further assume that electricity prices in neighbouring countries do not differ from the 'baseline' scenario. Unchanged import electricity prices presume implicitly that these countries do not implement any measures to reduce greenhouse gases that lead to an increase in electricity prices. The difference between domestic and foreign electricity prices caused by the participation of the electricity sector in emissions trading leads to an increase in electricity imports compared to the 'baseline' scenario.

Scenario 2: Auctioning with revenue recycling

The basic framework of scenario 2 is the same as in scenario 1 in terms of participants in the trading system (manufacturing and electricity generation) as well as the increase in the share of renewables in electricity generation. The major difference in scenario 2 lies in the allocation mechanism for emission permits. Instead of grandfathering, all emission permits are allocated to the participants through auctioning. The revenues of the auction accrue to the public budget and are recycled via a reduction in labour-related taxes to the participating sectors. This simulation scenario tests for a 'double dividend' effect – positive environmental and positive economic effects - of auctioning with revenue recycling.

The overall cost/benefit situation for firms in the case of auctioning is determined by the following factors:

- difference in total energy costs ('pure' energy costs plus total expenditure for permits)
- net revenues/costs due to selling/buying permits to cover the difference between actual emissions and permits bought at the auction
- cost decreases due to revenue recycling via lower labour taxes.

The costs related to emissions trading (higher energy costs, costs of permits) are treated in the multisectoral model in the same way as in scenario 1. The total revenue from auctioning is redistributed to the participating sectors via a decrease in the labour tax rate (ad valorem tax) ensuring *ex ante* revenue neutrality of the emissions trading system. This implies a lower gross wage rate, which in turn leads to higher labour demand per unit of output and lower labour costs passed on to domestic output prices.

Scenario 3: CO_2-Leakage

This scenario is intended to show the effects of a national emissions trading system with manufacturing and electricity supply as participants, but without additional financial support to increase the use of renewable energies. Therefore, the share of electricity from renewable energy remains at the level of the 'baseline' scenario, and foreign electricity prices are also equal to the 'baseline' scenario. Emission permits are grandfathered to the participating sectors. This scenario shows the extent of CO_2-leakage of a domestic emissions trading system assuming that no similar measures are established in foreign countries. The degree of the CO_2-leakage is affected by the liberalisation of the electricity market in Europe. The implementation of a national emissions trading system augments the wedge between electricity prices in Austria and countries within the liberalised electricity market. This in turn induces a rise in the import share for electricity. Scenario 3 assumes a fully flexible import share for electricity and shows more or less the maximum potential for shifting Austrian CO_2-emissions to foreign countries.

4. Simulation Results

Table 5 shows the different permit prices measured per ton of CO_2 for the three scenarios, ranging from 26.8 to 43.2 € in the 'compliance year' 2010. Although we simulate a domestic emissions trading system, these permit prices do not deviate much from results of other studies on European trading systems. For example, Capros et al. (2002), who analyse the sensitivity of the permit price on coverage (both regional and sectoral) of emissions trading systems, end up with a permit price range of 32.6 to 56 € (prices 1999) per ton of CO_2 for a trading system among energy intensive industries and electricity generation. Böhringer (2000) simulates a domestic CO_2 tax scenario for compliance of Austria as a benchmark for emissions trading and derives a price of 41 € (prices 1995) per ton of CO_2.

There is no difference in the permit prices between scenarios 1 and 2, as the design elements affecting the emission costs are identical and the feedback from the macroeconomic results is not large enough to generate differences. The permit price in scenario 3 ('carbon leakage') is significantly higher than in the other scenarios, mainly due to the lack of electricity generation from renewable energy in this scenario. That means that – at least for the quantitative relations chosen here – the use of renewables makes it easier to meet the emission reduction target as compared with having no constraints on CO_2 leakage. However, it is important to remember that an increase in the use of renewables leads to additional costs in terms of financial support to electricity producers to cover the higher costs, which must be financed from other sources. For the grandfathering scenario (1), that implies a decrease in other public expenditures or an increase in other taxes. In the auctioning scenario (2), it would be possible to finance these support measures out of auction revenue, making only part of the auction revenues available for a reduction in labour taxes. Another alternative would be to set up a tariff system with higher compensation (feed-in tariffs) for renewable electricity that is fed into the grid. In our model simulations we did not integrate this aspect of additional costs of renewables. Instead we put the emphasis on the difference between a scenario with the accompanying measure for an increase in the use of renewables and the alternative of full CO_2

