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Transportation Research Procedia 12 (2016) 584 – 597

Transportation Research Procedia

www.elsevier.com/locate/procedia

The 9th International Conference on City Logistics, Tenerife, Canary Islands (Spain), 17-19 June 2015

Impacts of planning and policy strategies on freight flows in urban areas

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Abstract

This contribution focuses on policy and planning strategies to reduce air pollution caused by heavy goods vehicle traffic. It examines the impacts of the implementation of the autobahn toll for heavy goods vehicles (HGVs) in Germany and the significance of environmental zoning in Berlin, Germany, for improving air quality, by using the conceptual framework of planning analysis.

Peer-review under responsibility of the organising committee of the 9th International Conference on City Logistics

Keywords: regulations; policy impact; logistics; freight flows; autobahn toll; environmental zoning

1. Introduction

In Germany, freight transport is one of the major sources of climate relevant pollutions and of negative impacts on the liveability of cities. Because of this, policy and planning authorities in Germany have aimed to reduce the externalities of lorry traffic for decades. However, only a small range of restrictive measures targeting commercial traffic were realised by planning authorities in Germany so far. Two of these few measures that were actually implemented is the introduction of the autobahn toll for HGVs (> 12 tonnes) and environmental zoning, which is now effective in status 3 in more than 40 big cities and three regions (as of February 2015). With these measures based on the most recent environmental regulations at EU and national levels, it is hoped that commercial traffic

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Peer-review under responsibility of the organising committee of the 9th International Conference on City Logistics
doi:10.1016/j.trpro.2016.02.013

will be optimised and the impact of traffic will be reduced, in order to improve the liveability in urban areas in Germany and to combat climate change.

The goal of this research is to identify environmental benefits provided through changes in freight flows by introducing planning and policy strategies, and to derive lessons for further implementation processes. For so doing, this contribution examines the implementation processes of these two policies in Germany by using the planning analysis framework, in order to identify the substantive outcome on commercial traffic and the environment as well as to derive lessons learned that might be considered to be useful elsewhere. The hypothesis of this research is that steering by environmental standards and by regulation (such as the autobahn toll) tends to be more effective than implementing measures addressing only a particular segment of traffic in local action plans or to set incentives for the transport companies. The analysis is conducted by using the planning analysis framework (Flämig 2004). Because of space constraints this contribution presents only parts of the results of the planning analysis. It concentrates on a brief description of the research methodology and the discussion of the substantial outcome of the implemented measures: the reduction of air pollution and factors influencing this pollution, e.g. changes in the spatial distribution of lorry flow in urban areas expressed by differences in vehicle kilometres travelled by vehicles of less and more 3.5 tonnes. For this purpose, empirical and statistic data are evaluated.

This contribution is based on an earlier paper (Flämig 2013) on the related topic and was updated for this purpose. The update was realised by analysing more recent data, using the Transport Emission Model (TREMOD) ran by the German Umweltbundesamt, and considering other new sources of data and information.

In the following, the target, action and outcome system will be traced for the implementation of the autobahn toll for HGVs in Germany and the environmental zone in the city of Berlin. Besides the description of the measure, the results of the measure outcome analysis (analysis of the target achievement) and the action outcome analysis (a review of the deviation from the targets) are being presented. This paper concludes with a critical reflection of the implementation process of these two measures and lessons learned for German and other cities.

2. Methodology

In order to assess the implementation processes of the two different sets of policies in Germany as named above, the so-called planning analysis framework (Flämig 2004) has been applied (see Fig. 1). This framework was developed to identify success factors and obstacles from the very first idea until its actual implementation to derive lessons learned for future implementation processes. It was initially established on the basis of a triangulation of policy analysis as outlined by von Prittwitz (1994), and organisational theory following Kosiol (1962). The framework of the planning analysis includes investigating the initial conditions, the outputs and the outcomes/impacts of action on several dimensions. Following policy analysis and organisational theory, the planning analysis is divided into the analysis of the actors' "arena", the institutional framework (polity) and the organisation of physical processes and the preceding decision making (politics). The integration of the stakeholder point of view helps to identify soft factors of the implementation process. By integrating organisational theory, organisational requirements and barriers can be identified. The visualisation of processes helps to discuss the procedures with the stakeholder and to develop measures for improvement.

Based on this research approach the planning analysis consists of a systemic consideration of the system of target, of actions undertaken and the system of impacts. This leads to the assumption of five different layers of analysis (Flämig 2004). Fig. 1 gives an overview of the interaction and the interrelationship of the various phases of analysis.

The situation analysis provides an overview of the subject matter of the planning, the initial point and the structural characteristics of the planning process. The target analysis provides the associated orientations of the practices involved. The measures analysis includes the various measures, approached or concepts as unbiased as possible for a systematically description of any interventions into the system. The impact analysis evaluates the impact of actions from actors of companies, planning or policy actors to analyse the target achievement (measure-outcome analysis) and to review differences between the targets and the target achievement based on actions (action-outcome analysis). For this purpose the analysis is explicitly divided in measure-oriented and action-oriented parts. The determinants analysis investigates the structural and process related organisation, the political arena and the decision-making processes, by taking into account the existing external framework conditions. In so doing, it is able to reconstruct the initial setting and the framework conditions for action. Also, the obstacles and success factors for implementation can be determined, which may eventually inspire related processes elsewhere. The assessment of organisational and operational structures alongside with decision processes (stakeholders and their behaviour) aims to identify hard facts (e.g. technical, organisational) and soft facts (e.g. action, behaviour) as formal and informal determinants.

