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Contribution of an emission trading scheme to reduce road traffic induced CO_2 emissions in Austria

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Abstract

The Emission Trading Scheme for green house gases is a key tool of European climate protection. Including the road transport sector might be a promising strategy to limit its CO_2 emissions. This could be realized within a common market (trans-sectoral trading permitted) or separated markets (trans-sectoral trading not permitted). Starting from different assumptions on emission reduction objectives, the impact of both options is analyzed using a quantitative model. Although an emission trading scheme is ecologically effective regardless of the trading model, it turns out that CO_2 emissions and emission allowance prices differ strongly between both design options due to sector specific price elasticities of allowance demand.

CO_2 emissions trading scheme; trading model; road transport; stated-preference-analysis

1. Introduction

The EU has obligatorily committed itself in the Kyoto Protocol (entered into force in 2005) to reduce greenhouse gas (GHG) emissions in the period of 2008-2012 by 8 % on average compared to 1990 level. Austria has imposed itself to lower GHG emissions about 13 % in the same period. So far, first signs of mitigation efforts are visible both in Austria and in the European Union (EEA, 2011). However, this is not true for all GHG emitting sectors; in particular, hardly any progress was made in the transport sector. A weak decline could only be observed between 2008 and 2009, which was presumably caused by the economic recession. In 2009, the share of transport-induced GHG emissions in Austria was 27 % with an increase of 54 % between 1990 and 2009 (EAA, 2011). The failure to reduce GHG emissions made road

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transport to the largest emitter. This is also true for all of the other EU member states (Ryan et al., 2009; EEA, 2011). This development contradicts GHG emission savings in other sectors.

Within the European Union different approaches to limit road traffic induced GHG emissions are in discussion or operation. Amongst others, they include programs for a voluntary change of travel behavior (Brög et al., 2002) and technological standards of fuel efficiency (Frondel et al. 2009). Above all, financial policies with focus on vehicle fuel efficiency or car use are widespread in the EU. They aim at a reduction of fuel consumption by higher fuel prices or on the promotion of environmental friendly vehicles by consumption-based vehicle taxes. It is widely accepted that financial policies have a higher impact on road traffic induced GHG emissions than non-financial policies (Ryan at al. 2009).

One out of several financial tools to limit GHG emissions is emission trading. The principle is that the owner of a GHG emission allowance is entitled to emit a certain amount of GHG. All market participants have to hold allowances for their GHG emissions. Excess allowances can be saved over time (banking) or sold. If the marginal abatement costs of a market participant are below the market price of the emission allowances, measures to limit GHG emissions will be implemented; otherwise GHG emission allowances will be bought. The emission trading scheme – at least in theory – ensures the achievement of a given emission reduction target at optimal costs. In doing so, it combines economic efficiency and ecological effectiveness (Raux, 2004; Wadud, 2010). There is evidence from different studies that a trading scheme has advantages over tax-based approaches. Flachsland et al. (2011) see particular advantages in a trading scheme if (i) there is limited knowledge on marginal abatement costs, (ii) quantitative emission reduction objectives exist and (iii) an emissions trading scheme is in operation in other sectors.

The European Union introduced an Emission Trading Scheme (EU ETS) in 2005. Up to now it is limited on selected facilities of energy supply and industry. They have to hold allowances to cover their GHG emissions; not required allowances are tradable. In order to assure ongoing climate protection measures, the third EU ETS trading period starting in 2013 provides for an annual reduction of allowances of 1.74 % corresponding to a 21 % reduction until 2020 compared with the 2005 level. The focus of the EU ETS is mainly on CO_2; for a detailed overview of the EU ETS see e.g. Perdan and Azapagic (2011).

Verhoef et al. considered tradable permits as the optimal trade-off between efficiency, effectiveness, and social feasibility of regulatory policies in road transport already in 1996. Systematic evaluation of the existing EU ETS is still missing, but preliminary findings indicate good achievements: CO_2 emissions in EU ETS sectors are decreasing more sharply than in other sectors (EEA, 2011). The promising results laid the ground for an expansion of EU ETS to the aviation sector in 2012 (Vesperman and Wald, 2011) and a geographical expansion beyond the borders of the EU. It is therefore overdue to think about a transfer of the EU ETS to road transport. In this paper we show the impact of different emission trading scheme design options on allowance and fuel prices under the assumption that an emission trading system is applied to road transport.