leakage. We can see that allowing full CO_2 leakage does not ease adjustment as much as additional renewables and that the accompanying measures for renewables decrease costs of permit trading (measured by the permit price). Actually, we cannot directly compare scenarios 1 and 3 to conclude about the impact of CO_2 leakage on costs and the permit price. We would assume that the *c.p.* impact of CO_2 leakage is to decrease costs, i.e., if CO_2 leakage were ruled out and no accompanying measures for renewables were implemented, the permit price would be higher in such a scenario than in the CO_2 leakage scenario.

Table 5: Permit price (per ton CO_2)

Table 6 shows the changes in energy demand for the sum of all manufacturing industries and the electricity generation sector. Again, the effects are identical for grandfathering and for auctioning. In scenario 3 the higher permit price (due to the lacking option of additional renewable electricity generation) leads to larger decreases in energy demand in manufacturing (higher costs) and smaller decreases in the electricity sector. Generally in manufacturing, electricity is substituted for fossil fuels, thereby shifting the burden to the electricity sector. The consequences of this shift differ between scenarios 1 and 2 and scenario 3. In the latter case domestic electricity is substituted by imports due to full market openness. This again leads to CO_2 leakage abroad. This is a specific result of a domestic emissions trading system comprising manufacturing and the electricity sector in liberalised electricity markets. In scenarios 1 and 2 the CO_2 leakage to the electricity sector is partially compensated for by the increase in renewables.

Table 6: Reduction in energy demand (in percent) in 2010

The higher costs of fossil fuel inputs in the electricity sector lead to an increase in the domestic market price for electricity (s.: equation (6) in the *Appendix*). Electricity generation from renewables in scenarios 1 and 2 also has an impact here, as the share of more expensive thermal generation (due to the permits) is lower than in scenario 3. This effect, together with the higher permit price, explains the considerably larger increase in the electricity price in scenario 3. The electricity price increase for households and service sectors represents a spillover effect of emissions trading to other energy demanding sectors, which becomes relevant in the overall economic evaluation of scenarios 1 and 2.

Table 7: Change in electricity prices (in percent)

The net import share reacts to changes in the price of thermal generation in relation to the import ('baseline') price. This import share is significantly higher in all scenarios than in the 'baseline' scenario. As the higher permit price in scenario 3 is accompanied by higher costs of thermal generation, the net import share in scenario 3 increases more than in scenarios 1 and 2.

Table 8: Change in CO_2 emissions (in percent) in 2010

The change in emissions by industries is the result of energy demand changes and shows considerable differences across industries due to different abatement costs, which are the main argument for the efficiency of emissions trading. The distribution of the differences in emission reductions between total manufacturing and the electricity sector in the scenarios shows again that CO_2 leakage abroad is no perfect substitute for accompanying measures to increase the use of renewables in the electricity sector. It further shows the significance of domestic CO_2 leakage from manufacturing using less fossil fuels and more electricity to the power generation sector.

