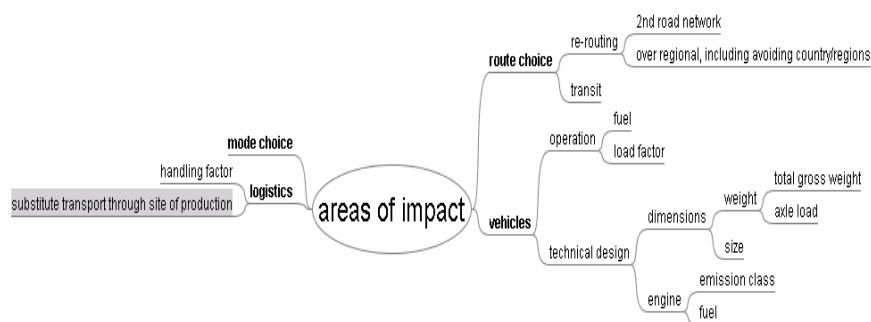


## Road User Charging for Heavy Goods Vehicles - Overview of Regional Impact



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## Summary

The purpose of this study is to investigate and analyse which impacts the implemented heavy vehicle road user charging systems have had on route choice, modal choice, choice of vehicles and logistics. Another aim is to investigate how regional impacts were considered when the road user charging systems were designed and, how did they influence the system design?

Distance based road user charging for heavy goods vehicles is on the political agenda in Sweden as well as in Europe. Charging for the use of infrastructure is not a new concept. New, however, is the increased ability to reflect the socio-economic marginal costs and contribute to achieving general transport policy objectives. The objectives for implementation vary between, e.g. infrastructure financing, reducing road congestion, increasing efficiency and influencing modal choice.

The three existing distance based road user charging systems in Europe have different objectives:

- The Austrian system is mainly focused on road infrastructure financing,
- The Swiss system has a clear focus on applying the “user pays” principle, protecting the environment and increasing the rail share,
- The German system has a strong focus on the infrastructure financing but there is also a focus on applying the “user pays” principle, more efficient use of transport capacities and emission-related tolls as well as providing fairer conditions for rail transport.

Toll avoidance de-routing is a negative impact of the implementation of road tolls in Germany and Austria but not in Switzerland, since all roads in Switzerland are included in the scheme. In Germany there are tendencies to de-routing to secondary roads (national roads) which are running parallel to motorways and have a motorway-like standard. The same tendencies can be found in Austria but to a somewhat lesser extent.

The experiences so far of possible modal-split effects are difficult to separate from other influencing factors. In Switzerland there are almost no measurable modal-split effects – even though this was one of the main aims of the system – since the effect of the introduced road toll was almost totally compensated by efficiency gains in the road sector through higher permitted lorry weights.

In Germany there are some indications of a modal shift among larger shippers towards an increased use of rail transports (+3.1%), but the largest effects are on an increased consolidation of road transports. The indications of changes in modal-split are difficult to specifically relate to the impact of the road tolls as there are a number of other influencing factors e.g. increased fuel prices, changed vehicle weights, open market towards Eastern Europe.

The impacts of the implemented road user charging systems on logistics are mainly an increased efficiency in the road freight sector in terms of e.g. consolidation of road transports, reduced number of empty runs and concentration in the haulier business.

These effects can be found in Germany, Austria and Switzerland.

There is an interest in vehicles with reduced emissions (EURO 4 and 5 class vehicles) in Germany and Switzerland and there is a tendency in all countries towards adjustments of the fleet composition as a response to the charging criteria.

Different studies indicate that high road fee levels are required to achieve a change of modal-split in favour of rail transport (see McKinsey 2005 and Transcare 2005 with fee levels in the range of 0,5-1,0 €/vehicle km) whereas the strategic simulation studies carried out for international freight transports (BMT 2002, 2004) indicate lower road fee levels to achieve a modal-split effect. The simulation studies are on a strategic level and the model parameters assumes that the market operators have adapted to the new situation, which might take some time in reality.

Road pricing is one of several different measures to influence a country's transport policy and needs to be put in the context of the overall transport plan.

The analysis shows:

- A clear connection exists between the impacts and the design of the different schemes. Therefore, it is most important that the goals are carefully

considered and consequently reflected in the design of the schemes.

- The risk for road toll avoiding de-tours has to be considered carefully, mainly due to its effect on disturbances, accidents and thereby on public opinion. Including all roads as in Switzerland eliminates the problem. The planned system for Sweden which is to include all roads might even increase traffic on the motorways, since the same fee level is planned for all roads.
- **The modal-split effects so far are limited. There are indications of changes of modal-split, but it is difficult to separate the impact of road tolls from other influencing factors. It is recommended to follow these initial effects over a longer time period in order to evaluate the effects more in detail. It is also clear that to achieve an increase of the rail market share, improvements within the rail sector are required.**
- The road transport sector is clearly influenced and efficiency improvements are achieved. It recommended to analyse how the different segments of the haulier industry are affected by the toll systems implemented.

## 1. Introduction

Distance based road user charging for heavy goods vehicles is on the political agenda in Sweden and a number of research projects are focusing on different aspects. Both the Interreg project EastWest and the SIR-C<sup>1</sup> national project "Effects of user charges for heavy road vehicles, potentials to influence modal split " are studying *regional impacts from road user charging systems for heavy good vehicles* and both projects have an interest in understanding what has happened in other European countries. This report is the result of the joint work between the two projects with the objectives to:

- collect existing knowledge,
- learn of other experiences.

The results will be used by both projects as input to further work; e.g. as support for the definition of scenarios and simulations. The SIR-C project has a focus on modal split between road and rail transport. The report therefore pays special attention to modal split experiences, e.g. chapter 2.3 is dedicated to modal split studies.

The purpose of this study is to investigate and analyse which effects the implemented heavy vehicle road user charging systems have had on route choice, modal choice, choice of vehicles and logistics. Another aim was to investigate how regional impacts were considered when the road user charging systems were designed, and how did they influence the system design?

The work was commissioned by the Swedish Road Administration and the Swedish Rail Administration and it was carried out by Inger

Gustafsson, Peter W. Cardebring and Ralf Fiedler at BMT Transport Solutions GmbH.

## 2. Background

### 2.1 Road user charging in a context

Charging for the use of infrastructure is not a new concept. New, however is the ability to reflect the socioeconomic marginal costs and contribute to achieving general transport policy objectives. Objectives for implementation vary between, e.g.:

- infrastructure financing,
- reducing road congestion,
- increasing efficiency,
- influencing modal choice,
- create fairness between domestic and foreign vehicles.

Throughout Europe there is a need to raise additional revenue to fund maintenance and expansion of transport infrastructure and road user charging is seen as one possibility. Road user charging is also a tool for influencing the usage of the infrastructure. These objectives are quite different from each other and result in different requirements on the tolling systems. A common view behind the implementations is the desire to relate charges more closely to the external costs.

Two European directives are important for the planning and the implementation of road user charging for heavy goods vehicles. The directive on the charging of heavy goods vehicles for the use of certain infrastructures (European Commission 2006), provides the institutional framework for the implementations. Further the directive "On interoperability of electronic road toll systems in the Community" (European Commission 2003) lays down the conditions necessary to ensure a European electronic toll service that

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<sup>1</sup> The project is part of the Swedish Intermodal Transport Research Centre – SIR-C – and is jointly financed by the Swedish Road Administration and the Swedish Rail Administration

is interoperable at the technical, contractual and procedural level. The aim is to have a single contract between the user and all operators and provide a set of technical standards that allow the industry to provide the required equipment in a competitive market.

## 2.2 The Swedish situation

In Sweden a governmental commission has investigated the possibilities and suitability of implementing an inter-urban kilometre charging system for heavy goods vehicles (Governmental Commission on road tax charges, 2004). The commission's proposal is based on the principles that charges will be collected for all public Swedish roads as well as some of the privately owned, and that the payment base is the distance travelled in

combination with vehicle characteristics. Vehicles above a total weight of 3,5 tons should be charged. The overall objective for the transport policy in Sweden is that taxes and charges in road traffic should reflect the socioeconomic marginal costs and contribute to achieving the transport policy objectives. For a distance based tax for heavy goods vehicles this calls for internalisation of external effects like wear, maintenance costs, pollution and accidents.

The governmental transport policy document presented in spring 2006 recommends that distance based tax for heavy goods vehicles shall be implemented and this is further supported by a parliament decision. A final decision is expected in spring 2007 when a number of additional analyses are finalised. The process is illustrated in

- Vehicle tax – based on type of vehicle, weight and number of axles
- Vignette – based on number of axles and emissions (EURO class)

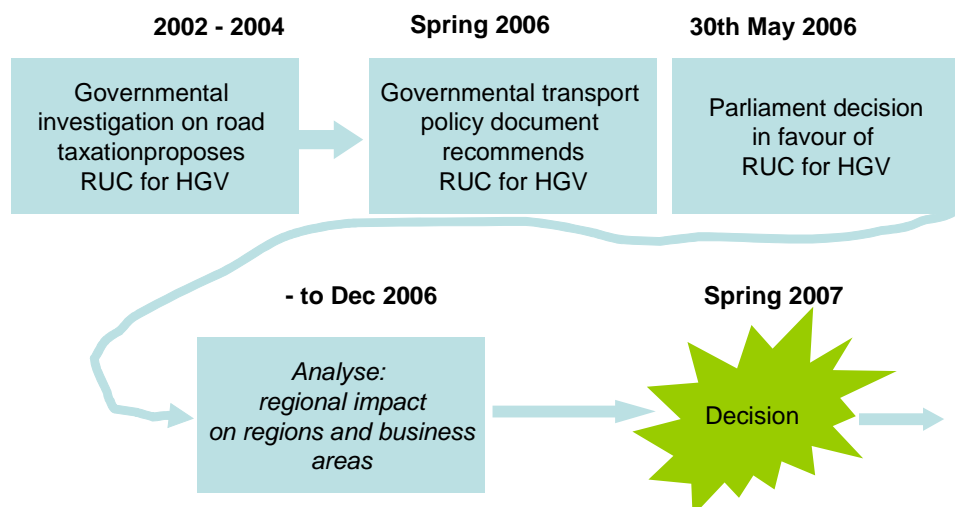
It is today still unclear to what extent the distance based tax will be compensated through other tax reductions.