2. Emission trading scheme in road transport

Two key issues have to be addressed if an emission trading scheme is applied to the transport sector: the certification approach and the trading model. The certification approach specifies which economic agents are obliged to obtain GHG emission allowances. The trading model specifies whether or not trans-sectoral trading of allowances between transport sector and other sectors is permitted. Another determining factor beyond these two options is the emission reduction target (Soleille, 2006). Moreover, the initial allocation of allowances as well as the reporting, control and sanctioning system are essential issues; these are however not touched upon in this paper.

Three design options of the certification approach are under consideration: an upstream approach that obliges both producers and importers of fossil fuels to obtain GHG emission allowances; a midstream approach that includes the vehicle manufacturers in the emissions trading scheme; and the downstream approach that is based directly on car users (Abrell, 2010). Upstream and downstream trading would roughly correspond to an increase of fuel tax; and midstream trading to a differentiation of the consumption-based registration tax. Assuming that allowance prices or costs of mitigation efforts were fully passed on to car drivers, the effects of an upstream and downstream approach are very similar (Winkelman et al., 2000). The applicability of these approaches is subject to ongoing academic debate. The downstream approach is often ruled out because of the large number of allocation units and its transaction costs for a long time (Van Essen et al., 2010; Flachsland et al., 2011). However, there are differing opinions as well; Wadud (2010) suggests the possibility of individualized cards for car users to store emission allowances. Transactions could be organized using the internet or an agency platform to be established.

Regardless of these implementation problems we see specific advantages of an up- or downstream-approach, because both options offer car users an additional possibility to react. Whereas the midstream approach only affects car ownership and vehicle fuel efficiency, and thus might be susceptible to a significant rebound effect, upstream and downstream trading also affect travel demand. This aspect allows optimal behavioral adaptations with respect to individual abatement costs in these three fields (Jansen & Denis, 1999; Wadud, 2010).

It has to be decided in view of the trading model, whether road transport is integrated in the existing EU ETS (as it is done with aviation starting in 2012) or a separate emission trading scheme is introduced. In the following we use the terms 'common market' and 'separated markets' in this context. Separated markets result in sector specific allowance prices for a given emission reduction objective; separated markets would also allow for setting sector specific emission reduction objectives.

The allocation of allowances in a common market as well as the allowances price in both market schemes depends on market participants' willingness to pay for the use of fossil energy resources. It is expressed by the sector specific elasticity of allowance demand with respect to the allowance price. However, price elasticities reported in the literature vary greatly (see e.g. Hössinger et al., 2011). It is often assumed that

- price elasticity in the transport sector is lower in magnitude than in the EU ETS sectors (Van Dender, 2009; Van Essen, 2010); this may be due to the higher cost awareness and the higher availability of measures to avoid CO_2 emissions in EU ETS sectors;
- passenger transport is more elastic than freight transport; however, there are hardly any studies existing for freight transport; most of the few studies addressing elasticities in freight transport are focusing on total transport costs rather than fuel costs (Graham et al., 2004);
- the price elasticity of passenger transport varies over time; on the one hand, it decreased considerably in the last 20 years (Brons et. al., 2008); on the other hand, it increases with the exposure time of a higher price (short term vs. long term effect, see, e.g., Goodwin et al., 2004 and Hymel et al., 2010);
- reactions in car ownership to higher fuel prices are quite low; and progress in combustion technology was outnumbered by the trend towards luxury cars; as a result, car travel demand at single trips is the dominant contributor to emission reduction in case of higher fuel prices (Goodwin et al., 2004).

If the fuel price elasticity of a given sector is lower in magnitude than in other sectors, the resulting price for GHG emission allowances would be higher in a separated market than in a common market. Jochem (2010) shows for a hypothetic integration of road transport into the EU ETS that the allowance price paid by the transport sector is almost twice as high in separated markets than in a common market after a trading period of ten years.

If market participants have different emission abatement costs, an emission trading scheme results in higher economic efficiency than a tax-based regulation (Soleille 2006); this even more applies to a common market. However, the market participants' ability to pass their emission reduction efforts to other sectors could be considered as a potential disadvantage of a common market. Although assuring overall economic efficiency as well as environmental effectiveness, a common market might be not conducive in a normative way (Van Essen et al., 2010).

3. Methodical approach

We developed an impact assessment model in order to analyze the consequences of an emission trading scheme under different design options. A key task was the estimation of sector specific price elasticities of allowance demand for passenger road transport and for the current EU ETS sectors.