Table 9: Output prices by industries (difference in percent) in 2010

The change in net costs affects domestic output prices in a first stage (Table 9). In scenario 1 the price effects are near zero, which shows that grandfathering represents a minor change for firms in terms of cost changes. Considerable price increases are found only in the food & tobacco industry due to limited adjustment flexibility and in the paper & pulp industry due to its energy intensity as well as its limited adjustment flexibility. The picture changes slightly in scenario 2 (auctioning). The magnitude of the change in net costs becomes much larger in this scenario, as all emissions of a firm are priced now and the total sum of auction revenues is redistributed. Therefore the policy intervention is larger and the situation of 'winner' and 'loser' industries is much more pronounced. All industries lower their prices due to the labour tax cut except ferrous & non-ferrous metals, food & tobacco and paper & pulp. The output price change in ferrous & non-ferrous metals is zero as in scenario 1, because the output price of this industry in *MULTIMAC* is generally determined by world market prices. Therefore no pass-through of costs to prices is possible for this industry and cost increases have to be borne by profit squeezes. On the other hand, that represents a downward bias of the price effect estimates, which would be higher if all costs were passed on to prices.

Table 10: Macroeconomic effects in 2010

The macroeconomic effects (Table 10) mainly consist of a decrease of private consumption and exports due to higher output and consumer (electricity) prices. Imports react in the same proportion, and the decline in total final demand therefore translates into a similar small negative GDP effect. The consequence for the labour market is a small decline in employment (about 7000 employees) and increase in unemployment (about 0.2 percentage points) in scenario 1 and almost no change in scenario 2. Revenue recycling via labour taxes therefore compensates for the potential negative labour market impact of emissions trading. This smaller impact on labour translates into smaller decreases in income and consumption in scenario 2, which again dampens the negative macroeconomic impact.

The output effects by industry (Table 11) show the negative impact in the energy producing sectors, which is the same for both scenarios (due to the same energy demand reactions). In scenario 1 almost all industries are affected negatively, within manufacturing as well as services. Positive output effects in some industries (non-metallic mineral products, chemicals, textiles, clothing & footwear, rubber & plastic products) mainly stem from cost savings due to grandfathered permits and high inter-fuel substitution potential. In scenario 2 almost all manufacturing industries exhibit positive output effects due to revenue recycling via lower labour taxes, that increases international competitiveness. The negative impact on service industries is generally smaller in scenario 2 due to the smaller impact on private consumption. Only the business services sector is more affected in scenario 2, due to less intermediate demand from the heavily affected ferrous & non ferrous metals sector in scenario 2. The overall output effect is almost the same in both scenarios.

Table 11: Output effects (constant prices) by industries (change in percent) in 2010

The negative output effects in manufacturing directly translate into negative employment effects in scenario 1, whereas in scenario 2 positive output effects as well as microeconomic substitution effects increase manufacturing employment in most industries. The smaller negative impact on service sector employment in scenario 2 is caused only by output effects. Microeconomic substitution effects are not acting there, because revenue recycling via lower labour taxes is limited to the sectors participating in the emissions trading system.

Table 12: Employment effects by industries (change in percent) in 2010

Conclusions

This paper analyses three different scenarios for a national CO_2 emissions trading system using auctioning and grandfathering as permit allocation mechanisms and accompanying measures to boost electricity generation from renewables. Special emphasis is given to the role of a fully liberalised electricity market as exists in Austria. In such a setting CO_2 leaks from manufacturing to the electricity sector (electricity/non-electricity substitution) and subsequently from the electricity sector to abroad. The additional measures for renewables (financial support to electricity generation) partially offset this latter CO_2 leakage effect and induce a reduction of emissions in the electricity sector. Given the quantitative relation of this assumption for additional renewables, this option is preferable to full CO_2 leakage abroad, as the permit price is lower. On the other hand, the additional measures for renewables raise costs, which should have been accounted for in the macroeconomic system.

An overall economic evaluation reveals that grandfathering consists of a small intervention without pronounced ‘winner’ and ‘loser’ positions across industries and very small, although slightly negative, macroeconomic effects. On the other hand, auctioning clearly puts some industries in a ‘loser’ position and others in a ‘winner’ position. Compared to grandfathering it constitutes a large intervention with almost no impact for the labour market. The impact on employment is not positive as in other model studies on environmental taxation, because auction revenues are only redistributed to the participating sectors (manufacturing, electricity generation) and not also to the more labour intensive service sectors.