Figure 1.

Today's cost structure for Swedish registered lorries:

- Fuel tax – based on used litres of fuel

Figure 1: The Swedish decision process



## 2.3 Example of existing studies of Modal split - selection

A number of studies have been carried out at the European level regarding the relationship between road tolling and modal split. The focus has mainly been on modal split between road and rail. Below follows a short overview of the results from studies carried out by BMT, McKinsey and TransCare. The studies are using different methods and are commissioned by different interest groups. The McKinsey study is based on a cost – price calculation for the railway. It claims that road user charging is required to support the European railways and a road charge of 0.49 Euro/km would increase the rail volumes, i.e. a rail freight share of 16%-17%. The TransCare study on the other hand claims that road user charging is not a suitable tool to impact modal split. The approach of the TransCare study is to study which goods could potentially be moved from trucks to rail.

### Capacity 2015, BMT

The purpose of the multi-client study Capacity 2015<sup>2</sup> in 2004 was to provide a strategic assessment of the future transport capacity in selected transport corridors between Scandinavia and the Continent in 2015. The assessments were based on a trade forecast for 2015 and a review of actual transport infrastructure and national infrastructure programmes. The relation between demand and supply in the corridors was studied under different assumptions regarding road pricing levels.

The main findings of the study were:

1) International road transport volumes will increase significantly; both in passenger and

in freight transport. In most corridors, the growth in freight transport exceeds the growth of passenger transport.

2) The growth of lorry transport was simulated with the EFM-STAN simulation model in 4 different scenarios. The model showed that lorry charging limits road transport growth. The mean value of international lorry transport growth until 2015 in the study for the different tested scenario was:

- 58% in Scenario 0+ (2015 transport demand but no other changes, i.e. transport infrastructure as today)
- 93% in Scenario 1 (2015 transport demand with planned infrastructure improvements but no charging)
- 75% in Scenario 2 (as Scenario1 but lorry charges amounting to 0,15 EUR/km in all concerned countries)
- 56% in Scenario 3 (as Scenario1 but lorry charges amounting to 0,30 EUR/km in all concerned countries)

3) Potential bottlenecks in the road network will increase in number and the congestion in the identified bottlenecks will get worse between 2003 and 2015. A considerable number of infrastructure improvements do not achieve any real congestion reduction in comparison with today – this is mostly evident in the densely populated areas.

### The Future of Rail Freight in Europe, McKinsey&Company

2005 the Community of European Railways and Infrastructure Managers (CER) commissioned McKinsey to carry out a quantified perspective on the future of the rail freight sector.

The analysis was based on a cost – price calculation for the railway. The conclusion was that the rail market on average is operating at a loss and that prices need to be increased to cover the costs, which in turn would lead to

<sup>2</sup> The study was carried out by BMT Transport Solutions GmbH, TFK Institute for transport research and Centre for Maritime Studies, see <http://www.bmt-ts.com/en/projects/index.html>

decreasing volumes and further price increases. The study forecasts a rail volume decrease of 50-70% to reach equilibrium. This would mean that today's 14% rail share of transport work would decrease to 4%-7% and that there would be an additional 35 000-50 000 lorries on the road.

The study also recognises the ongoing reconstruction of the rail market and it is expected that the cost of the railways will decrease. But the report also points out that the road sector has a short term potential to lower their costs by 10%-20% within the next years mainly due to higher utilisation and lower cost for east European labour. Through the foreseen restructuring, the rail market would still lose 30%-40% of its volumes. This would mean that the rail share would decrease to 8%-10% and there would be an additional 20 000-30 000 lorries on the road. Therefore, the recommendation of the report is that road charging is required to support the European railways. In two scenarios a road charge of 0.20 Euro/km and a road charge of 0.49 Euro/km is applied. With a road charge of 0.20 Euro/km rail would still lose market shares and volumes. With a road charge of 0.49 Euro/km rail would increase its volumes by 10%-20% leading to a rail freight share of 16%-17% and a decrease of 7 000-15 000 lorries on the road.

### **Impact of lorry-charging on modal split in Freight transport, TransCare**

In parallel to the McKinsey study, the International Road Transport Union and Bundesverb(IRU) and Güterkraftverkehr Logistik und Entsorgung (BGL) commissioned the consulting company TransCare to examine the impact of road user charging on the modal split between road and rail in 2005.

TransCare took a quite different starting point by looking into the existing road transport volumes and analysed which volumes could be transported by rail. The analysis focused on the transports in Germany and France. After reducing road transport volumes that are

“not transferable” with regard to: type of goods, distance, commercial issues and lacking quality of rail supply, only 1,2% of the original volume remained. The study argues that these 1,2% theoretically can be transferred to rail. If the supply of the rail would improve, the potential would be 4,1%.

In a second step it was analysed which road charge level would be required to ensure the modal split. The transport market was divided into five segments: package, part pallets, full pallets, part lorry load and full lorry load. For each segment the transport cost share of the total supply chain cost was calculated. The share varied from 10% for the package to 75% for the full lorry load, i.e. for packages only 10% of the cost is caused by the transport.

As a third step, different levels of road charging was assumed ranging between 0,25 Euro/km to 1 Euro/km. It was further assumed that a modal split would only take place if the supply chain cost increased by at least 10%. With this assumption a fee of 1 Euro/km would be required to achieve the full modal split potential.

The recommendation of the study is that road tolling is not a tool to influence modal split since the required fee level is so high and the potential so low. According to the study, a fee level of 1 Euro/km would cause severe damage to the economy.

### 3. Methodology

The basis for the study has been literature reviews and semi structured interviews with national experts. Both activities were carried out with the goal to answer the questions:

- Were regional impacts a topic when designing the system for the distance based road user charging for HGV, and how did they influence the system design?
- Which actual impacts have been noticed?

The following key actors were interviewed:

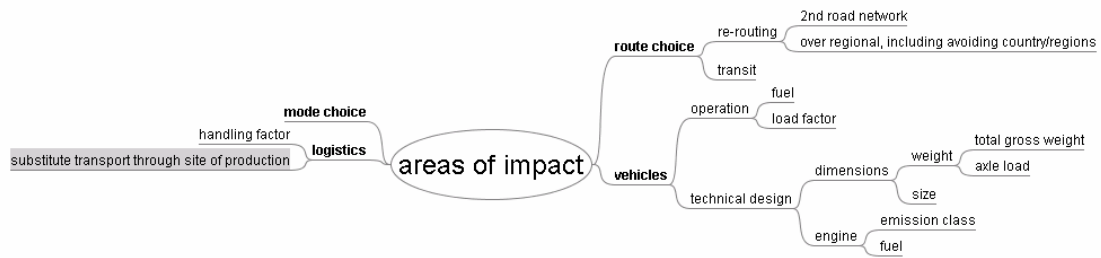
- Karl-Heinz Stappert, TÜV Germany
- Uli Balmer, Switzerland
- Martin Jones, Department for Transport, UK
- Phil Blyth, University of Newcastle, UK
- Jesper Engdahl, Rapp, Switzerland, Austria, Germany, UK
- Krisitian Appel, Traficon, Finland
- Kaisa Leena Välipirtti, Ministry of transport and communications, Finland

Before the studies were initiated, an internal workshop was organised to agree on the scope of the notion regional impact. Road user charging will have impact on a number of different levels e.g.: it will lead to increased cost per kilometre (unless compensations are introduced), it will cause increased administrative burdens, lead to changes in the work environment of the haulier sector etc. Due to the scope of the project it was decided to focus on the impacts closely related to the increased cost per kilometre. It was decided

to include impacts that were planned for as well as unplanned and even undesired impacts. However, we had no ambitions to study what impact the increased cost per kilometre would have on total transport cost and further to the development of regions and industry sectors. This is a very important issue that should be considered carefully when a road user charging system is implemented and the Swedish government has commissioned a study on this that will be presented in March 2007.

The workshop resulted in four main areas of impact as illustrated in figure 2

**Figure 2: Areas of impact included in the study**



**Route choice.** The route choice can be influenced by road user charging. Over regional re-routing can take place to areas where no charging systems are in place. When only parts of the network is charged for, e.g. the motorways, operators can cut their toll payments by reducing the distance travelled on motorways.

A change of **mode choice** or modal split, i.e. increased usage of road transport, is an impact that is often desired.

**Vehicles.** Depending on how the charge is defined it can be expected that the vehicle park can change. The dimensions of the vehicles can be adjusted towards an optimised charging class and less polluting vehicles can be become more attractive through a lower level of charging. Also the usage of the vehicles can become more efficient through an increased load factor.

**Logistics.** Logistics is a very wide notion and in this context, focus is on the handling factor and possible substitutions of transport through alternative sites for production.

### **3. Country reports**

The basis for introducing more advanced road user charge systems differ between countries. In continental Europe several countries are subject to extensive transit traffic by lorries using the roads but not paying their fair share, as they fill up with cheap diesel in other countries and thus do not pay any diesel tax in the transit country. Other countries have environmental concerns and use the charges for promoting modal shift of freight to more sustainable modes. Other countries wish to finance the infrastructure investments with road user charges. Another issue that vary from country to country is the differing legal status of road user charges. In some countries the legal basis for the system is taxation whereas in others it is to charge for road use.

This chapter presents country reports from Germany, Austria and Switzerland describing observed impacts from systems in use since 2001, 2004 and 2005. Further the plans from UK, Denmark, and Finland are described

Within the Tango Collect project an overview of the planned and existing systems was carried out. The overview was updated by Blythe, Schelin and Gustafson in 2005 see Figure 3. It must be stated that this is not a complete list as it is recognised that The Czech Republic, Hungary, Slovenia, Belgium and The Netherlands are also in the advanced stages in their plans to implement road user charging system. Others, such as France and Greece have recently announced feasibility studies in this area. It should also be stressed that the overview focused on how the systems were designed and not on impacts.