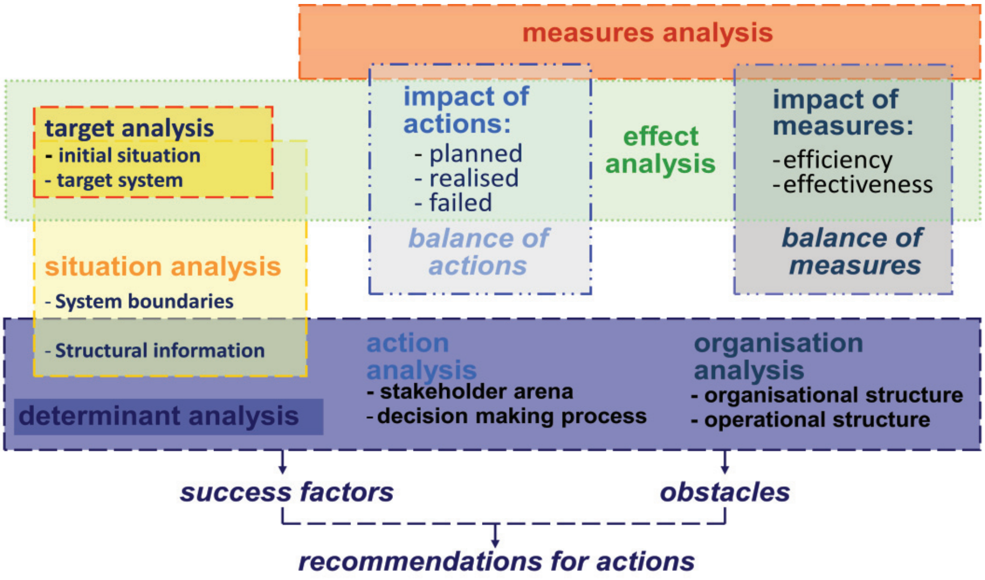


Fig. 1. Planning Analysis Framework (Flämig 2004)

This contribution examines the environmental effects of the autobahn toll for HGVs (> 12 tonnes) in Germany and of environmental zoning in Berlin. In doing so, a generic model is being applied for assessing the substantial impact of measures on air pollution as presented in Fig. 2. The traffic-related emissions and the resources consumption caused by freight transport are usually identified by applying a standard formula: the transported quantity of goods (tonnes) is multiplied with distance (kilometres) and a factor for emission or resource consumption per mode of transport (gram per ton-kilometre). This allows for deriving the main factors influencing the environmental impact and the use of resources: (1) the transported goods in terms of weight and volume, (2) the transport distances, (3) the choice of transport mode and vehicle as well as (4) the utilised capacity. Further important impact factors are (5) vehicle technologies (type of transport means, size, motorisation, traction and fuel use), (6) mode of operation (e.g. speed, driving behaviour, cruising altitude) and (7) environmental conditions such as topography, flow conditions, weather) (Flämig 2012).

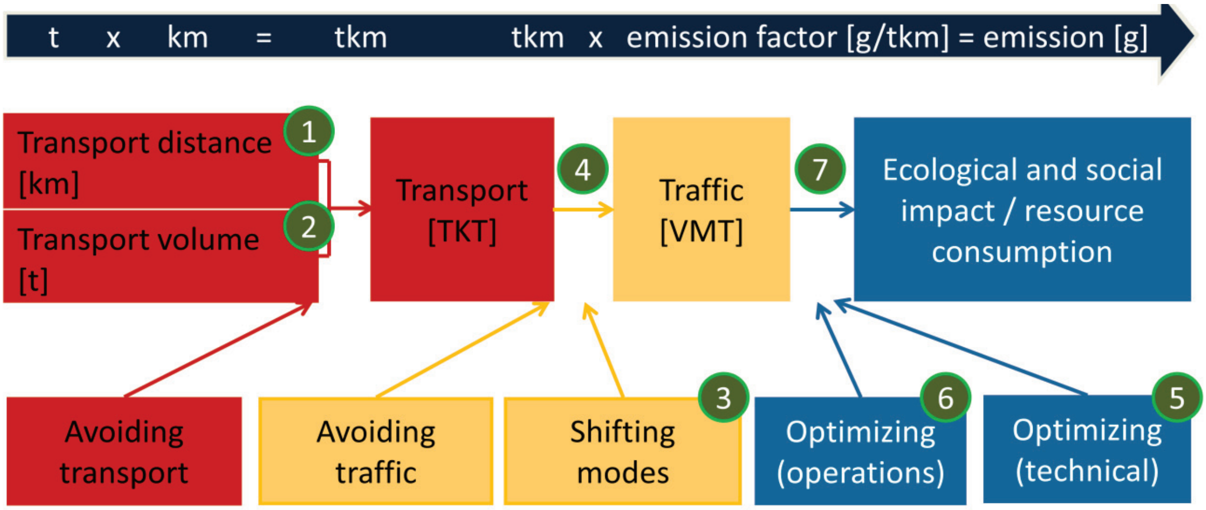


Fig. 2. Generic transport generation model for assessing the environmental impact (Flämig 2012)