3.1. Price elasticity of passenger road transport

In upstream and downstream emission trading the allowance price is assumed to be fully allocated to the fuel price. Car users respond to rising fuel prices by adapting their car ownership, fuel efficiency, and travel demand (Brons et al., 2008). According to Goodwin et al. (2004) price elasticities reported in literature are often concentrated on only one of these three kinds of elasticity or at least do not use the same data source for different elasticity estimates. Our response probabilities of car ownership and travel demand were derived from the same data set using discrete choice analysis and a multinomial logit approach; the price elasticity of vehicle fuel efficiency was derived from a literature review.

Data were collected by means of a revealed and stated preference survey of 230 Austrian car users in 2009 and 2010. In several stated preference experiments respondents were faced with increasing fuel prices; the experiments included daily car travel demand, travel demand at long distance trips, and car ownership. They were based on the respondents' actual behavior, e.g., the daily car travel demand experiments built on recent real life trips. Additionally, existing car disposal plans were recorded (Situational Approach, Hössinger et al. 2011). A two-stage survey design was applied combining telephone and face-to-face interviews. In the experiments respondents stated whether they would maintain their actual behavior under the assumption of higher fuel prices or not. The choice options in the car ownership experiment were (i) to keep, (ii) to sell, or (iii) to replace the existing car, respectively.

The revealed- and stated preference data fed into a discrete choice analysis using a multinomial logit approach. The analysis results in utility functions for alternative choice options, which facilitate the calculation of choice probabilities for these options under varying assumptions. For further information about the method see Hössinger et al. (2011). The resulting price elasticity of fuel demand differs with the fuel price level and with exposure time (short term vs. long term). At a fuel price range between 1.0 and 1.5 € per liter the price elasticity is -0.10 and -0.19 in the short and long term, respectively; the corresponding figures for a fuel price of 4.0 € per liter are -0.13 and -0.20; the maximum responsiveness was found between 2.5 and 3.5 € per liter with a long term elasticity of -0.21.

3.2. Price elasticity of EU ETS sectors

There are several studies available focusing on the elasticity of energy demand with respect to energy price (Table 1). However, to our knowledge, the elasticity of demand of GHG allowances with respect to the allowance price was not investigated directly yet. In order to achieve an elasticity estimate for the already obliged ETS sectors energy and industry, we used two different sources of trading data for EU allowances.

First, future contracts on EU emission Allowances (EUAs) from the European Climate Exchange (ECX) from September 2008 until April 2010 were used. The first EU ETS trading period from 2005 to 2007 worked as rehearsal, therefore we expected the obliged companies to unveil their actual preferences only in the second period from 2008 to 2012, of which we used the data for our analysis. ECX's share of the market for futures on EUAs increases continuously, being responsible for nearly 25 % of total traded volume of EUA futures by October 2009 (ECX, 2009). The large market share and the transparency of available trading data gave reason for our decision to use EXC trading data for estimating the demand elasticities of EUA futures. A two stage least squares estimation reveals a demand elasticity of -0.96 in the EXC futures market.

In order to check for the robustness of these econometric results, we used spot market trading data from the BlueNext exchange. BlueNext has a market share of more than three quarters in exchange based spot market trading of EU allowances (Marcu, 2008). The econometric results of the spot market demand elasticity (-1.00) is astonishingly similar to the estimate derived from futures market data. Thus, we see this as a consistent estimate of current trader's price elasticity for EU allowances.

Given a fuel price elasticity of -0.15 in the transport sector (corresponding to an allowance price elasticity of approx. -0.008) an EUA demand price elasticity of about -1.00 is incredibly high. The high elasticity may be a consequence of the generous primary allocation of allowances at the introduction of EU ETS, so that the price is no indicator of scarcity yet. This is expected to change as soon as the quantity of available EUAs falls below the actual allowance demand. Therefore, we double-checked our estimation results using two additional approaches. In the first check we used energy demand price elasticities from literature and estimated the potential price elasticities of EUAs in proportion of the CO_2 intensity of electricity production (row 3 to 5 in Table 1). Due to the lack of precise energy consumption data of the ETS industrial sector on energy carrier basis, this approach could only be applied to ETS energy sector. The second check used existing CO_2 abatement cost curves to estimate the demand elasticity of EUAs. The figures for the sectors energy and industry were provided separately (rows 6 and 7 in Table 1) so that it was possible to estimate sector specific elasticities.