**Figure 3 Overview of implemented and planned road user charges for heavy goods vehicles in Europe (Blomberg and Poersch, 2004) and updated in 2005 (Blythe; Schelin and Gustafsson, 2005)**

	<b>Switzerland</b>	<b>Austria</b>	<b>Germany</b>	<b>Sweden</b>	<b>Great Britain</b>
	Implemented system (Birle, 2003)	Implemented system Egeler & Bibaritsch, 2003)	Implemented system Kossak, 2004)	Planning Stage (Schelin, 2004)	Cancelled: (to be subsumed into National Charging Scheme) (Makinnon, 2004)
<b>COSTS</b>					
Object of fee	Vehicle above 3,5 tons total weight	Vehicle above 3,5 tons total weight	Vehicle above 12 tons total weight	Vehicle above 3,5 tons total weight	Vehicle above 3,5 tons total weight
Fee	Public land fee, i.e. on all roads	Public road fee, i.e. on high- and expressways only	Public road fee, i.e. on highways only	Tax on all roads.	Fee on all roads
Tariff	Per kilometre	Per kilometre	Per kilometre	Per kilometre	Per kilometre
Foundation of costs	Weight Number of axles Pollution class	Number of axles	Number of axles Pollution class	Vehicle type Number of axles Pollution class (Later: Time of the day)	Vehicle type Road type Time of the day
Specials		Higher tariffs on sensitive roads		(Later: Different costs on different roads)	Different costs on different roads (not in the beginning)
OBU	Until 2004 free of charge Est. unit cost = 1300 Euro	5 Euro	300 Euro (to be used as fee credit)	Not decided yet. (possible solutions: internet, OBU, mobile phone)	
Who pays installation of OBU?	Vehicle owner	Vehicle owner	Vehicle owner (for up to 4 hours)	Vehicle owner	Vehicle owner
<b>TECHNOLOGY</b>					
Technique	DSRC	DSRC GPS for control	GSM/GPRS GPS	Not yet decided. Possible solutions: DSRC GNSS/CN	Satellite based

Price list	OBU	Server	OBU	Server, OBU	
PAYMENT					
Pre/post	Both	Both	Both	Both	
Methods	Cash Debit Credit	Cash Debit Credit	Cash Debit Credit	Debit Credit	
Means	CHF, Euro Major fuel & credit cards	Euro Quick (electronic purse ) Major fuel & credit cards	Euro and at terminal location official foreign currency Major fuel & credit cards	Not decided	
Periods	60 days to send billing information 1 calendar month for paying bill	Daily transmission of data from credit institute Bill sent out every fortnight	Daily transmission of data from credit institute Monthly check of credibility	Post pay up to several days Transmission for each performed HGV journey to tax authorities	

## 4.1 Germany

The introduction of the Maut<sup>3</sup> (road tolls) in Germany was initiated through the discussion to privatise the German motorways. This was however too controversial since it implied the introduction of the motorway charging for all vehicles including private cars.

The Federal State, however, as the owner of the motorways and the national road network looked for extra income to finance necessary maintenance and new construction of road infrastructure. The so called Pällmann Commission was called up in September 1999 by the Federal Government as an expert commission under presidency of William Pällmann (previous executive of the Federal Railways and the Federal Postal Administration). The task was to examine the possibilities for financing of the federal road network outside of the Federal Budget and to suggest concrete steps to tap new sources for funding. The commission presented its final report<sup>4</sup> in 2000 proposing a distance based charge for HGVs of 0,25 DM (~0,125 Euro) per km based on an assessment of the external costs for HGV traffic.

The goal of the Pällmann Commission was limited to look for new opportunities for infrastructure financing. Ecological, social or regional effects were not on the agenda. During the following process of defining and setting up the German road toll system, the following strategic objectives were defined<sup>5</sup>:

- Additional revenues for transport infrastructure financing

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<sup>3</sup> Maut is the German name for road tolls for lorries

<sup>4</sup> [http://www.bmvbs.de/Anlage/original\\_5991/Bericht-der-Paellmann-Kommission.pdf](http://www.bmvbs.de/Anlage/original_5991/Bericht-der-Paellmann-Kommission.pdf)

<sup>5</sup> HGV tolls in Germany based on satellite and mobile communication technology...G. Schultz, BMVBW, CEMT 2006

- Application of the "user pays" principle
- More efficient use of transport capacities
- Emission-related tolls to protect the environment
- Fairer competition between road and rail transport

In total, the revenues from the Maut in 2005 amounted to EURO 2,86 Billion. The first half year of 2006 the revenues had increased by 6% compared with same period 2005.<sup>6</sup>

### Route choice

Soon after the delayed introduction of the Maut in January 2005 a public discussion emerged about allegedly increased lorry volumes on national roads (not motorways). The Federal Government asked the States (Länder) to identify roads, where a large increase of over-regional lorry traffic could be recognised. Despite the large public discussion, only 20 routes were identified, of which only 3 have been included in the network for fee collection from January 2007. These routes are B 75 between the motorways A 261 and A 253 (Hamburg), B4 north of A 23 (Schleswig-Holstein), B9 between to the German-French border and A 65 (Rheinland-Pfalz).

Effects were only evident where national roads with a good design standard run parallel to the motorway and do not cause much time delays, sometimes even shortening the geographic distance.

The study made for the Deutsche Bundestag states the following:

- The traffic development of lorries on secondary roads may have a number of reasons. On some roads the lorry traffic has increased, on other roads lorry traffic

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<sup>6</sup> <http://www.bmvbs.de/Verkehr/Strasse/Pressemeldungen>

has decreased. The EU-enlargement in May 2004 has e.g. caused increased lorry transports in the German-Czech border region, see figure 4<sup>7</sup>

- Detour traffic caused by the Maut is not evident in all of Germany. Surveys show that effects were only evident where national roads with a good design standard, that run parallel to the motorways, and would not cause much time delays and sometimes even shortening the geographic distance were chosen. Here effects can be seen e.g. west of Bremen towards the Dutch border, along the German-French border and south-east of Hamburg, see figure 5 and 6<sup>8</sup> below..
- On average the traffic growth (DTV) on national roads in the second quarter of 2005 was 7,6% compared to 2004 and the main part of this increase was caused by the Maut (6,6%).

Besides the possibility to include additional roads into the Maut regime to prevent HGVs from avoiding the Maut, a more controversial solution is not to permit HGVs at all on those sections of the road network. This is possible for the regional decision makers. In August 2006, 850 km of national roads have been banned for HGVs.<sup>9</sup> This was done e.g. in Saxony, where many Czech lorries used an alternative road instead of the motorway to enter Germany.

Diversion of lorry traffic has also been registered along the motorways in France along it's borders with Germany, especially in Alsace, where motorways runs along either side of the Rhine which forms the frontier. A modification of the French transport law (law 2006-10 of 5.1,2006) allows the region of Alsace to introduce a charge between 0,1-0,15 Euro/km on sections of the motorway not already subject to a toll for vehicles over 12 tons for an experimental period of 5 years<sup>10</sup>.

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<sup>7</sup> The results are based on an evaluation of the 1 300 automatic traffic counting units (600 at Motorways, 700 at main roads) were a before-after comparison has been made. Unfortunately it is not possible to count lorries >12 tons total weight as a separate category. Instead lorries registered with a total weight > 3,5 tons with and without trailer as well as semi-trailer units have been counted as a proxy.

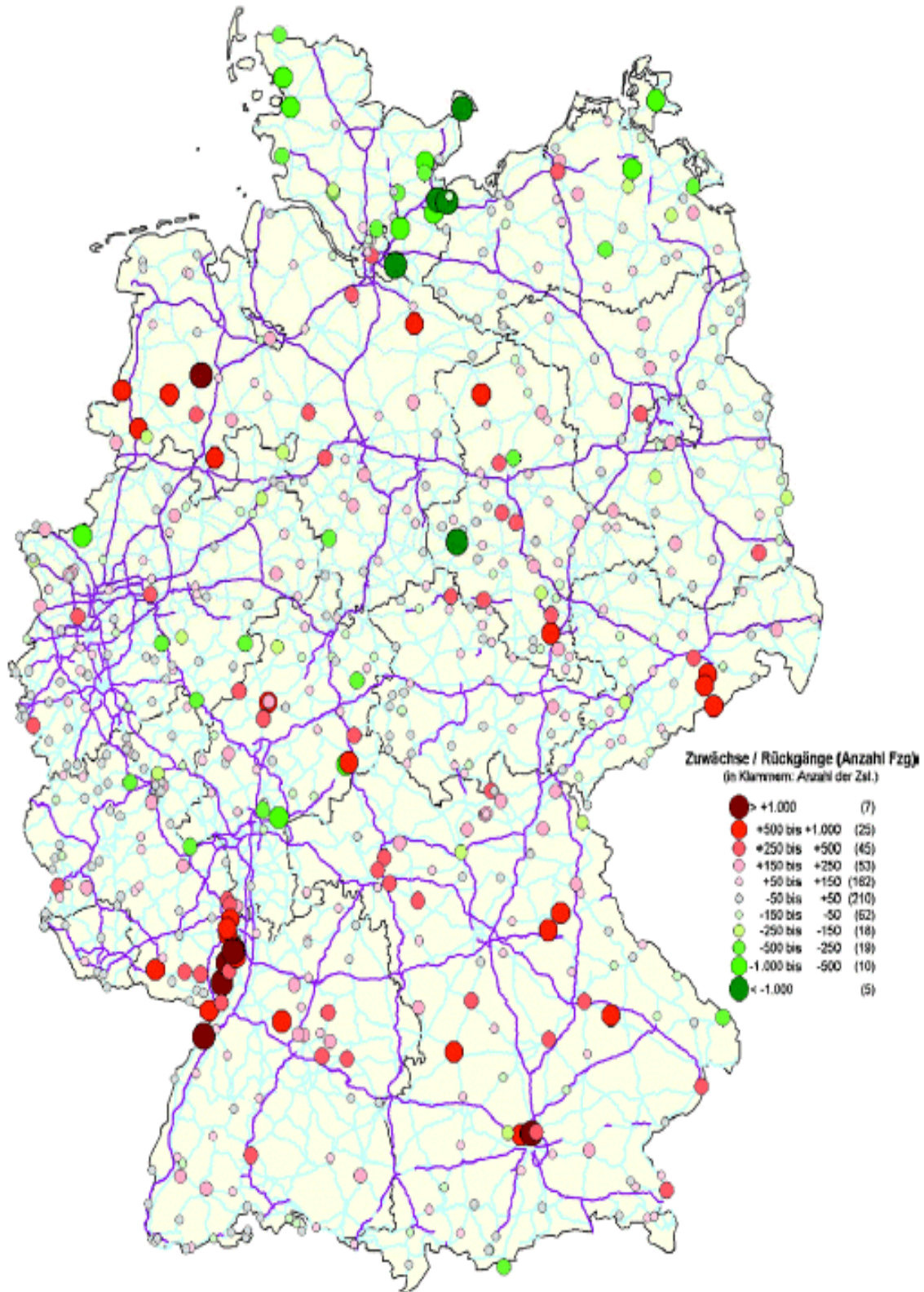
<sup>8</sup> To estimate the effect on lorries > 12 tons total weight, special model calculations have been made.