APPENDIX : Model structure of DAEDALUS and MULTIMAC

1. Energy demand by industries (DAEDALUS):

Total energy and electricity

(1) $\log(ENTO/QA) = F(\log(QA), \log(PETO), \log \boldsymbol{Z})$

(2) $ENEL/ENTO = F(\log(ENTO), \log(PEEL/PEFO), \log \boldsymbol{Z})$

with

ENTO total energy bundle, ENEL electricity, PETO price of the total energy bundle, PEEL consumer price of electricity, PEFO price of the fossil energy bundle, QA gross output, ***Z*** additional explaining variables (as degree days).

The fossil energy bundle (Generalized Leontief)

(3) $ENKO/ENFO = \alpha_{KO} + \beta_{KO,DO}(PDO/PKO)^{½} + \beta_{KO,G}(PG/PKO)^{½} + \beta_{KO,t}\, t^{½} + \gamma_{KO,t} t$

(4) $ENDO/ENFO = \alpha_{DO} + \beta_{KO,DO}(PKO/PDO)^{½} + \beta_{DO,G}(PG/PDO)^{½} + \beta_{DO,t}\, t^{½} + \gamma_{DO,t} t$

(5) $ENG/ENFO = \alpha_{G} + \beta_{KO,G}(PKO/PG)^{½} + \beta_{DO,G}(PDO/PG)^{½} + \beta_{G,t}\, t^{½} + \gamma_{G,t} t$

with

ENFO fossil energy bundle, ENKO coal, ENDO derived oil, ENG gas, PKO price of coal, PDO price of derived oil, PG price of gas

2. Thermal Electricity Generation (DAEDALUS)

The fossil energy bundle (Generalized Leontief) as above

Electricity prices

(6) $PEL = \sum_i P_{EL,i}$; i = EVU, BASE and other sources (hydropower, wind)

(7) PEEL = (1+μ_{el}) PEL with μ_{el} as mark up (for grid, etc.)

Electricity import share function (Armington):

(8) $m_{EL} = \left(\frac{P_{EVU}}{P_{BASE}}\right)^{\eta_{EL}} + m_C$, $\eta_{EL} = 0.1$

PEL wholesale price of electricity

P_{EVU} price (=average costs) of thermal electricity generation

P_{BASE} import price = wholesale price of 'baseline' scenario

3. Factor Demand by industry (MULTIMAC)

Input demand functions

(from Generalized Leontief – cost functions via Shephard's Lemma) for intermediates (including energy) V and labour L with corresponding factor prices p_v and w (=gross wage rate):

(9) $\frac{V}{QA} = \alpha_{VV} + \alpha_{VL}\left(\frac{w}{p_V}\right)^{½} + \gamma_{Vt}t^{½} + \gamma_{tt}t$,

(10) $\frac{L}{QA} = \alpha_{LL} + \alpha_{VL}\left(\frac{p_V}{w}\right)^{½} + \gamma_{Lt}t^{½} + \gamma_{tt}t$.

Output prices= fixed mark up on marginal costs :

(11)$p = [1 + \mu]\ [\alpha_{VV}p_v + \alpha_{LL}w + 2\alpha_{VL}(p_v w)^{½} + \delta_{vt}p_v t^{½} + \delta_{Lt}wt^{½} + \gamma_{tt}(p_v + w)t\ ]$.

Price of intermediates

(12) $\mathbf{p_v} = (\mathbf{p_m}\,\mathbf{Z(m)} + \mathbf{p}\,\mathbf{Z(d)})$

with

Z constant structure matrices for the n inputs within **V/QA** for domestic (d) and imported (m) inputs, **p** and $\mathbf{p_m}$ as (row) vectors of output and import prices

4. Goods Demand (MULTIMAC)

Input – output commodity balance

(13) $\mathbf{Q} = \mathbf{QA} + \mathbf{M} = \mathbf{QH} + \mathbf{F}$

(14) $\mathbf{F} = \mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{EX}$

with

Q goods demand vector, **M** imports vector, **QA** vector of domestic output, **F** final demand vector, **C** vector of private consumption, **I** vector of gross capital formation, **EX** vector of exports, **G** vector of public consumption (exogenous)

Exports by good *i* :

(15) $\log(EX_i) = a_{0i} + a_{1i}\log(p_i/p_{if}) + a_{2i}\log(Q_{if})$

with

p_{if} output prices abroad, Q_{if} total demand abroad, calibrated with $a_{1i} = 1$.