Table 1: Sector specific estimations for the CO_2 price elasticities

	CO_2 price elasticity (at 20 EUR/t)	Energy price elasticity	Sector, Region	Estimation approach	Source
(1)	-0.9556	-	ETS sectors, ETS area	Econometric analysis of futures market data	own estimation
(2)	-1.0018	-	ETS sectors, ETS area	Econometric analysis of spot market data	own estimation
(3)	-0.008 to -0.04[†]	-0.11 to -0.55	Energy, USA and international	CO_2 markup on electricity price elasticity	Branch (1993)
(4)	-0.0007 to -0.059	-0.01 to -0.8	Energy, USA and international	CO_2 markup on electricity price elasticity	Klobasa (2007)
(5)	-0.0256	-0.35	Energy, industrialized countries	CO_2 markup on electricity price elasticity	Persson, Azar & Lindgren (2006)
(6)	-0.194	-	Industry, Germany	Abatement costs	BDI (2007)[‡]
(7)	-0.497	-	Energy, Germany	Abatement costs	BDI (2007)

It can be seen from Table 1 that our own estimates of the price elasticity of EUAs in row (1) and (2) are much higher than those derived from energy demand price elasticities shown in row (3), (4), and (5).

[†] Calculated with international electricity price elasticities and the Austrian electricity mix (74.4 % renewable, 28.6 % fossile; on average 195.16 g/MWh (E-Control, 2010)) A survey of 9 international electricity price elasticities can be found in Klobasa (2007).

[‡] A similar approach was used by Jochem (2009).

The latter estimates also stem from market observations, but they are associated with severe uncertainties; their calculation required several intermediate steps, each of which using uncertain literature based assumptions, and there is a high variation between different literature estimates, so that a cautious interpretation is required. Considering these uncertainties we feel that the elasticities shown in row (6) and (7) may best reflect the preferences of market participants. They were calculated from a bottom up approach using abatement cost curves. The elasticities lay between our own trading data results and those derived from energy demand price elasticities.

The excessive elasticity estimates of our own market observations may result from two reasons: (i) most of the currently traded allowances were not auctioned, but distributed without costs; and (ii) the reduction objectives in the second trading period were still not challenging. As a result, no serious scarcity emerged on the market yet and obliged companies could afford to show different preferences than they would do under more severe scarcity.

We expect companies to look at their abatement costs (and their technological opportunities) more closely, once their endowment is distributed more efficiently beforehand (e.g. by using auctions for the full quantity of EUAs) and thus, they are not willing to strive for more EUAs than they really need, as there would be no more windfall profits. Consequently, obliged companies do not seem to strictly follow their abatement costs curves with respect to their demand elasticity, as they were expected to do, once EUAs were getting scarcer. For this reason we see the CO_2 price elasticities calculated by trading data for EU allowances driven to a greater extend by speculation rather than abatement costs and technological opportunities. We assume to experience a more inelastic demand of EUAs, once the EUAs became scarcer in the future. Therefore, we use an average demand elasticity of -0.30 for the EU ETS sectors energy and industry in our model-based predictions.

3.3. Model of the inclusion of the transport sector in emission trading

The model used in the analysis combines a disaggregate fuel demand model of road transport and an econometric model of the existing EU ETS market. Figure 1 shows a flowchart of the common market.