<sup>9</sup> <http://www.schenker.de/deutsch/news>

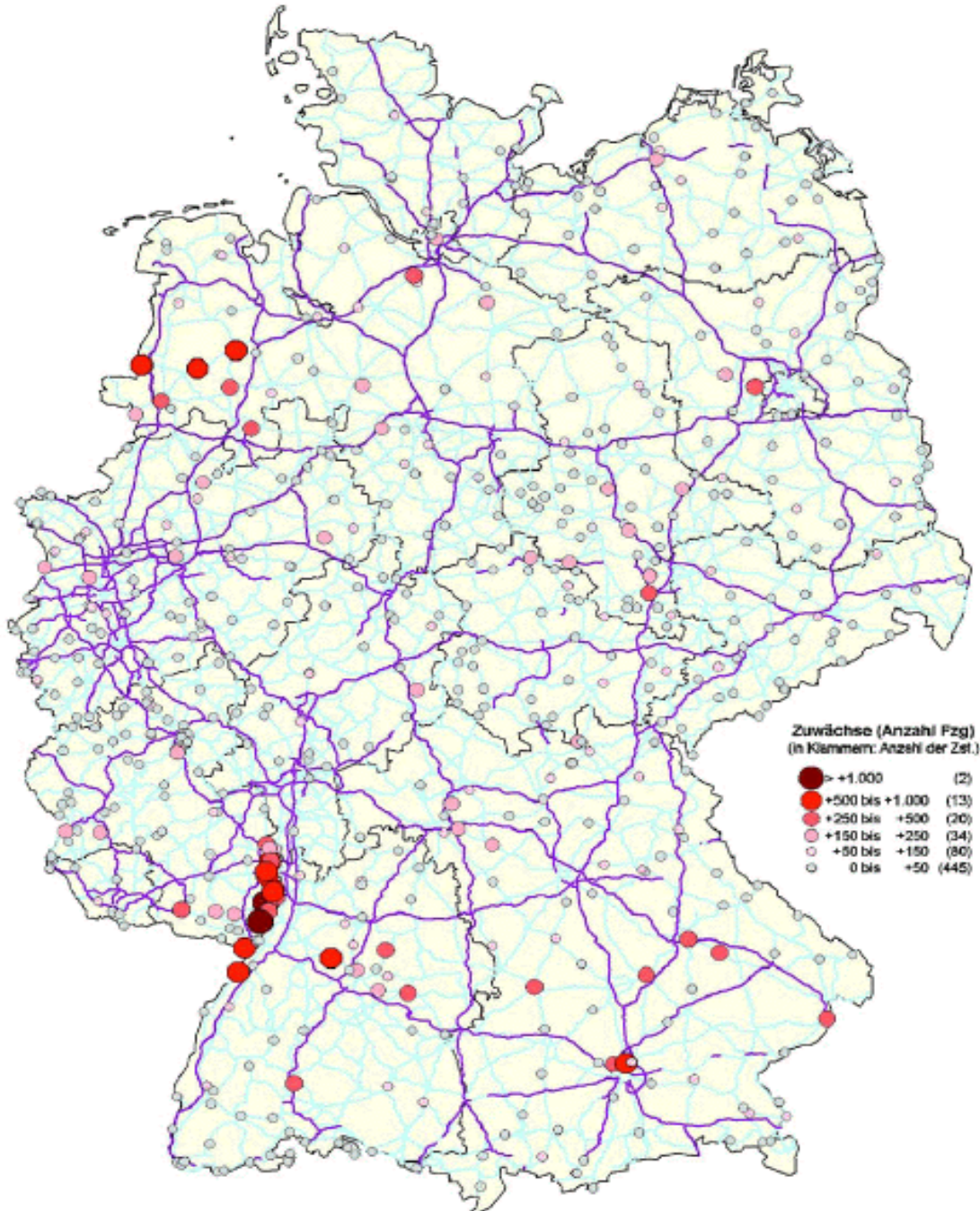
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<sup>10</sup> Conference of road charging systems: technology choice and cost efficiency, CEMT, 2006

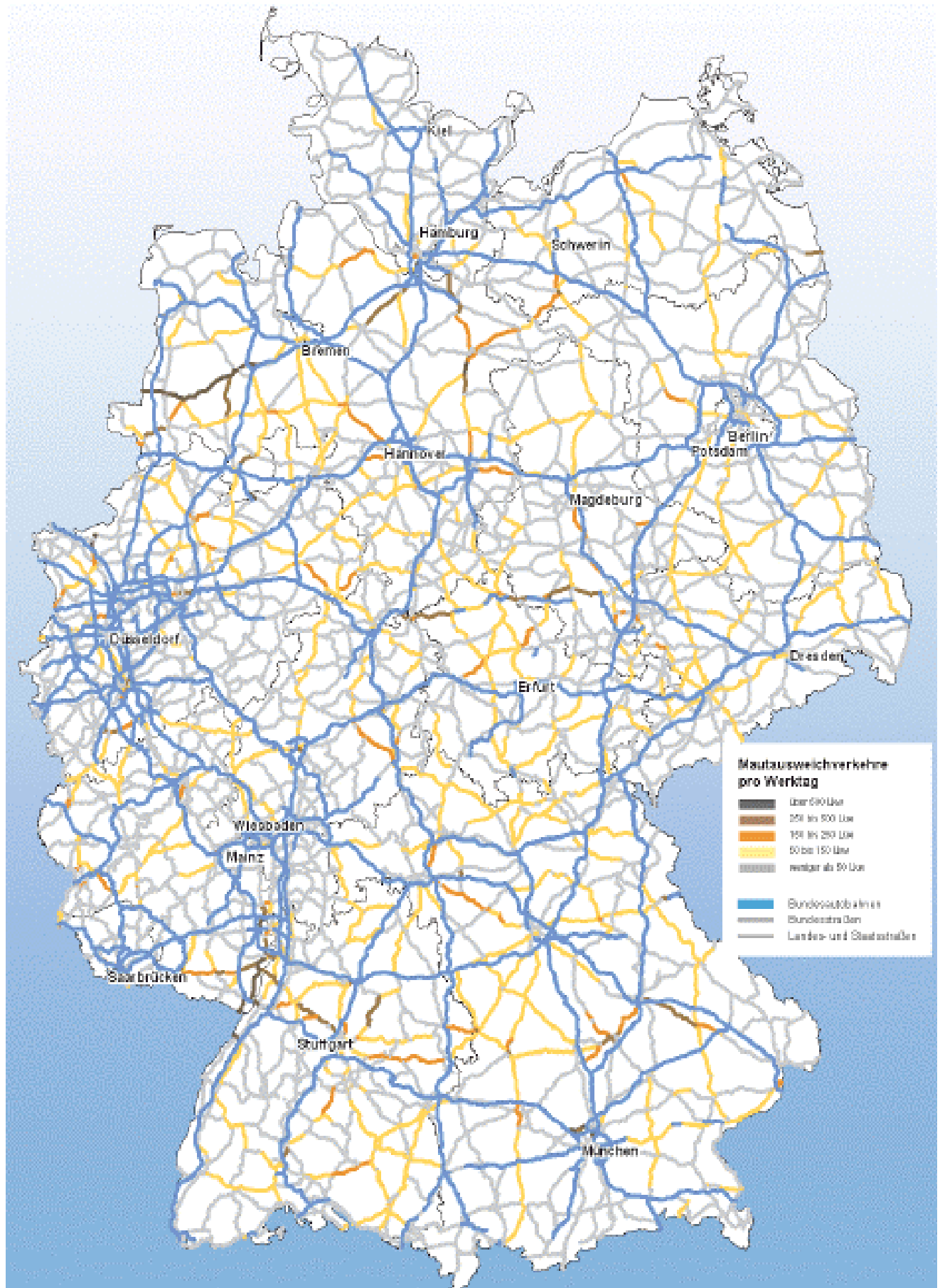
**Figure 4. Development of the average daily lorry traffic (DTV, > 3,5 ton), general comparison of traffic development 2004/2005 (2nd quarter)**



**Figure 5 : Increased average daily lorry traffic (DTV, > 3,5 ton) caused by introduction of the Maut. Comparison of traffic development 2004/2005 (2nd quarter)**



**Figure 6: Increase of lorry transports (>12 ton) on national roads caused by the Maut**



### Modal choice

In early 2005 after the introduction of the Maut the BAG<sup>11</sup> registered in its market assessment study (September 2005) a modal shift towards intermodal transport, This trend observed in winter 2005 could however not be confirmed during the following months. Both the railways and the intermodal operators raised their tariffs partly caused by the increased fuel costs. Intermodal transport has not become considerably cheaper than a road transport from door to door.

Shown below is the development of retail price for diesel, which is a critical cost factor, for the period 2002-2006.