Only the implementation of the environmental zone investigated is driven by environmental policy, however, both measures are closely coupled to emission factors (threshold values). Classified for the generic transport generation model shown in Fig. 2, the relevant European Union's Directives for the two investigated policies mainly aim to improve vehicle technology (factor 5) and partly enforce modal shift (factor 3). Accordingly, these policies aim at directly influencing the environmental impact. The analysis of the respective contribution to minimising resources consumption and environmental burden (substantial impact) of this two policies are carried out based on official statistics of road vehicle registration (differentiated by size and environmental standards). These databases are also blended with data on traffic flows (absolute numbers of vehicle-kilometres) in each vehicle category.

The related values may have also changed because of the other factors of influence 1, 2, 4, 6 and 7. Hence the overall transport volume (1, 2) and load factors will be analysed as well. The environmental conditions (7) as factors deploying an indirect influence are taking into account statistically once measuring the substantial changes of emissions. The environmental data concerning road haulage were taken from the TREMOD database. Own additional analyses were undertaken based on this data.

3. Tolls for HGVs on autobahns in Germany

3.1. Background

Germany is situated in the core of the European Continent, with the result of a high amount of traffic passing through. The territory covers round about 357,000 km². In the year 2012 the length of Germans federal autobahn network was 12,862 kilometres. The federal highways extend to a network of 31,705 kilometres (BMVI 2014).

Based on the so-called Eurovignette directive, a usage-dependent toll for HGVs on autobahns was introduced in Germany in the year 2005 and replaced the previous time-related toll system (so-called vignette) (Council Directive 93/89/EEC, replaced in 1999 by the Council Directive 1999/62/EC, most recently amended by Council Directive 2006/103/EC).

No target definition can be found before the actual promulgation of the HGV road toll law in Germany. However, the report on road infrastructure costs that was compiled during the introduction of the toll identified three objectives:

- An cause-based impact-related charge for the use of traffic infrastructure is a starting point for a reorganization of the financing of the transport systems from taxes to charges.

- Creation of incentives for a more economical use of the given traffic infrastructure capacities.
- A more equitable distribution of costs between domestic and foreign carriers (IWW/Prognos 2002).

Nowadays, the following target formulations for the HGV road toll can be found on the Ministry of Transport's website:

- A more cause-based road pricing: In particular, HGVs cause high costs for the maintenance and operation of highways. [...]
- Securing financing for further expansion and maintenance of the traffic infrastructure [...].
- Creating an incentive for an ecologically meaningful shift of freight transport to rail and waterways and for a more efficient use of HGVs.
- Promotion of innovative technologies. (BMVI 2015)

The result of the target analysis shows that originally the source-based road pricing focuses only on an equitable distribution between foreign and local carriers as well as on the distribution of infrastructure costs. The goal of basic affordability of infrastructure expansion and the target of an ecologically-driven shift to rail and waterways were included later.

3.2. Variation of tolls by applying the polluter pays principle

In the first Directive on the charging of HGVs for the use of certain infrastructures (Council Directive 1999/62/EC) only HGVs over 12 tonnes total load were included. In the amending Directive to this first one, beginning in 2012 all toll-collect systems in the European Union had to include a "motor vehicle or articulated vehicle combination intended or used exclusively for the carriage by road of goods and having a maximum permissible laden weight of over 3.5 tonnes" (Council Directive 2006/38/EC).

However, exceptions from this amendment can be made and so it was applied in Germany. In case associated costs would be disproportionately high (30 per cent of additional revenues) the toll does not has to be implemented for vehicles greater than 3.5 tonnes and lighter than 12 tonnes. Accordingly, the toll was first implemented on the entire German autobahn network, effective for vehicles over 12 tonnes only (ABMG 2002). Motorways in built-up areas, like the Berlin city motorway, were included as well. In response to certain toll-avoiding traffic flows, the toll had been extended to seven sections of federal highways since 1st January 2007 (MautStrAusdehnV 2006, annex). In April 2011 it was decided to introduce the toll on another 1,000 kilometres of federal highways (Bundesrat 2011a). Through roads and shorter sections remained excluded from the new charging arrangements. This decision was based on the assumed re-distribution of toll-avoiding traffic to the subordinate transport network, which would impose a heavy burden on people living nearby (Bundesrat 2011b).

In principle, EC law does not require that HGV tolls be charged. Member states are allowed to apply those charges that may avoid discrimination and are reasonable. The fees collected can exceed the cost of infrastructure only in exceptional cases. However, the fees may vary, depending on the day of the week, time of day, Euro-emission level or particular NO_x-emissions.

The toll rates to be paid in Germany depend on the length of the toll road, the number of axles and the emission class of the vehicle or vehicle combination (Lkw-MautV 2003). The initial figures were 0.141 to 0.288 Euros per km. They grew up with the changes in the year 2006, 2008 and 2009. Starting on the first of January 2015, the toll rates have decreased in most categories and now include the Euro 6-Standard.