Consumption by category :

Single equations for *Gross Rent and Water* (3), *Transport* (4), *Heating* (8), and *Furniture* (9).

(16) CNAIDS = CN – CN3 – CN4 – CN8 – CN9.

with

CNAIDS total expenditure on all goods within the system of non durables, CN total nominal consumption and CN3, CN4, CN8, CN9 nominal consumption of consumption groups 3, 4 8, and 9.

Total private consumption

(17) $\Delta CR_t = (\Delta(YD_t/PC_t), ECM)$

(18) CN= PC CR

CR total consumption at constant prices, PC aggregate consumer price index,

YD disposable household income, ECM error correction mechanism.

AIDS Model

(19) $$w_i = \alpha_0 + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{CNAIDS}{P^S}\right)$$

(20) $$\ln P^S = \sum_k w_k \ln p_k \;,$$

with

w_i budget share of good i, p_j price of good j, , P^S price – index of Stone.

Conversion of categories into industries (Bridge Matrix)

(21) **C** = **BM**(ij) * **CR** .

with

C vector of consumption by *j* industries, **CR** vector of consumption by categories *i* and **BM(ij)** as bridge matrix.

Gross Capital Formation by industry

Capital Stock Identity

(22) $K_{i,t} - K_{i,t-1} = J_{i,t} - \delta K_{i,t-1}$.

with δ depreciation rates, $K_{i,t}$ capital stock in industry *i*, $J_{i,t}$ gross investment.

Stock adjustment – model

(23) $\log(K_{i,t}) - \log(K_{i,t-1}) = \tau_1 [\log K^*_{i,t} - \log K_{i,t-1}] + \tau_2 [\log K_{i,t-1} - \log K_{i,t-2}]$.

with K* desired capital stock and the condition $\tau_1 < 0$.

(24) $\log(K^*_{i,t}) = F[\log QA_{i,t}]$

(25) $\log(K_{i,t}) - \log(K_{i,t-1}) = \alpha_K + \gamma_K \log(QA_{i,t}) - \tau_1 \log(K_{i,t-1}) + \tau_2 (\log(K_{i,t-1}) - \log(K_{i,t-2}))$

Imports by good *i* :

Slightly modified AIDS

(26) $$\frac{MN_i}{QN_i} = \alpha_m + \gamma_{md} \log p_i + \gamma_{mm} \log p_{m,i} + \beta_m \log\left(\frac{QN_i}{PQ_i}\right) + \mu x$$

with

QN, QAN demand and output at current prices, and x aggregate export share (shift variable)

5. Labour Market and Wages (MULTIMAC)

Participation rate of the labour force

(28) $(LF/POP) = F(QA, w_n/PC, L)$

with

LF labour force, w_n consumer gross wage rate, so that $w = (1 + t_L)w_n$ with t_L as payroll tax rate of employers.

Labour force and wages by *i* skill sectors

(29) $LF_i/LF = a_1 + a_2 \log(LF) + a_2 \log(w_{ni}/w_n)$

(30) $ur_i = (LF_i - L_i) / LF_i$

(31) $\Delta\log(w_{ni}) = a_1 + a_2 \Delta\log(PC) + a_3 \Delta\log(QA_i/L_i) + a_4 \Delta\log(ur_i) + a_5 \log(ur_i)$

(32) $\Delta\log(w_{nj}) = a_1 + a_2 \Delta\log(w_{ni}) + a_3 \Delta\log(QA_j/L_j)$

with

j 36 industries, i 3 skill category industries, w_n aggregate consumer gross wage rate.