**Figure 7 Development of diesel prices in Germany in Euro cent/litre<sup>12</sup>**

Period	Diesel price per litre
2002	83,6
2003	88,4
2004	93,7
2005	106,1
July 2006	115,1

In a recent industrial survey<sup>13</sup>, there are some indications of a modal shift as a result of the introduction of the Maut. 3,1% of the companies in the survey answered that they use the railway to a larger degree than earlier

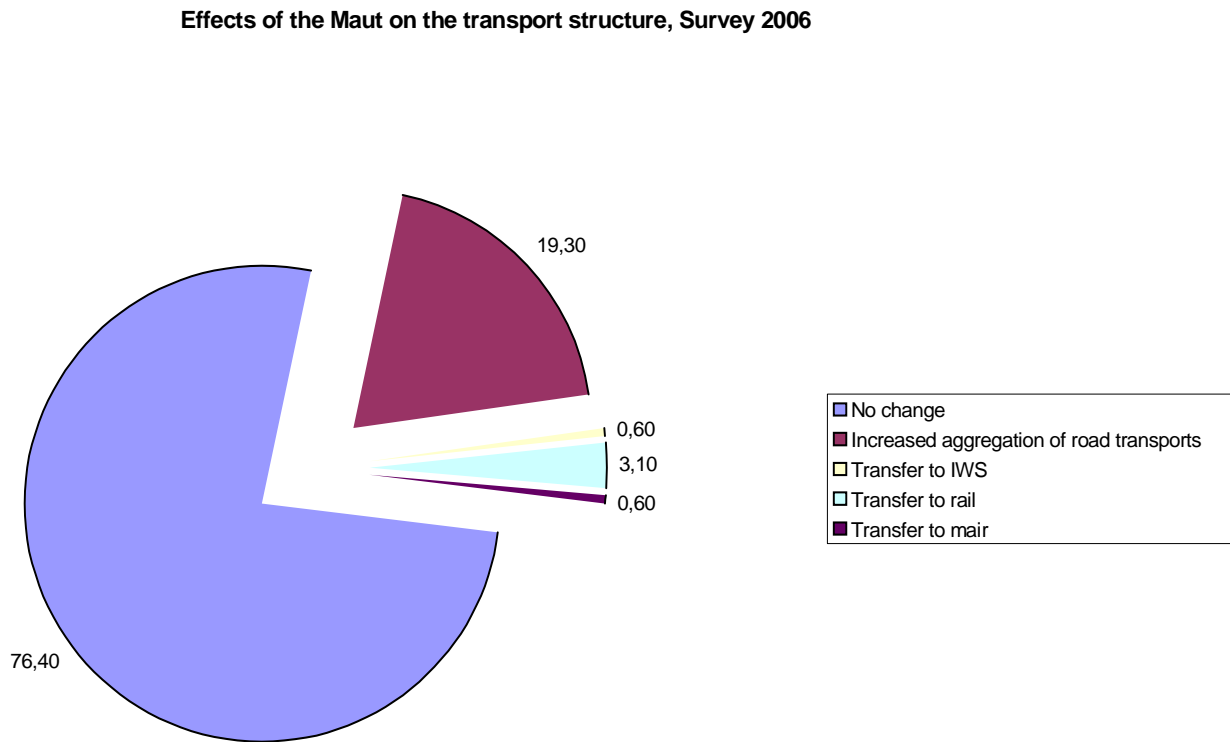
and it is mainly in the larger companies (turnover of EURO 5-50 million). 76,4% have not changed anything, 19,3% have consolidated their road transports thereby increasing utilisation. Some minor changes in increased use of inland waterways (0,6%) and air freight (0,6%) have also been registered.

<sup>11</sup> Bundesamt für Güterverkehr, Köln

<sup>12</sup> ADAC

<sup>13</sup> Modale Verlagerung des LKW-Verkehrs durch die Maut, Liedtke Gernot, Universität Karlsruhe, (INTBMEAUT), 2006

**Figure 8 Effects of the Maut on the transport structure, Survey 2006<sup>14</sup>**



<sup>14</sup> BME Umfrage, 2005. Based on 158 evaluated questionnaires which has been sent out to BME member companies. In November 2006 the results of the next survey will be available.

### **Effects on the transport industry**

The Maut increased the economic pressure on the German hauliers. While the increased freight rates for full lorry loads (FTL) were paid by the cargo owners, the empty runs have to be paid by the haulier themselves. In groupage transport (LTL) sector however, most companies have managed to increase their rates to cover both the full and the empty kilometres, so that they seem to suffer less from the increased costs. An indication for increased efficiency of the transport sector is the amount of empty running. In Germany, the total amount of empty runs have decreased by 15%<sup>15</sup>

### **Effects on other industry sectors and trade**

The impact of the Maut on the general price level is on average +0.15%, further for wood and wood products +0.16%, tobacco +0,11%, paper and paper products 0,10% and food and food products +0,09%.<sup>16</sup> It is estimated that the Maut has increased the costs of road haulage by 5-7% and it has a variable impact on profitability across the haulage sector<sup>17</sup>.

It is expected that the Maut will have a negative effect on already economically weak regions. Companies situated in such regions are likely to have to cover the costs for a higher share of empty runs. Because of that

the competitive position of companies situated in peripheral regions will decrease. There is however no evidence that such an effect would have caused companies to move or close down facilities.<sup>18</sup>

### **Effects on emission**

The Maut has an effect on the choice of vehicle and their emission class. The downgrading of Euro 4 vehicle from the beginning of 2006 resulted in a stronger interest in Euro 5 vehicles. However, such steering effects are also already caused by taxation of vehicles according to their engine and emission class. Currently the tariff system of the Maut is subject to changes to encourage the use of low emission vehicles. The adoption of the revised tariff system also suits the purpose to sustain the income for the federal government, but the new tariffs are not expected to lead to any reduction of gas and particle emissions in absolute figures, since the technical improvements are consumed by the traffic growth.

### **Concluding remarks**

The possible route choice changes are limited but exist because the Maut only applies to motorways. There are efforts to introduce criteria for including other types of roads as well. E.g. where roads run in parallel to the motorways, have motorway-like standard and do not lead to time delays. At this point three additional national roads have been included into the Maut regime.

The evidence so far for possible modal choice effects is also quite limited. There are some indications of a modal shift among larger shippers in Germany towards an increased use of rail transports (+3.1%), but the largest

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<sup>15</sup> Press release from Bundesverkehrsministerium für verkehr, Bau und Stadtentwicklung. BVBS, Maut ist umweltpolitisches und wirtschaftliches Steuerungsinstrument, 11. November 2005, Nr.: 453/2005

<sup>16</sup> Information from BVBS, <http://www.bmvbs.de/-1436.22466/Weitere-Informationen-zur-Lkw-.htm#9>

<sup>17</sup> McKinnon, Alan, A review of European truck tolling schemes and assessments of their possible impact on logistical systems, International journal of logistics, Edinburgh, 2006

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<sup>18</sup> Deutscher Bundestag Drucksache 16/298, Bericht der Bundesregierung über die Verlagerung von schwerem LKW Verkehr auf das nachgeordnete Straßennetz infolge der Einführung der LKW Maut., Berlin, 2005

effect is an increased consolidation of road transports.

The largest effect though, seems to be a higher load factor for their road transports.

In various earlier studies<sup>19</sup> modal shift effects have been estimated indicating a reduction of road transport volumes by 14,1 m tons (-1,4%) and an increase of rail transport volumes by 4,4% (+14 m tons) with a Maut of 0,12 EURO/tonkm. Other studies have shown more limited effects.

Looking at the actual development on the freight transport market in Germany, road transports increased by 9% (tonkm) between 2003 and 2005 whereas rail transports increased by 17%. This effect has to be described more in detail:

- a) The effect of the Maut is mixed with the effect of the large increase in fuel prices since 2000 which has led to an increase of tariffs, which is comparable with the cost increase caused by the Maut. During 2005 when the Maut was introduced, no significant increase in rail transports was noticed.
- b) The increase in tonkm is mainly an effect of longer transport distances rather than increased transport volumes.
- c) Whether the increased port hinterland transports are causing the increase in rail transports (tonkm) also remains to be analysed.

The industrial survey carried out by BME<sup>20</sup> indicates that 3,1% of the larger shippers are using rail transports as an effect of the Maut.

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<sup>19</sup> Modale Verlagerung des LKW-Verkehrs durch die Maut, Liedtke Gernot, Universität Karlsruhe, (INTBMEAUT), 2006

<sup>20</sup> Modale Verlagerung des LKW-Verkehrs durch die Maut, Liedtke Gernot, Universität Karlsruhe, (INTBMEAUT), 2006

## Switzerland

In Switzerland the discussions about introducing "performance dependant heavy vehicle toll fee" (LSVA) <sup>21</sup>started in the end of the 1970s. A first step was made in 1985, this was the implementation of the heavy traffic road fee (pauschale Schwerverkehrsabgabe), which was similar to the later introduced Eurovignette system. This system was only an intermediate solution before the planned performance dependent heavy vehicle toll fee was introduced. In 1994 the Swiss people supported such a system in a referendum and in 1998 the necessary law was accepted by the parliament and the Swiss regions<sup>22</sup>. In 2001 the new system was implemented.

- The heavy vehicle toll system LSVA is only understandable in the context of the Swiss negotiations with the EU regarding an increase of the total permitted weight of lorries, at a time when Switzerland only permitted 28 tons.
- The Swiss people feared an avalanche of transit lorries and were willing to accept a road toll for all freight vehicles. To charge only transit vehicles was part of the discussion but failed in negotiations with the EU. Approximately 15% of all transport work on Swiss roads is caused by transit traffic.
- The background context also included the big infrastructure projects and their financing like the NEAT<sup>23</sup> and the political sensitive issue of Alpine transit of lorries over the Gotthardt, even though absolute volumes were quite small.

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<sup>21</sup> LSVA - Leistungsabhängige Schwerverkehrsabgabe

<sup>22</sup> Kantonen

<sup>23</sup> NEAT is the railway project consisting of the construction of the world longest railway tunnel under the Gotthard, which is planned to be ready 2015.

- Regional effects of any kind were not an issue in planning<sup>24</sup> the LSVA. The political issues were clearly a modal shift and the organisation of a financing source for new (rail) infrastructure.

### Modal split

- There are almost no effects on the modal split, since the extra costs of the LSVA have been almost fully compensated by efficiency gains through higher permitted weights<sup>25</sup>. The increased total weight for lorries led to an improved productivity for road transports and the introduction of LSVA has neutralized this effect. Modal split was an envisaged goal, but no increase of the rail share has been observed, maybe because it is already the highest in Europe.

### Route choice

- There are no effects on route choice, since the LSVA is paid per km driven in Switzerland, no matter which road is used. Additionally Switzerland is quite small and more service than production oriented, so effects were very limited.