3.3. Analysis of environmental effectiveness of the HGV toll charge

Using the planning analysis framework and the generic transport generation model, the following assessment of the achieved targets of the HGV toll charge is made. The used indicators (addressed factors) have been chosen to evaluate the formulated targets of "better use of traffic infrastructure", "ecologically-driven shift to rail and waterways" and the "environmental effects" of the HGV toll charge:

- The development of transport demand (1, 2) and of modal splitting (3) to verify the effects of modal shift to the rail and the inland waterway system.
- The development of empty runs (6) and the average daily traffic volume to determine the capacity utilisation of the road transport infrastructure.
- The development of new vehicle registrations (5) and vehicle mileage by emission class to determine the ecological effect of any redistribution.

3.3.1. Modal shift to road

Following Germany's reunification, a significant increase in goods being transported by lorries (measured in ton-kilometres) has been observed, exceptional the economic crisis in the years 2008/2009. Inland waterways have a nearly constant share of the transport volume, hence they lost market share. The railway system has gained market share and volume, but on a much lower level compared to road transport (BMVI 2014).

More than 80 per cent of the entire goods volume in Germany (measured in transported tonnes) is being carried via road transport; judging from ton-kilometres, the related score is about 70 per cent. A study from 2006 also indicates that no significant shift has happened as regards to the railway system (1.22 per cent maximum) (TransCare 2006). In a report to the federal government in 2009, a working group reaffirmed the failure of the road toll for HGVs with regard to modal shift (Deutscher Bundestag 2009). This assessment is also supported once analysing transport distances. Indeed, the share of regional and long-distance traffic (up to 150 km) increased more markedly (BMVI 2014). In sum, German lorries are contributing to goods transport (measured in ton-kilometres) by about four fifth in the range of 150 kilometres and almost 60 per cent in the range of 50 kilometres (BMVI 2014). The evaluation of road transport by distances and volume indicates no influence caused by the HGV toll on the nature of business relations over shorter distances (less than 50 km).

3.3.2. Increase in capacity utilisation of the road transport infrastructure

The reduction of empty runs could be an indication that the introduction of a road toll for HGVs has led to efficiency gains in both long- and short-haul road transport. Empty runs as a proportion of the distance covered by long-haul goods traffic began to decrease in comparison with the base year 2000 (BGL 2011). In 2005 empty runs were about 30 per cent less than in 2000. After the introduction of road tolls for HGVs on 1 January 2005 the proportion of empty runs at first continued to fall only slightly – by 0.03 per cent in 2006 – but rose again between 2007 and 2009. Compared with the previous year, rates of change in empty runs over long distances range from -2 per cent to +5 per cent. Overall, however, the proportion of empty runs declined by nearly 20 per cent between the base year 2000 and 2006. The proportion of empty runs has not declined in equal measure over all distances. The gains have been much higher on long haul than on short-haul routes. The trend also shows that a proportion of empty runs of around 10 per cent in long-haul goods traffic would appear to be an organisational threshold for vehicle use. Over all distances the proportion is around 20 per cent. Furthermore, the rate of change would seem to indicate that the economic crisis of 2008 and 2009 had a greater effect on the proportion of empty runs than the road toll. The development of empty run mileage is portrayed in Fig. 3.

As for the assessment of capacity utilisation of road transport infrastructure, vehicle numbers concerning the use of autobahns and federal highways per 24 hours show that with the introduction of the HGV road toll in the year 2005, the number of HGVs on sections for which a toll was charged initially decreased, but returned to its previous level a year later (BMVBS 2011). Although figures are only available from the year before the toll was introduced, it can be inferred from analysing the statistics that the state of the economy has a greater influence on capacity utilisation than the road toll for HGVs.