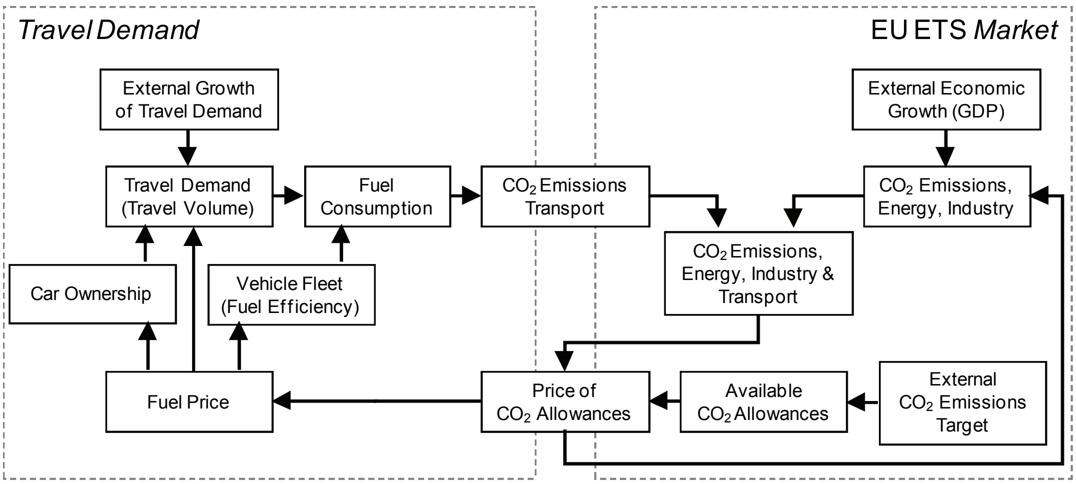

Figure 1: Integrated model of emission trading and travel demand

The travel demand model is a disaggregate model based on individual trips. It uses several combined utility functions to calculate the fuel demand for a given emissions allowance price: The latter is turned into a surcharge on fuel price depending on the allowance price and the amount of CO_2 covered by one allowance. The changed fuel price affects in turn the probability (i) to sell the car at all; (ii) to replace the existing vehicle by a more fuel efficient one, or (iii) to abandon the car at single trips, e.g. by suppressing the trip or using another means of transport. The fuel efficiency of new vehicles was calculated by a log-linear model using literature-based values (Hössinger et al., 2011). Freight road transport is included by assuming an elasticity of one third of passenger road transport, this proportional factor was derived from a literature review of Austrian freight transport (Pischinger et al., 1998). The resulting fuel demand for a given fuel price is used for calculating road transport induced CO_2 emissions.

In the econometric EU ETS-market model the demand for CO_2 emissions of the EU ETS sectors at a given allowance price is calculated. The sector-specific CO_2 emissions are summarized and compared to the reduction objective. Depending on the compliance, the allowances price is changed and the model application is repeated in an iterative manner, until the emission reduction objective is reached.

In a separated markets design, sector specific CO_2 emissions reduction objectives are given, and allowance prices are calculated separately for transport and non-transport sectors. Hence, the sector specific emissions are not added up, but every sector has to reach its reduction objective on its own.

3.4. Model features and application

The reference year of the model is 2010 with an average fuel price of 1.00 Euros per liter as well as the corresponding fuel consumption and CO_2 emissions. The model is a time series model with single periods representing one month. The fuel demand of the transport sector is assumed to increase by one percent each year due to external growth, what is a continuation of the previous trend. The same refers to the other sectors. The demand of CO_2 emissions of non-transport sectors is assumed to rise by two percent each year following an external growth of the GDP (constant production technology assumed).

We focus on a cap-and-trade system, where an overall emission reduction objective is set; in separated markets this is equivalent to sector specific emission reduction objectives. The number of available emission allowances is reduced consecutively. Market participants are assumed to form their preferences based on current prices; we disregard effects resulting from the awareness of future prices, e.g., the decision for a more fuel-effects vehicle due to the anticipation of higher fuel prices in the future.

We compare the effects of three different emission reduction objectives (scenarios). According to the low decrease of CO_2-emissions in the second EU ETS trading period ending 2012, we set a reduction objective of 0.48 % p.a. in the first three years in all scenarios. Scarcity of CO_2 emissions in EU ETS arises only from 2013. The first scenario assumes an annual reduction of GHG emission allowances of 1.74 %, what corresponds to a reduction of 20.1 % in the entire assessment period of fifteen years. The second and third scenarios refer to even higher emission reduction objectives as shown in Table 2.

Table 2: Assumed emission reduction objectives in the 3 investigated scenarios

Scenario notation	Annual emission reduction 2010-2012	Annual emission reduction 2013-2024	Overall emission reduction After 15 years
Scenario 1	0.48 %	1.74 %	20.1 %
Scenario 2	0.48 %	2.81 %	30.0 %
Scenario 3	0.48 %	4.05 %	40.0 %

The following analysis is based on several assumptions: (i) upstream and downstream approach are treated as one design option, since both build on fuel price as the same reference point; (ii) the midstream-approach is neglected due to the limited response options for road users as stated in section 2; (iii) CO_2 is the only greenhouse gas considered in our model, since it is most important in the transport sector. Using the model described above we calculated emission allowance prices for both trading models (common market and separated markets) and different emission reduction objectives, which affect the amount of CO_2 emissions, the allowance price, and the fuel price.