Table 1: Energy-related CO_2 emissions by aggregate sectors

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	1,000 tons									
Agriculture and forestry, fishery and fish farming	1,693	1,958	1,881	1,823	1,817	1,829	1,877	1,919	1,869	2,103
Manufacturing	34,186	35,208	30,898	30,011	30,675	33,012	33,908	35,942	35,877	35,324
Services, excluding transport	3,113	3,162	3,266	3,343	3,211	3,753	4,392	4,641	3,591	3,908
Transport	1,497	1,842	2,072	2,209	1,894	1,960	1,794	2,343	2,617	2,723
Public administration, defence, social security	485	496	546	590	528	528	384	366	361	379
Private households	14,580	16,817	16,047	16,615	16,376	16,701	17,133	15,732	15,960	16,010
Exterritorial organisations and bodies	0	0	0	0	0	0	14	14	12	13
Total	55,553	59,484	54,711	54,592	54,500	57,783	59,501	60,957	60,287	60,461

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Percentage shares									
Agriculture and forestry, fishery and fish farming	3.0	3.3	3.4	3.3	3.3	3.2	3.2	3.1	3.1	3.5
Manufacturing	61.5	59.2	56.5	55.0	56.3	57.1	57.0	59.0	59.5	58.4
Services, excluding transport	5.6	5.3	6.0	6.1	5.9	6.5	7.4	7.6	6.0	6.5
Transport	2.7	3.1	3.8	4.0	3.5	3.4	3.0	3.8	4.3	4.5
Public administration, defence, social security	0.9	0.8	1.0	1.1	1.0	0.9	0.6	0.6	0.6	0.6
Private households	26.2	28.3	29.3	30.4	30.0	28.9	28.8	25.8	26.5	26.5
Exterritorial organisations and bodies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Statistics Austria, energy balances for 1990 to 1999; WIFO calculations.

Table 2: Sectors with the highest emission intensities in 1999

	Total balance of CO_2 emissions	Manufacturing operatons	Emission intensity (emissions per gross output)
	1,000 tons	Number	1,000 tons per € billion
Ferrous & Non Ferrous Metals	9,085	36	2,422
Electricity Generation	8,936	115	1,134
Paper, Pulp	2,077	95	472
Coking, mineral oil processing	2,002	7	450
Non-metallic Mineral Products	1,863	390	425
District heating utilities	1,233	22	2,529
Total of emission-intensive sectors	25,196	665	
Total of manufacturing	35,324	12,197	
Total of CO_2 emissions	60,461		

Source: Statistics Austria, energy balance for 1999, business statistics for 1999; WIFO calculations.

Table 3: Own and cross price elasticities of fossil energy demand in manufacturing

	Coal/Oil	Coal/Gas	Coal
Ferrous & Non-Ferrous Metals	0.08	0.02	-0.09
Chemicals	-0.34	1.68	-1.34
Non-metallic Mineral Products	-0.48	0.97	-0.48
Food and Tobacco	0.05	0.38	-0.43
Textiles, Clothing & Footwear			
Paper, Pulp & Printing	0.03	0.10	-0.14
Machinery, Electronics, etc.	-0.34	0.57	-0.24
Other Industries			

	Oil/Coal	Oil/Gas	Oil
Ferrous & Non-Ferrous Metals	0.31	0.51	-0.82
Chemicals	-0.13	0.44	-0.31
Non-metallic Mineral Products	-0.09	0.15	-0.07
Food and Tobacco	0.00	0.01	-0.01
Textiles, Clothing & Footwear		0.05	-0.05
Paper, Pulp & Printing	0.01	0.02	-0.03
Machinery, Electronics, etc.	-0.01	0.01	0.00
Other Industries		0.05	-0.05