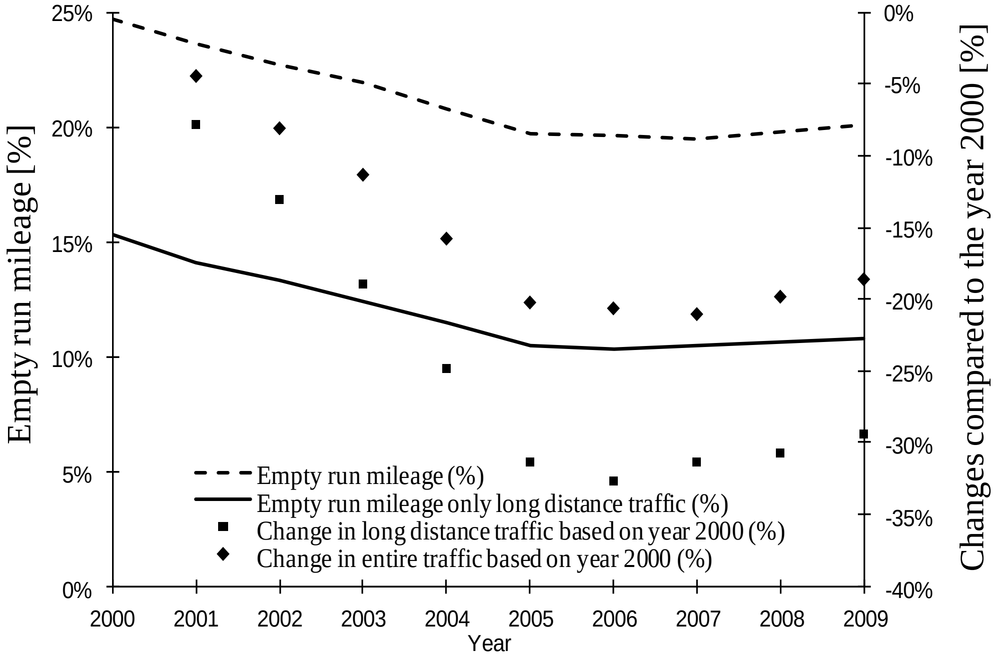


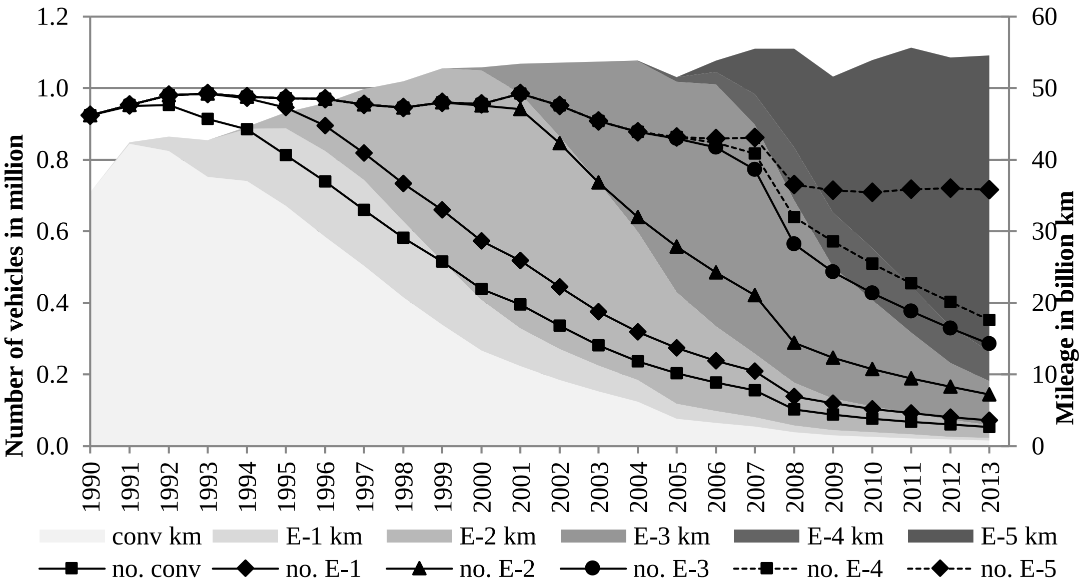
Fig. 3. Development of empty run mileage of German HGVs (2000 - 2009) (own chart based on BGL 2011)

3.3.3. High environmental standard of new vehicle

Between 2000 and 2009 new registrations of HGVs developed differently by weight class. The number of newly registered smaller goods vehicles (< 3.5 tonnes gross vehicle weight) clearly rose continuously from 2004 until the economic crisis. A closer look at changes in new registrations of vehicles with a permissible total weight of 12 tonnes or more reveals that immediately prior to the introduction of road tolls for HGVs, disproportionately large numbers of vehicles were newly registered in the 7.5 to 12 tonne class and in the category of HGVs with a permissible total weight of more than 20 tonnes. Overall, the vehicle fleet underwent a change.

New registrations were accompanied by a significant modernisation of the vehicle fleet. New registrations of vehicles with the poorer Euro standards declined disproportionately, but in the wave of renewal with the introduction of the Euro V standard, the rate at which the latest Euro standards were taken up appears to have slowed down. Overall, however, the Euro V standard does not appear to be prevailing any faster than the Euro III standard did.

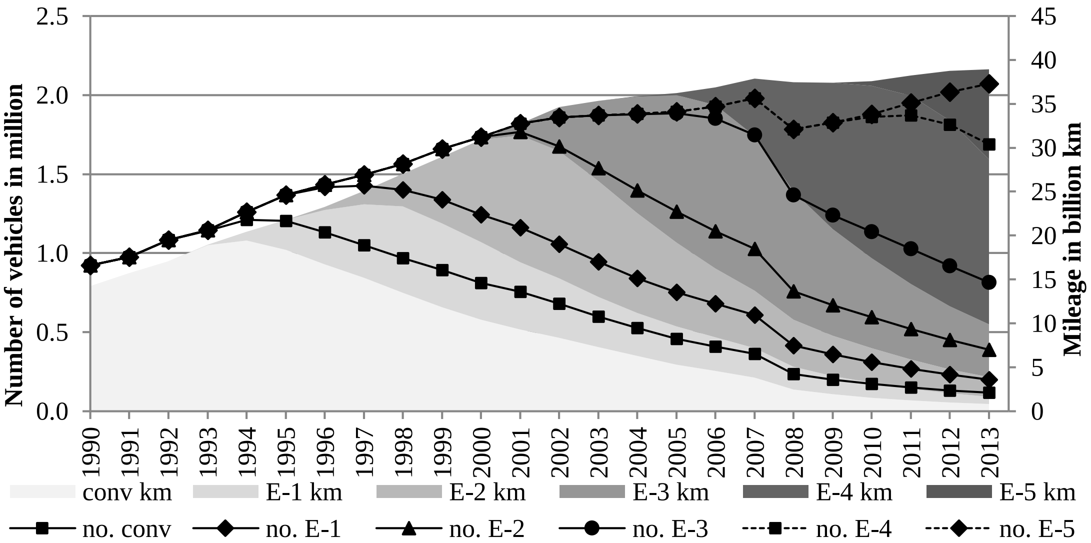
The development of mileages covered by German HGVs with a permissible total weight of more than 3.5 tonnes by emission class between 1990 and 2013 is shown in Fig. 4 and for less than 3.5 tonnes in Fig. 5. They contradict the argument put forward by the opponents of road tolls that the HGV toll has no effect on the environment. The swift decline in Euro II and Euro III HGVs as a proportion of overall mileage is accompanied by a disproportionate increase in mileage covered by Euro V HGVs. Euro V HGVs accounted for about 76 per cent of the total mileage of HGVs of over 3.5 tonnes in the year 2013.