4. Results

The following figures show the sector specific development of CO_2 emissions dependent on the trading model (separated and common market specification) and different reduction objectives (scenario 1 to 3). Figure 2a shows the trading models effect for scenario 1. The change in the emission reduction obective at the beginning of the third EU ETS trading periode after 36 months is clearly visible by the changing slope of the curves. The seperated market specification requires every participating sector to meet the same emission reduction objective on its own, so that the curves of the transport and non-transport sectors are in perfect alignment.

This is not the case in the common market. The allocation of emissions depends on the sector specific price elasticities of emission demand. The EU ETS sectors decrease their CO_2 emissions for almost 40 % to 19.2 megatonnes within 15 years, while the emissions of the transport sector rise above the status quo (24.2 megatonnes). Obviously, the exogenous growth of transport demand outweighs the response to the rising fuel price, which is limited due to the inelasticity of travel demand. As a result, almost all 'reduction burden' is shifted to the current EU ETS sectors. However, the transport sector's demand reaches a peak after 120 months with 5.63 % above status quo and decreases afterwards. This follows from the demand elasticity of non-transport sectors, which becomes more and more inelastic due to the log-linear specification. Thus, in the long run, the transport sector is also required to contribute to the reduction objective.

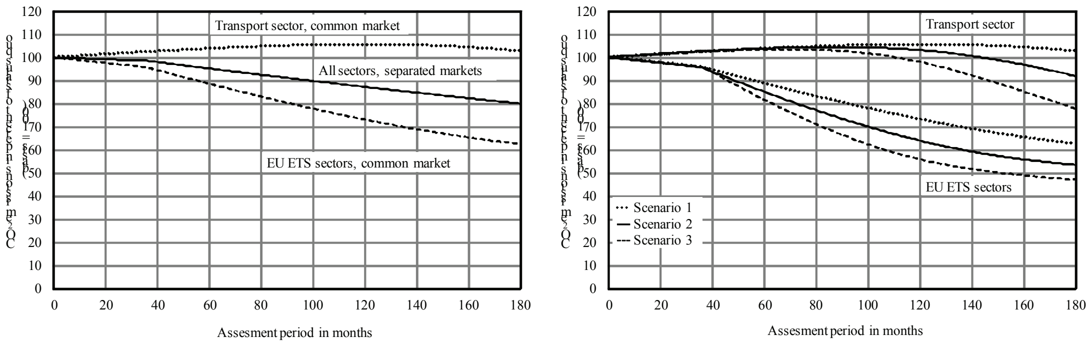

Figure 2: (a) CO_2 emissions in a common market and in separated markets in scenario 1; (b) CO_2 emissions in a common market in dependence of different emission reduction objectives (scenario 1 to 3)

Figure 2b shows the CO_2 emissions for the 3 different scenarios by means of a common market specification. It turns out that different emission reduction objectives do not change the allocation pattern fundamentaly. All 3 scenarios result in stronger CO_2 emission reductions in the EU ETS sectors than in the transport sector after 15 years (Table 3). However, a higher emission reduction objective causes an earlier convergence of the curves of transport and non-transport sectors; the divergence of CO_2 emissions after 15 years reaches a maximum in scenario 2 (21.7-16.4=5.3 Mt CO_2); an even stronger reduction objective as assumed in scenario 3 makes the difference smaller (18.2-14.4=3.8 Mt CO_2). The reason is again the inelastic demand of non-transport sectors at lower emission levels, which becomes effective earlier in case of sharp reduction objectives.

Table 3: CO_2 emissions in annual megatons in the common market by the end of 2024

	Scenario 1 (emission reduction: -20.1 %)	Scenario 2 (emission reduction: -30.0 %)	Scenario 3 (emission reduction: -40.0 %)
Transport sector	24.2	21.7	18.2
EU ETS sectors	19.2	16.4	14.4

Figure 3 shows the development of emission allowance prices in dependence of the two trading models by means of scenario 1. In a common market exists only one unique allowance price for all sectors; it reaches 256.0 Euros after 15 years in scenario 1 with an emission reduction objective of -1.74 % p.a. from 2013 onwards. This is a remarkable increase given the issue price of 20.0 Euros per allowance. The inelastic transport sector accounts for most of this increase. Obviously, car users are willing to pay a high price for maintaining their travel behaviour.