	Gas/Coal	Gas/Oil	Gas
Ferrous & Non-Ferrous Metals	0.01	0.13	-0.14
Chemicals	0.17	0.12	-0.29
Non-metallic Mineral Products	0.15	0.13	-0.28
Food and Tobacco	0.02	0.01	-0.03
Textiles, Clothing & Footwear		0.06	-0.06
Paper, Pulp & Printing	0.02	0.01	-0.03
Machinery, Electronics, etc.	0.02	0.01	-0.03
Other Industries		0.04	-0.04

Table 4: Design elements of the three scenarios of a national emissions trading system

	Allocation				
	Grandfathering	Auctioning	Increased share of "Renewables"	Revenue recycling	Macro-economic evaluation
Scenario 1: "Grandfathering"	*		*	-	*
Scenario 2: "Auctioning with Revenue recycling"		*	*	*	*
Scenario 3: "CO_2-Leakage"	*			-	-

Table 5: Permit price (€ per ton CO_2)

	2002	2006	2010
	€ per ton CO_2		
Scenario 1: "Grandfathering"	2.6	13.9	26.8
Scenario 2: "Auctioning with Revenue recycling"	2.6	13.9	26.8
Scenario 3: "CO_2-Leakage"	4.2	21.6	43.2

Table 6: Reduction in energy demand (in percent) in 2010

	Scenario 1	Scenario 2	Scenario 3
		in percent	
Total manufacturing			
Total Energy	-4.0	-4.0	-6.0
Electricity	5.3	5.3	6.6
Electricity generation	-20.2	-20.2	-14.7

Table 7: Change in electricity prices (in percent)

	2002	2006 in percent	2010
Manufacturing			
Scenario 1: "Grandfathering"	0.34	1.49	2.02
Scenario 2: "Auctioning with Revenue recycling"	0.34	1.49	2.02
Scenario 3: "CO_2-Leakage"	0.79	3.33	4.98
Private Households			
Scenario: "Grandfathering"	0.25	1.07	1.45
Scenario 2: "Auctioning with Revenue recycling"	0.25	1.07	1.45
Scenario: "CO_2-Leakage"	0.57	2.39	3.57

Table 8: Change in CO_2 emissions (in percent) in 2010

	Scenario 1	Scenario 2 in percent	Scenario 3
Ferrous & Non-Ferrous Metals	-3.3	-3.3	-3.9
Chemicals	-22.1	-22.1	-29.3
Non-metallic Mineral Products	-13.1	-13.1	-17.5
Food and Tobacco	-9.8	-9.8	-11.4
Textiles, Clothing & Footwear	-2.2	-2.2	-3.5
Paper, Pulp & Printing	-10.7	-10.7	-15.2
Machinery, Electronics, etc.	-20.1	-20.1	-26.1
Other Industries	-0.1	-0.1	-0.1
Total of manufacturing	-8.1	-8.1	-10.6
Electricity generation	-20.9	-20.9	-17.1
Total	-13.1	-13.1	-13.1

Table 9: Output prices by industries (difference in percent) in 2010

	Scenario 1	Scenario 2
	difference in percent	
Ferrous & Non-Ferrous Metals	0.00	0.00
Non-metallic Mineral Products	-0.20	-0.13
Chemicals	-0.21	-0.36
Metal Products	0.00	-0.51
Agricultural and Industrial Machines	-0.01	-0.45
Office machines	-0.01	-0.32
Electrical Goods	0.00	-0.29
Transport Equipment	0.01	-0.21
Food and Tobacco	0.29	0.06
Textiles, Clothing & Footwear	-0.15	-0.41
Timber & Wood	-0.03	-0.34
Paper, Pulp	0.15	0.51
Rubber & Plastic Products	-0.03	-0.45

Table 10: Macroeconomic effects in 2010

	Scenario 1	Scenario 2
	difference in percent	
Private consumption	-0.43	-0.31
Gross investment	-0.11	-0.10
Exports	-0.05	-0.02
Final demand	-0.20	-0.14
Imports	-0.13	-0.19
GDP, constant prices 1995	-0.22	-0.08
	difference in percentage points	
Unemployment rate	0.18	0.00
	difference in persons	
Employment	-7,014	-670