[1] The amount of Euro-6 mileage is less than 1% and was therefore not included.

[2] From 2008, temporaily deregistered vehicles were excluded from statistical coverage in

Fig. 4. HGVs (>3.5t) mileage and number of vehicles per emission class in Germany 1990 - 20131,2 (own chart based on TREMOD 5.53 data from 15.11.2014)



[1] The amount of Euro-6 mileage is less than 1% and was therefore not included.

Fig. 5. Light commercial vehicles (<3.5t) mileage and number of vehicles per emission class in Germany 1990 - 20131,2 (own chart based on TREMOD 5.53 data from 15.11.2014)

A slightly different development is revealed in the case of light commercial vehicles (LCV) by emission class between 1990 and 2013, which are not included in the toll system. Fig. 5 shows for light commercial vehicles (LCV) with a permissible total weight of less than 3.5 tonnes a share of only 24 per cent of the Euro V of the overall mileage in this class. However, the data also indicate that the stock of LCV is growing further; also, in such cases vehicles complying with the Euro V standards are preferably being purchased.

With regard to the substantial impact, that is the question of possible environmental improvements, the transport system is characterised by an increasing efficiency. This means that changes in the emission of carbon-dioxide equivalents tend to decouple from the associated change of transport in ton-kilometres. According to Fig. 6, the mileage driven by small vehicles (passenger cars) has increased rather than decreased in absolute numbers, yet the related carbon dioxide emissions have decreased significantly. Even though the freight transport sector has achieved efficiency gains, the strong growth of freight transport (in ton-kilometres) subsequently leads to rising carbon-dioxide emissions. In sum, the decoupling of traffic volume and GHG emissions did not contribute to a decrease of negative impacts by freight transport. Nevertheless, the significant improvements in the change rate at the ecological dimension could, at least indirectly, be explained by the coupling of the autobahn toll with the Euro-emission standards.

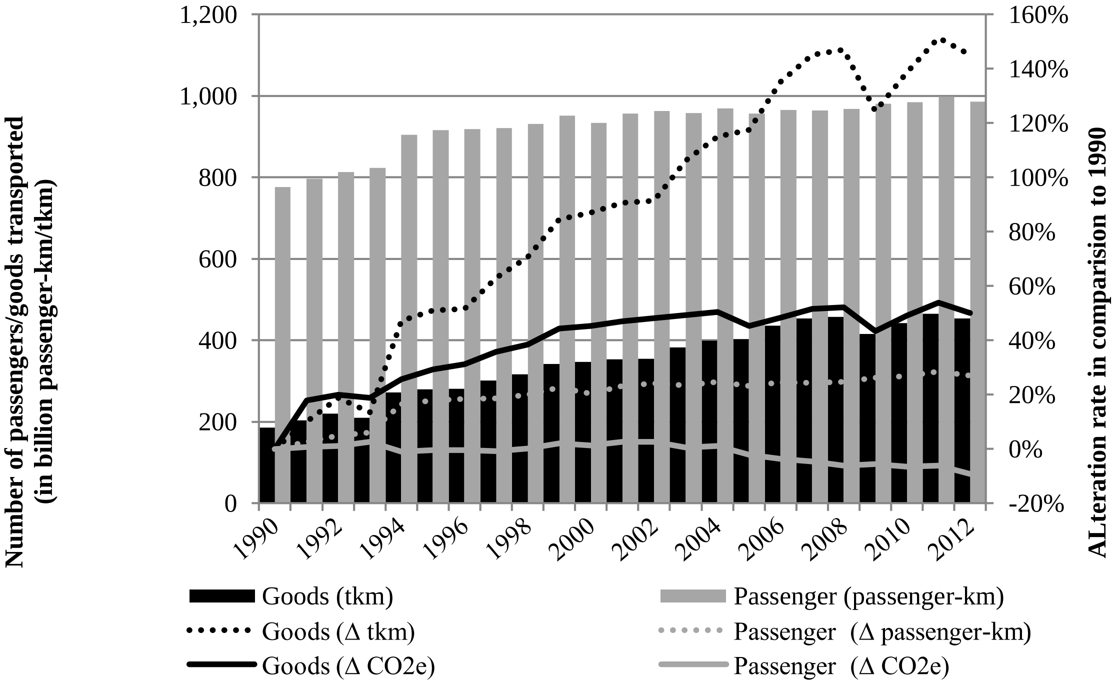


Fig. 6. Passengers and goods transported: GHG and mileage in Germany 1990 - 2012 (own chart based on TREMOD 5.53 data from 15.11.2014)