### Effects on the transport industry

- The forwarders and hauliers tried to optimise their fleet based on the LSVA regulations, either by changing to smaller or to larger vehicles, depending on their customer base. A lot of players changed to cleaner vehicles. However, domestic

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<sup>24</sup> To achieve a transfer of freight transports from road to rail transports requires an increased productivity and reliability for rail transports. For the international transports, the problem of delays has to be solved. Without these improvements, a transfer of freight volumes will be difficult (Source: Werder Hans, Impact of the Heavy Goods Vehicles Fee, Central Pillar of the Swiss Transport Policy, EKVM Seminar, 2004, London)

<sup>25</sup> The weight limit for lorries was increased from 28 tons to 34 tons in January 2001. In January 2005 the weight limit was increased to 40 tons.

lorries run fairly few vehicle km in Switzerland and only a total of 52 000 lorries are registered in the country. The lorry manufacturers did profit from the renewal of the fleet, but as they are not producing in Switzerland they did not lobby against the LSVA.

- The changed structure of the lorry fleet and changes in the forwarding industry, led to a change in the earlier experienced growth trend for HGV. On the national level the earlier experienced yearly vehicle kilometres growth by 7% was broken. In the years 2001 and 2002 yearly lorry vehicle kilometres were reduced by 4% and 3%<sup>26</sup> respectively. In 2003 the yearly vehicle kilometres increased somewhat compared to 2002, with a further increase in 2004 by 4%.
- For the alpine transit through Switzerland, the increased weight limit led to an increased use of semi-trailers. At the same time a reduction of the number of lorries with lower weight limits could be observed, which kept the total number of transit lorry trips more or less constant in 2001. In 2002 the number of transit transports was reduced by 9%, which partly was an effect of restrictions caused by the accident in the Gotthardt tunnel.
- In the beginning, there was resistance against the LSVA from the forwarders and hauliers. However, large forwarders soon admitted that the concentration and the more efficient operation will lead to a consolidation effect in the sector, from which they will profit. Consequently, the association was not very strongly against the LSVA.
- No manufacturer was willing to produce the OBU at own risks. Public money was put into research programmes to finance

this development. To gain a technological advantage was only a minor argument from the beginning, because the system was designed to be very simple and it soon became clear, that with the technological progress anyone could build such machines.

### **Other issues**

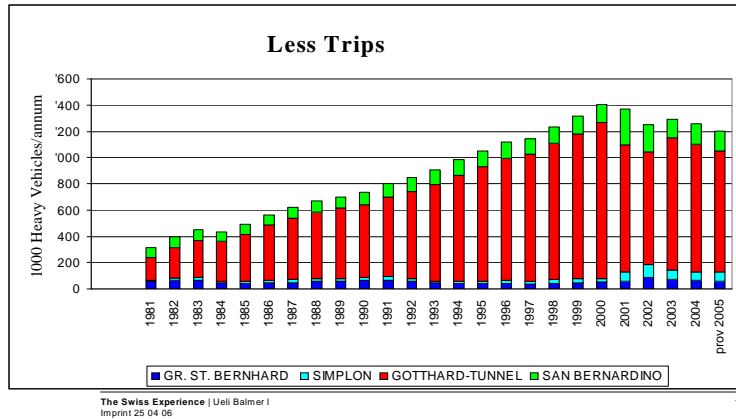
- Data security of the LSVA has never been an issue in Switzerland
- Border controls simplify the control of the LSVA payments. Additionally 19 control points have been installed in Switzerland which read the number plates of lorries not equipped with an OBU.

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<sup>26</sup> The reduction in vehicle km 2001 and 2002 was not completely caused by the introduction of the LSVA, but also partly as an effect of the reduced economic growth in 2001.

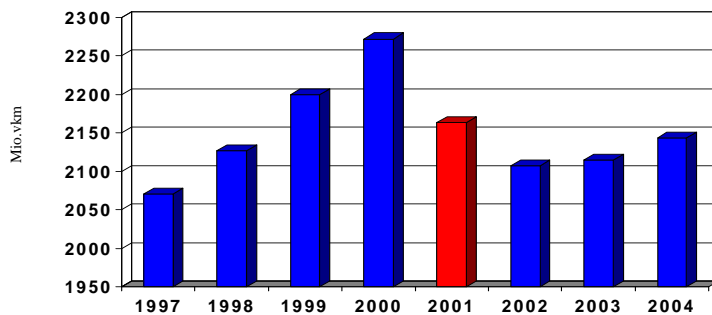
**Figure 9: Development of number of trips in transalpine transport**

**Effect Transalpine Transport** 



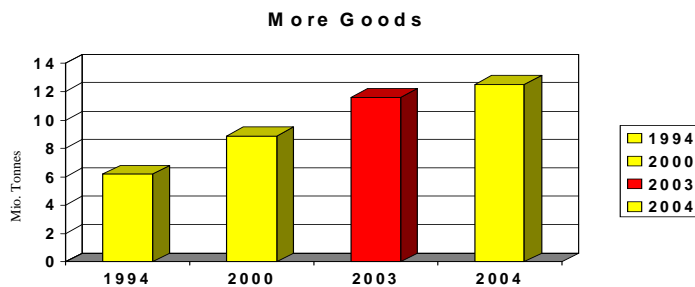
**Figure 10: Effects on vehicle kilometres of the LSVA**

**Effect on Vehicle Kilometers** 



**Figure 11: Effect on Transalpine Transport of the LSVA**

**Effect Transalpine Transport** 



## **Concluding comments**

The effects of the road pricing system LSVA in Switzerland could be summarized in the following way:

There are no effects on route choice, since the LSVA is based on km driven in Switzerland, no matter which road is used

There are almost no effects on modal split, since the extra costs of the LSVA were almost fully compensated by efficiency gains through higher permitted total weights for lorries.

The lorry traffic growth rate has been reduced (vehicle kilometres).

An adjustment of the lorry fleet composition has taken place (cleaner fleet and more optimized fleet lead to a positive effect in terms of reduced emissions (NOX and particles)).

A concentration in the haulier business has taken place (better use of logistics, less empty trips and fleet adaptation).

## **4.3 Austria**

Due to increasing problems of road financing, after several years of studies, the Austrian Government decided in the mid-90 to introduce an electronic toll system on all motorways and express roads (existing and new roads) for vehicles with more than 3,5 tons total weight (LKW-Maut). Austria had a long tradition and good experience in conventional tolling on certain sections of the road network. The existing toll collection companies belonged to the "private sector" and there was a legal basis for earmarking the toll revenues to cover road costs only.

The Austrian electronic toll system was successfully introduced in 2004. It is distance based and builds on DSRC (microwave communication) technology. Interoperability with the existing systems and with systems of other states was a strong objective when designing the system.

The following general requirements were identified for the road toll system:

- No excessive formalities for access
- No obstacles at internal EU-borders
- No obstruction of traffic

The fee has to be paid for each vehicle above 3,5 ton maximum total weight and the payment depends on:

- Total weight of the vehicle and the number of axles
- Distance travelled on highways and expressways

Figure 12 illustrates the fees by vehicle category in 2006. Notice that there is no differentiation according to emission class, i.e. there are no incentives to invest in vehicles with higher EURO class.

**Figure 12: Fee structure**

	Vehicle class 2, 2 axles	Vehicle Class 3, 3 axles	Vehicle class 4, 4 or more axles
Axles	2	3	4 + more
Toll rates € / km	0,130	0,182	0,273
Relation between the classes	1	1,4	2,1

The introduction of the system was strongly driven by financing objectives as Austria faced a situation with road traffic increasing rapidly at the same as time the road budget was not sufficient to provide for required improvements of the infrastructure. Therefore, the main goal of the system was financing of motorways with expected revenue 600 million Euro in the first year. The following secondary objectives were also identified:

- Reduce the growth rate of freight-traffic
- Road transport costs to become more important to stimulate a more efficient transport market

Liechti and Renshaw<sup>27</sup> (2006) point out the following experiences:

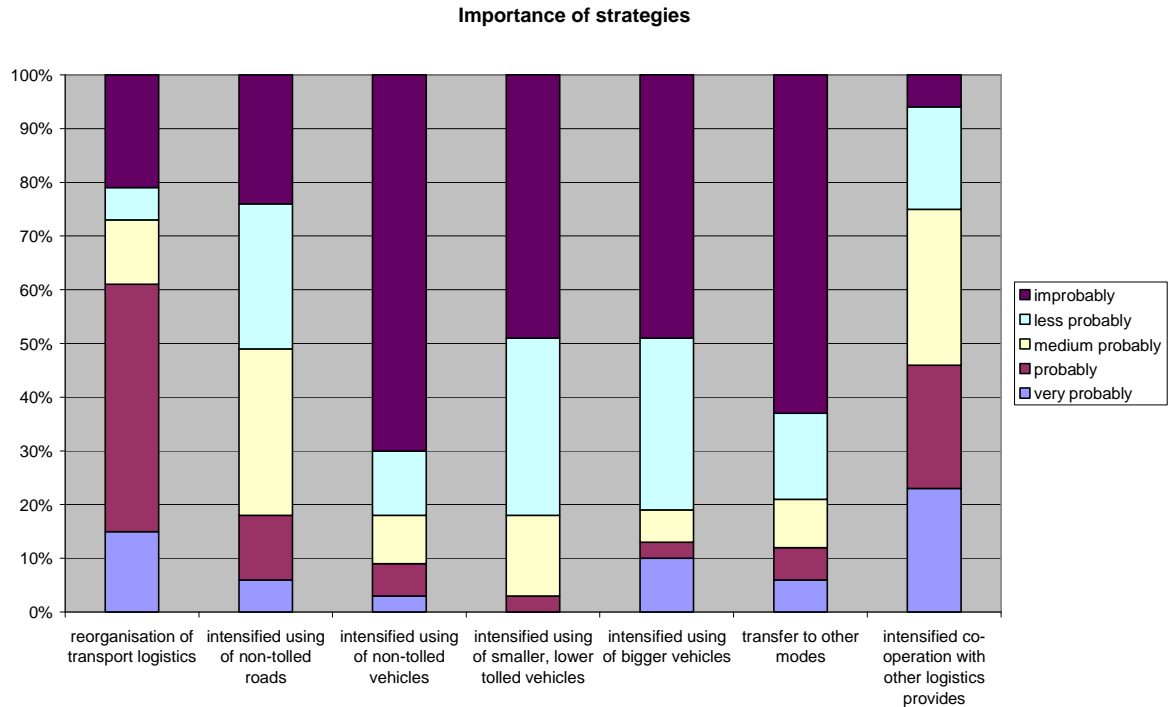
- The LKW-Maut was successfully implemented despite strong opposition at the outset
- The scheme now has high acceptance among users
- The scheme is based on well known and simple technology which makes it reliable (99,9% correct transactions)
- It is also simple and readily understandable for users and causes them only low equipment costs (5 Euro for a "Go-Box, free to install in vehicle)
- Revenues in 2005 totalled 780 million Euro

Researchers at Vienna University of economics and business administration have carried out a number of studies connected to the Lorry Maut in Austria. In autumn of 2003, 4 months before the toll was implemented, Einbock (2005)<sup>28</sup> carried out an empirical study survey. A standardised questionnaire was sent out to over 1 000 companies from different sectors. At the end 140 questionnaires were returned and valid to use. 34 of those were from forwarders and carriers. Figure 13 illustrates the answers of the forwarder and carriers in regard of importance of strategies.