This becomes most evident in a separated market specification, where each sector must reach the same emission reduction objective and the allowance price differs between sectors. The allowance price in the transport sector reaches 607.8 Euros after 15 years even in the most moderate scenario 1; a stronger reduction objective such as scenario 3 would boost to price beyond 1,000 Euros (Table 4). The allowance price in non-transport sectors would remain clearly lower due to the separation; the increase in the assessment period lies between 113.9 (scenario 1) and 294.9 Euros (scenario 3).

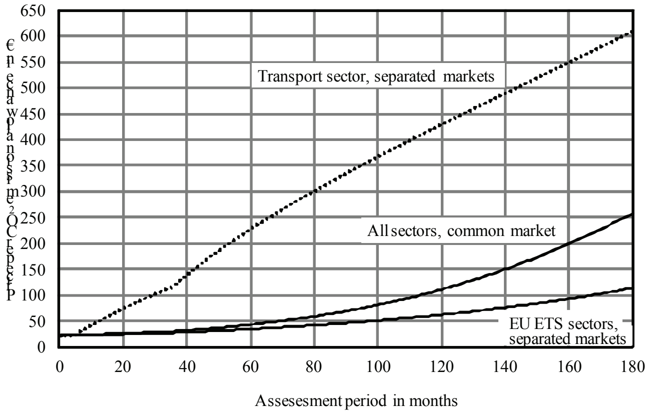

Figure 3: CO_2 emission allowance price in a common market and in separated markets in scenario 1

Table 4: CO_2 emission allowance prices in Euros in a common market and in separated markets by the end of 2024

	Scenario 1 (emission reduction: -20.1 %)	Scenario 2 (emission reduction: -30.0 %)	Scenario 3 (emission reduction: -40.0 %)
Separated markets, transport sector	607.8	791.3	1,026.2
Separated markets, EU ETS sectors	113.9	176.5	294.9
Common market, all sectors	256.0	433.7	670.5

From the car driver's point of view it is not the allowance price, but the fuel price that matters. We assume the allowance price being fully passed on to the fuel price, so that the latter is a linear function of the allowance price. The issue price of 20.0 Euros per allowance corresponds to a fuel price increase of 0.05 Euros per liter. The further development of the fuel price depends on the market model and on the emission reduction objective (Table 5); the first scenario implies a fuel price of 1.78 and 2.85 Euros per liter in a common and separated market specification, respectively. Diesel produces a higher specific amount of CO_2 than gasoline, and freight transport uses a higher share of diesel than passenger transport, so that emission trading would cause a slightly higher fuel price increase in freight transport.

Table 5: Sales fuel price in passenger transport in Euros per liter in a common market and in separated markets by the end of 2024

	Scenario 1 (emission reduction: -20.1 %)	Scenario 2 (emission reduction: -30.0 %)	Scenario 3 (emission reduction: -40.0 %)
Common market	1.78	2.32	3.04
Separated markets	2.85	3.41	4.13

5. Conclusion

Both trading models are feasible options to meet preset emission reduction objectives, but the distribution of burden between the sectors fundamentally depends on the regulation of the emission market. A separated markets specification requires each participating sector to reach its own objective; it results in sector specific allowance prices, which depend on the sector specific price elasticities of allowance demand. The current EU ETS sectors are much more price elastic than the transport sector, so that transport sector's allowance (and fuel) prices would rise substantially in separated markets. A common emission market would result in a common allowance price for all sectors, which is much lower, but the emissions reduction duties of the transport sector are pushed towards the current ETS sectors energy and industry.

From our results it is obvious that (i) an emission trading scheme in the transport sector is ecologically effective regardless of the trading model, and (ii) the transport sector responds less flexible to increasing emission costs than current EU ETS sectors. This inequality results either in a shift of burden from the transport sector to other market participants (in a common market) or in a very high transport specific allowance price (in separated markets), which are clearly beyond what is conceivable with regard to social and political acceptance.

Thus, emission trading in the form of a common market may be ecologically effective and also most cost-efficient, but it is rather not the first choice for reducing transport sector induced CO_2 emissions. However, it should be seen as one out of several possible financially incentivized policies aiming at the reduction of CO_2 emissions in road transport. In any case, if implemented, it would definitely require accompanying measures to avoid social hardship. For an overall impact assessment several possible interferences should be taken into account, in particular with the labour market, inflation, car technology and land use patterns.

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