However, no inferences may be drawn as to whether the changes in the composition of the fleet led to a net reduction in emissions from road transport because between 2000 and 2009 foreign HGVs increasingly gained market share of the tonne-kilometres covered in Germany in intra-German and cross-border traffic. There is, however, no robust study on the ecological steering effect of the HGV road toll that takes the ecological standard of foreign HGVs into consideration. In view of the high proportion of HGVs from Eastern Europe it must be assumed that the ecological effect has in principle been less than the number of new vehicle registrations in Germany might lead one to expect. The decline in toll revenues may nonetheless be attributed in part to better HGV Euro standards. Fundamentally, then, a positive effect may be assumed (cf. BAG 2011). It is merely impossible to quantify exactly in this context.

3.4. Assessing the road toll for HGVs

The results of the action outcome analysis show a user-based system of charges that takes the number of the vehicle’s axles and its emission class into account, due to the EU’s demand for a toll charge system that was non-discriminatory and fair.

Through the measure outcome analysis it became clear that a fair sharing of burdens would not be accompanied by changes in traffic patterns. There are no indications of freight being transferred to the inland waterways or to the railway network as a result of the introduction of the road toll for HGVs.

The HGV toll also does not appear to have any steering effect in terms of the quantity of goods carried or the distances covered. This also applies to the reduction in empty runs. In conclusion the road toll system does not appear to have any significant effect, or indeed any effect at all, on the volume of goods traffic, mode choice, or mileage driven.

The lack of a substantial modal shift effect and a more extensive use of the road infrastructure’s capacity would seem to indicate that the present implementation of the autobahn toll is not sufficient for achieving the desired effect. With a higher toll charge, an consideration of all HGVs greater than 3.5 t and an application on all roads certain changes in behaviour can be expected (cf. the HGV toll in Switzerland).

The measure outcome analysis also reveals effects that were not intended, but are of relevance for urban goods traffic. In particular, the composition of the vehicle fleet has changed in two respects:

- First, the size structure of vehicles has undergone a change, with a greater emphasis on smaller vehicles with a permissible total weight of less than 3.5 tonnes and on larger HGVs with a permissible total weight of more than 20 tonnes. Initially, there was also a disproportionate increase in the number of new registrations in 7.5- to 12-tonne permissible total weight category, which was just below the level at which the toll kicked in.
- Second, the Euro standard changed, but closer scrutiny of the acceptance of the latest norms at any given time would seem to indicate that the Euro V standard would have prevailed just as fast even without the road toll for HGVs.

4. The environmental zone in Berlin

4.1. Background

New European threshold values for air pollutant emissions have been in force since 1st January 2005. The EU’s air quality framework Council Directive 96/62/EC were adopted by national law, the Federal Immission Protection Act, in 2002 (BImSchG 2002). In section 47 (2) it provides for drafting a clean air programme and a plan of action in the event of thresholds being exceeded. Section 40 BImSchG requires to apply restrictions on traffic if they are listed as part of the clean air programme and plan of action. The major traffic-related measure in these plans in Germany is the implementation of an environmental zone. The provision of the scheme provides permission for low-emission vehicles to enter these environmental zones.

4.2. User advantages for vehicles in line with emission standards

Berlin was one of the first cities in Germany that decided to impose a driving ban for diesel vehicles that did not meet at least the Euro II emission category from 1 January 2008, because the effect analysis showed that atmospheric pollution thresholds were exceeded quite significantly. Traffic accounts for more than 50 per cent of the nitrogen oxide pollution citywide. The causal analysis, worked out for the year 2002, accounting around a quarter of all particulate emission to local road traffic induced by vehicle exhausts, tyres, road surfaces, brake abrasions and road dusts. Two thirds of the total particulate matters are attributable to HGVs (SenStadt 2005a). The evaluation of the central vehicle register showed “that only about 50 per cent of Berlin-registered HGVs comply with the latest exhaust regulations” (SenStadt 2005b).

Berlin's "Integrated Concept for Managing Commercial Traffic" (ICTC) specified a “reduction in traffic-generated air pollution (benzole, nitrogen dioxide, particulate matter10 µm (PM_{10}), carbon monoxide and polycyclic aromatic hydrocarbons) with the target of a 25 per cent overall improvement in the threshold values to be observed by 2015 as defined in the EU sub-directives" (SenStadt 2005b).

The results of the causal analysis from 2002 showed the exceeding of the particulate ceilings (a 24-hour total of PM 10 particulate at 50 μg/m³) on about 450 kilometres of city roads. More than 190,000 residents were affected, mainly living in the inner city. For this reason, the defined environmental zone covers the area within the inner city loop of the suburban electric railway system. This zone exceeds to about 100 square kilometres including about 700,000 workplaces and 1 million inhabitants.

After introducing the first stage of the environmental zone in 2008, the second stage took effect on 2 January 2010. Diesel vehicles had to be in line with at least the Euro III standard and being equipped with a particulate filter to meet the requirements of the Euro IV standard. Entering the zone without a compliance sticker would impose a € 40 fine to the vehicle holder, and in addition one point in the Central Index for Traffic Offences would be recorded.