<sup>27</sup> Liechti M., Renshae N., A Price Worth Paying A guide to the new EU rules for road tolls for lorries, T&E publication, Brussels 2006

<sup>28</sup> Einbock M, Effects of the Austrian road toll system on companies, International Journal of Physical Distribution & Logistics Management, Vol 36 No2, 2006

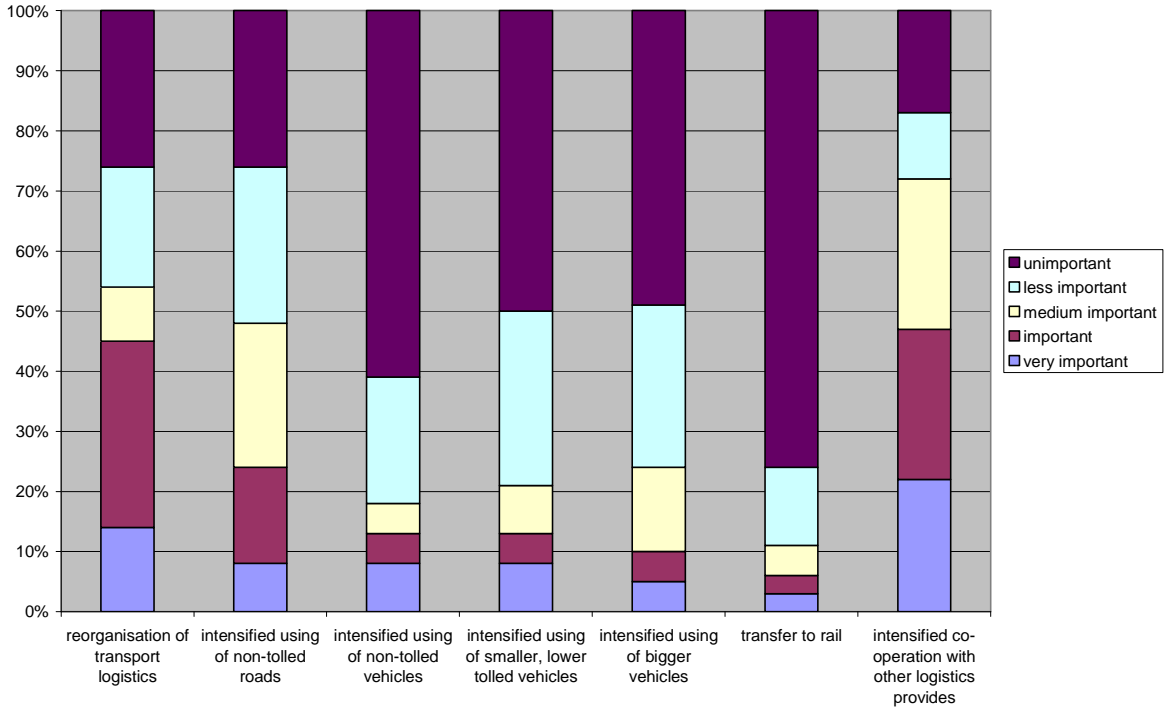
**Figure 13: Results from survey carried out 4 months before the Austrian Maut, indicating the importance of different strategies**



The survey indicates that a) reorganisation of transport logistics and b) intensified co-operation with other logistics provides are the most relevant strategies.

A follow up study was carried out in June 2005 were 47 companies from the transport sector participated. Some of the questions were asked again, see figure 14.

**Figure 14: Results from survey carried out 6 months before the Austrian Maut, indicating the importance of different strategies**



The answers from the follow up study are very much in line with the first results and underline that a) reorganisation of transport logistics and b) intensified co-operation with other logistics providers are the most relevant strategies.

One of the negative effects with the system in Austria is the diversion of traffic from the tolled parts of the network to the toll-free roads. Increased traffic on secondary roads leads to higher maintenance costs (Kummer und Nagel, 2005)<sup>29</sup> as well as to disturbances of the local citizens. The diversion of traffic "Mautausweichungsverkehre" is the topic of an on-line presentation by Nagel<sup>30</sup> who make the following definition:

*Toll avoidance de-routing: Transports carried out on non tolled road to avoid the distance based heavy goods vehicles toll. (Authors interpretation. )* In Austria the toll avoidance de-routing has been significant on the local level. However, Nagel points out the problems of making valid statements. A number of problems make it difficult to tell why the traffic has increased on the secondary road network and points out the following problems:

- New commercial areas have been established generating traffic
- New infrastructure
- Increased volumes of traffic from the eastern parts of Europe
- Temporarily closed motorways
- Temporarily increased traffic volumes on the motorways through holiday traffic
- Construction works

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<sup>29</sup> Kummer S., Nagel P., "Mautausweichverkehre", Internationales Verkehrswesen, Vol. 57 Nos1/2, pp10-15

<sup>30</sup> ([http://www.wu-wien.ac.at/itl/Praxis/Logistik\\_Cercle/Nagl\\_Mautausweichverkehre\\_72.pdf](http://www.wu-wien.ac.at/itl/Praxis/Logistik_Cercle/Nagl_Mautausweichverkehre_72.pdf)). He provides a definition of "Mautausweichungsverkehre":

Despite the above mentioned problems, Nagel claims that there is a significant increase of heavy goods transports at parts of the secondary road network in total between 2-3%

He further stresses that route choices are cost driven and that the toll is only one of many costs among, e.g. staff, gasoline, oil and tyres, distance based depreciations, distance based repair and maintenance.

According to Hofstetter (2006)<sup>31</sup> the transport sector has reacted with:

- Better logistics, reduction of empty trips
- Better use of loading capacities
- Use of other transport modes

Statistics on Alp traffic shows that the number of empty running lorries crossing the Alps have been reduced from 25% to 16% between 1994 and 2004 which is partly believed to be caused by the LKW-Maut<sup>32</sup>

## Concluding remarks

Austria has successfully implemented its LKW maut. It has a high acceptance among the users, high reliability and the financing objective is fulfilled. The system has lead to efficiency improvements in the transport market but also to diversions to the non tolled network.

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<sup>31</sup> Hofstette H., Electronic Tolling System in Austria, presentation at CEMT Conference on Road Charging, 2006

<sup>32</sup>

[http://www.bmvit.gv.at/verkehr/gesamtverkehr/statistik/downloads/ALPGUV\\_Broschuere\\_Online-06-06-12.pdf](http://www.bmvit.gv.at/verkehr/gesamtverkehr/statistik/downloads/ALPGUV_Broschuere_Online-06-06-12.pdf)

#### 4.4 UK

The UK Treasury published in November 2001 (HM Treasury, 2001) a consultation paper on distance based charging for all HGVs, British and foreign alike, to ensure fair competition in haulage and shift to an efficient direct charging regime "at the point of use." The idea had the backing of the Freight Transport Association (FTA) and of the Confederation of British Industry (CBI). The launch of the procurement phase was in May 2004 with the timetable then suggesting that the HGV charging would be introduced in the UK in 2008.

In July 2005, the National Lorry Road User Charging procurement programme (LRUC) was cancelled and at the same time plans were outlined for a National Road User Charging Scheme for some time after 2014 (earlier if the technology could be delivered). The National Lorry Road User Charging procurement programme was then re-born as a sub-project of the National Charging Research Programme.

Commentators suggest that this was not a bad thing (except for the industry involved!) as the management and programme costs had escalated and industry was being pushed to deliver to an unrealistic time scale, moreover, the LRUC programme was run by HM Customs and Excise and surprising had very little interaction with the UK Department for Transport and their National road user charging programme – which meant that LRUC would have been implemented as a non-interoperable system with other charging initiatives in the UK.

#### 4.5 Finland

Finland has a very broad and general view on road user charging<sup>33</sup>. Several ideas and possible charging systems for different purposes are being discussed at high level groups, but there are no plans for an introduction in the near future. This is mostly due to political lack of interest and perhaps this will change after the government election next year. The ministry of transport and communications closely follows the European development and countries that have implemented road user charging for HGV such as Germany, Austria, Switzerland etc. and the congestion charging systems in London and Stockholm.

In 1993 there was a concrete plan to introduce road pricing with the goal to finance traffic investments in the Helsinki region which was never realised due to political resistance. In 1995 the extension of Motorway 4 was discussed as a candidate, but it was financed as a shadow toll.

The Finnish road administration is interested studying road charging for financing new road infrastructure. It is regarded as a method to realise a much needed improvement of the road network in the absence of state funds, which is the case in most countries. The Traffic Ministry has (2005) initiated a comprehensive study to closely follow the development in Europe and a committee is investigating the future possibilities for road charging in Finland. ITS Finland strongly promotes the idea of developing road charging technology as a possible export product. The general view is

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<sup>33</sup> This chapter has been written by Thomas Sjöström at SWECO and is based on interviews with Krisitian Appel, Traficon and Kaisa Leena Välipirtti, Ministry of transport and communications

that the technique should be based on GNSS (Global Navigation Satellite Systems) for positioning even though no study has been performed and no goal for a potential charging system has been defined. It is clear however that the legal framework needs to be updated and new laws enforced in order to support an implementation.

New proposals under discussion:

- To charge Russian HGVs picking up passenger cars from Hangö harbour for further transportation to Russia, but the MOU between the countries does not allow such a charge.
- To introduce a regional charge in the Helsinki region. The discussions have not yet come to any concrete conclusions.
- After a study in 2005-06 a long term strategy was developed to introduce road user charging on the entire Finnish road network and in the short term implement a charge for HGV on a limited part of the network.