Table 11: Output effects (constant prices) by industries (change in percent) in 2010

	Scenario 1	Scenario 2
	difference in percent	
Agriculture, Forestry and Fishing	-0.17	-0.13
Mining of Coal and Lignite	-2.34	-2.34
Extraction of Crude Petroleum and Natural Gas	-0.58	-0.58
Manufacture of Refined Petroleum Products	-0.55	-0.55
Electricity, Steam and Hot Water Supply	-1.37	-1.37
Collection, Purification and Distribution of Water	-0.15	-0.18
Ferrous & Non Ferrous Metals	-0.33	-1.95
Non-metallic Mineral Products	0.09	-0.10
Chemicals	0.52	0.52
Metal Products	-0.03	0.19
Agricultural and Industrial Machines	-0.18	0.36
Office Machines	-0.40	0.18
Electrical Goods	-0.02	0.15
Transport Equipment	-0.04	0.11
Food and Tobacco	-0.25	-0.15
Textiles, Clothing & Footwear	0.24	0.53
Timber & Wood	-0.09	0.17
Paper , Pulp	-0.20	-0.74
Printing Products	-0.37	-0.35
Rubber & Plastic Products	0.20	0.42
Recycling	0.00	0.00
Other Manufactures	-0.10	-0.09
Construction	-0.12	-0.12
Distribution	-0.26	-0.22
Hotels and Restaurants	-0.79	-0.66
Inland Transport	-0.05	-0.10
Water and Air Transport	-0.10	-0.15
Supporting and Auxiliary Transport	-0.07	-0.09
Communications	-0.76	-0.71
Bank, Finance & Insurance	-0.27	-0.34
Real Estate	-0.09	-0.11
Software & Data Processing	-0.19	-0.19
R&D, Business Services	-0.35	-0.48
Other Market Services	-0.51	-0.40
Non-market Services	-0.16	-0.13
Total	-0.22	-0.22

Table 12: Employment Effects by industries (difference in percent) in 2010

	Scenario 1	Scenario 2
	difference in percent	
Agriculture, Forestry and Fishing	-0.23	-0.18
Mining of Coal and Lignite	-1.86	-2.54
Extraction of Crude Petroleum and Natural Gas	-0.58	-0.58
Manufacture of Refined Petroleum Products	-0.55	-0.55
Electricity, Steam and Hot Water Supply	-1.35	-1.40
Collection, Purification and Distribution of Water	-0.14	-0.19
Ferrous & Non Ferrous Metals	0.61	5.44
Non-metallic Mineral Products	-0.09	0.86
Chemicals	0.48	0.92
Metal Products	0.02	1.39
Agricultural and Industrial Machines	-0.09	1.58
Office Machines	0.28	7.29
Electrical Goods	0.06	1.26
Transport Equipment	0.13	2.36
Food and Tobacco	-0.24	0.15
Textiles, Clothing & Footwear	0.17	2.77
Timber & Wood	-0.08	0.54
Paper , Pulp	-0.11	0.18
Printing Products	-0.49	-0.36
Rubber & Plastic Products	0.20	0.44
Recycling	-0.02	-0.01
Other Manufactures	-0.04	-0.23
Construction	-0.10	-0.12
Distribution	-0.21	-0.20
Hotels and Restaurants	-0.80	-0.66
Inland Transport	-0.04	-0.09
Water and Air Transport	-0.08	-0.18
Supporting and Auxiliary Transport	-0.03	-0.10
Communications	-0.05	-0.05
Bank, Finance & Insurance	-0.22	-0.41
Real Estate	-0.25	-0.15
Software & Data Processing	-0.07	-0.36
R&D, Business Services	-0.34	-0.48
Other Market Services	-0.30	-0.15
Non-market Services	-0.15	-0.13
Total	-0.22	0.00

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