Finland is trying to find new and innovative methods to finance road infrastructure and succeeded in developing an extended version of the popular Public Private Partnership model called a life cycle model. The life cycle model is a concept that ensures the government that the contractor builds, operates and maintains new roads in a sustainable manner by adding external parameters such as traffic safety and safeguarding of the environment to the agreement with the contractors and also including the corresponding compensations. Usually road investments are financed by the state budget and lately by using the shadow toll concept, meaning the government pays the contractor a yearly compensation according to traffic volume and maintained service level of the road during the life of the contract.

## 4.6 Denmark

Denmark is today one of the members of the Eurovignette scheme and tolls exist e.g. on the bridges across Stora Bält and Öresund. Road user charging has been on the political agenda both for congestion charging for Copenhagen and for heavy goods vehicles on a national level and a number of studies have been carried out. However, presently there are no plans to introduce road user charges in Denmark due to expected negative effects on the Danish economy.

In order to prepare for the planned German Maut, the Danish Ministry of Transport commissioned a study of the potential effects of the planned German Maut in 2002.

The objective was to investigate the effects on route and modal split for freight transports to and from Denmark and transit flows through Denmark<sup>34</sup>,

The changes in potential route and modal choice were estimated with the simulation model EFM-STAN (European Freight Model).<sup>35</sup> The model includes database for transport demand, networks for different modes and estimations of purchasers' costs (operational costs, logistic costs and frequency).

The results of the simulations show changes in estimated transport work (tonkm) between the modes in Denmark and in Germany respectively. International lorry transport flows were estimated to be reduced in Denmark by 1% and in Germany by 3%. At the same time, a modal shift was indicated showing increased transport work by rail by 12% in Denmark and by 6% in Germany.

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<sup>34</sup> A route-and modal split simulation was carried out by BMT/Transnord EWIV (as part of a consortium led by Tetraplan A/S).

<sup>35</sup> For a model description, pl. see [http://www.bmt-ts.com/about/stan\\_eu.pdf](http://www.bmt-ts.com/about/stan_eu.pdf)

Short sea transports in Europe were estimated to increase by 0,4%.

The simulation results also indicate changes between different road transport corridors in Denmark and Germany e.g.:

- Reduced lorry transport flows along the corridor Jütland-Padborg-Hamburg-Hannover-Frankfurt/Würzburg area
- Increased lorry transport flows along the corridor Hamburg-Berlin-Leipzig-Nürnberg area

In 2004, the Danish Transport Ministry commissioned AKF (Amternes og kommunernes forskningsinstitut) to carry out an analysis on possible regional impact of road user charges for heavy goods vehicles<sup>36</sup>. Four scenarios were identified and one base line scenario with road user charges only implemented in Switzerland. The scenarios included a first scenario in which the planned Maut for Germany was implemented, a second with Maut also in the UK and Northern Ireland and a third and fourth scenario with Maut also in Denmark, Sweden, Norway, BeNeLux and Poland with different fee levels in scenario three (same fee level as Germany) and four (lower fee).

The regional impacts were calculated with the regional economic model LINE. According to the study, the prices for goods increase due to road user charges which lead to decreased available income for the households. If road user charging is implemented in Denmark (scenario 3 and 4), the income for the state will increase and make a tax reduction possible, which could benefit all households. However, this effect will be balanced by decreased production in the short and medium term reducing the Danish export. There will be no possibility for Danish import substitution since the national prices will increase more than the import prices. The

generated losses can not be compensated in scenario 3 and 4 by the increase of the available income for the households due to tax reductions

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<sup>36</sup> Regionale konsekvenser av införelse av körslavgifter för tunge köretöjer, Madsen, Larsen, Jensen Buteler, AKS Förlaget, 2004

## 5. Analysis

The figure below provides an overview of the road pricing schemes in Germany, Switzerland and Austria.

Figure 14 Comparison of different road pricing schemes

	<b>Germany</b>	<b>Switzerland</b>	<b>Austria</b>
Objectives	Financing of road infrastructure Apply user pay principle ----- - More efficient use of transport capacity Fairer conditions for intermodal competition	Limit growth of lorry traffic Protect environment Increase rail share	Financing of road infrastructure
Type of roads included	Motorways + selection of expressways	All roads	Motorways + selection of expressways
Average tax/fee level €/vehicle km (40 ton lorry)	0,12	0,67	0,27
Fee differentiation criteria	distance, number of axles, EURO class	distance, weight, EURO class	distance, number of axles
Revenues m Euro/year	3 000	800	770
Cost in % of revenue	20%-22%	5%-7%	10%-12%
<b>Impacts:</b>			
Route choice	Some tendencies to toll avoidance de-routing to secondary roads when: roads runs parallel to motorway, have motorway like standard and not leading to time delays. 6.6% increase of dtv on secondary roads.	N/A, all roads tolled.	Some tendencies to toll avoidance de-routing to secondary roads. 2%-3%% increase of dtv on secondary roads
Modal Split	Limited modal shift, some evidence among medium-large shippers (+3.1% increase of rail use)	Almost no effect, due to increased allowed total vehicle weight 40t.	Limited modal shift
Logistics	Increased efficiency in the transport sector e.g. consolidation of road transport, number of loaded runs increased by 2,1% to total 82,1%, 15% reduction of empty runs	Concentration in the haulier business Less empty trips	Reorganisation of transport logistics
Vehicles	Stronger interest in EURO 5 vehicles	Adjustments of the fleet composition towards cleaner vehicles and optimised size (smaller and bigger depending on customer basis)	

## Objectives

The three existing distance based road user charging systems in Europe have different objectives. The Austrian system is mainly focused on road infrastructure financing. The Swiss system has a clear focus on applying the "user pays" principle, protecting the environment and increasing the rail share. In the German system the infrastructure financing aspect is the most important but there is also a focus on applying the "user pays" principle, more efficient use of transport capacities and emission-related tolls as well as providing fairer conditions for railroad. These goals are reflected in the way the road fee structure is differentiated but also concerning which roads are included in the different schemes and the chosen fee level.

## Route choice

Toll avoidance de-routing is a negative impact of the implementation of road tolls in Germany and Austria but not in Switzerland due to that all roads in this country are included in the scheme.

In Germany there are tendencies of de-routing to secondary roads (national roads) which are running parallel to motorways and have a motorway-like standard and are as efficient in terms of time. The same tendencies can be found in Austria but to a somewhat lesser extent. The de-routing leads to unwanted effects in the form of, e.g. increased maintenance costs, increased number of accidents and noise levels.

## Modal split

The experiences so far of possible modal split effects are difficult to separate from other influencing factors. In Switzerland there are almost no measurable modal split effects – even though this was one of the main aims with the system. The effect of the introduced road toll was almost totally compensated by

efficiency gains in the road sector through higher permitted lorry weights.

In Germany there are some indications of a modal shift among larger shippers towards an increased use of rail transports, but the largest effects are an increased consolidation of road transports. Looking at the actual development on the freight transport market in Germany, road transports increased by 9% (tonkm) between 2005 and 2003 whereas rail transports increased by 17%. This effect however, is caused by a number of different factors:

The effect of the Maut is mixed with the effect of the large increase in fuel prices since 2000 which has led to an increase of tariffs, which is comparable with cost increase caused by the Maut. During 2005 when the Maut was introduced, no significant increase in rail transports could be noticed.

The increase in tonkm for rail is mainly an effect of longer transport distances rather than increased transport volumes.

The indications of changes in modal split are difficult to specifically relate the impact of the road tolls as there are a number of other influencing factors e.g. increased fuel prices, changed vehicle weights, open market towards Eastern Europe. The results so far from Germany are based on a period of 18 months, which is a short time period, especially due to the strategic character of using rail instead of road, where price is only one of many decision criteria.

Other studies indicate that high road fee levels are required to achieve a change of modal-split in favour of rail transport (see McKinsey 2005 and Transcare 2005 with fee levels in the range of 0,5-1,0 €/vehicle km) whereas the strategic simulation studies carried out for international freight transports (BMT 2002, 2004) indicate lower road fee

levels to achieve a modal-split effect. The simulation studies are on a strategic level and the model parameters assumes that the market operators have adapted to the new situation, which might take some time in the reality due to inertia, existing contracts etc.

## Logistics

Transport cost for general manufacturing is relatively low compared to the total sale revenue. A report commissioned by Naturvårdsverket<sup>37</sup>, claims that the cost of transport for the general manufacturing industry seems to be around 3-4% of sales revenue. For raw material based industry the cost of transport increases to 5-12%.

The impacts of the implemented road toll systems on logistics are mainly an increased efficiency in the road freight sector in terms of e.g. aggregation of road transports, reduced number of empty runs and concentration in the haulier business. These effects can be found in Germany, Austria and Switzerland.

## Vehicles

There is an interest in increased use of vehicles with reduced emissions (EURO 4 and 5 class vehicles) in Germany and Switzerland. There is a tendency in all countries towards adjustments of the fleet composition as a response to the charging criteria. This however, is a slow process following the normal life cycle of the vehicle fleet.

## 6. Recommendation

Road pricing is one of several different measures to influence a country's transport policy and needs to be put in the context of the overall transport plan.

The analysis shows:

- A clear connection between the impacts and the design of the different schemes. Therefore it is most important that the goals are carefully considered and consequently reflected in the design of the schemes. Make the objectives clear and communicate them
- The risk for road toll avoiding de-tours has to be considered carefully, mainly due to its effect on disturbances, accidents and thereby on public opinion. Including all roads as in Switzerland eliminates the problem. The planned system for Sweden which is to include all roads might even increase traffic on the motorways, since the same fee level is planned for all roads.
- The modal split effects so far are limited, but there are indications of changes of modal split, but it is difficult to separate the impact of road tolls from other influencing factors. It is recommended to follow these initial effects over a longer time period in order to evaluate the effects more in detail. It is also clear that to achieve an increase of the rail market share, improvements within the rail sector are required.
- The road transport sector is clearly influenced and efficiency improvements are achieved. It is recommended to analyse how the different segments of the haulier industry are affected by the toll systems implemented.

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<sup>37</sup> Åhman, 2004

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