The ICTC mentioned earlier covers inter alia one field of action which is directly connected to the environmental zone. Thereby inner-city logistics nodes (city-terminals) are gaining importance, and the action field to "ensuring sustainable railway infrastructure and logistic nodes" is also increasingly becoming important (SenStadt 2005b). As a consequence, it was expected to initiate modal shift to railways and inland waterways.

4.3. Analysis of the environmental effectiveness of Berlin´s environmental zone

The effectiveness of the environmental zone in reducing air pollutants was evaluated by the Berlin Senate's administration as of June 2011 (SenGUV 2011):

The annual average fine dust concentration is 7 per cent or around 2 micrograms per cubic metre lower. The number of days on which the 24-hour threshold is exceeded has been reduced by ten. In 2010 the diesel soot particles were down by 33 per cent on 2009 and by 52 per cent on 2007. This means that compared with the trend in non-environmental zone areas, diesel soot particles were down by 42 per cent in the first and by 58 per cent in the second stage (SenGUV 2011).

The nitrogen dioxide count was down by nearly 2 micrograms per cubic metre, or by about 5 per cent. This means that, compared with the trend in non-environmental zone areas, nitrogen dioxide levels were down by 6 per cent in the first and by 20 per cent in the second stage.

Over 88 per cent of the reduction potential was thereby achieved in spite of exemptions such as for vintage cars (SenGUV 2011). The measure outcome analysis comes to the conclusion that the reduction in air pollutants was achieved in roughly equal measure by upgrading cars and HGVs (SenGUV 2011).

By means of a combination of a spatially based driving ban and user advantages for vehicles conforming to a high environmental standard, vehicle owners should be motivated to a faster environmental upgrading of their vehicles and fleets (SenStadt 2005a). The forecast predicted that the implementation of the first stage of the environmental zone affected nearly 40,000 cars and 30,000 lorries (over 12 years old), and that the second stage affected another 20,000 cars and 10,000 lorries (over 10 years old) in Berlin (SenStadt 2005a). As of 1 January 2010 around 59 per cent, and as of 1 January 2011 around 73 per cent, of all 80,000 light and heavy goods vehicles registered in Berlin complied with the pollutant category 4 (green sticker) (SenGUV 2011). In sum, Fig. 7 shows a faster rate of environmental change of vehicles in the environmental zone than outside.

Traffic was also expected to be re-distributed as a consequence of the environmental zone (SenGUV 2009). Surveys indicate that the number of commercial vehicles in the environmental zone has declined by about 10 per cent at most (SenGUV 2011). HGV traffic is, however, subject to severe fluctuation. Furthermore, car and lorry traffic in the environmental zone has declined between 2002 and 2010 continuously by up to 15 per cent in total (SenGUV 2011). There is, however, a countervailing trend for overall and HGV traffic. HGV traffic in the environmental zone has tended to decline less than HGV traffic outside the zone. Compared with the base year 2002, the proportion of HGVs inside the environmental zone fell by 9.4 per cent and that of HGVs outside the environmental zone fell by 13.4 per cent by 2010. According to figures compiled by the Berlin Senate, this modernisation of the environmental standard in the environmental zone affects the city's entire road network, but is especially effective in the environmental zone itself (SenGUV 2011).

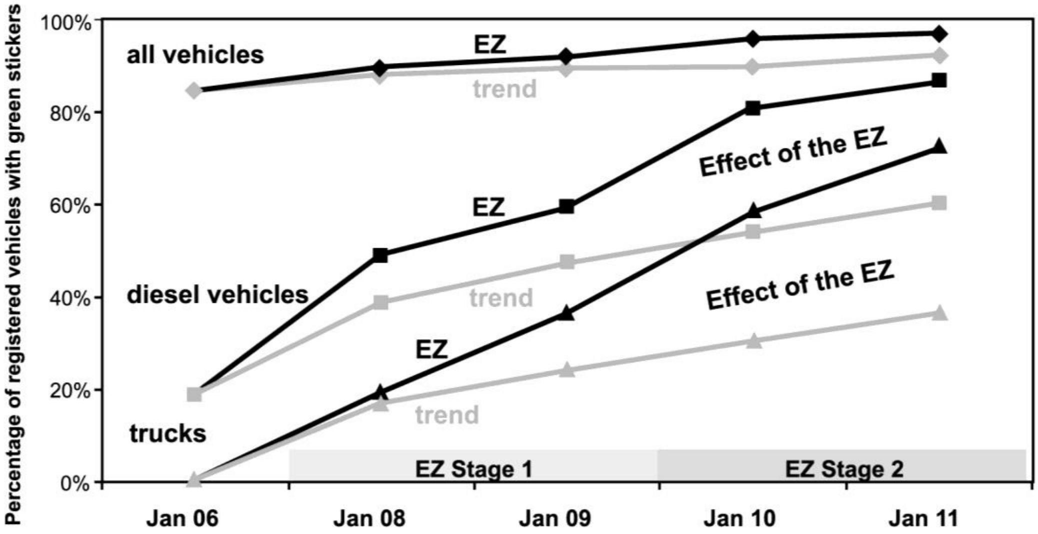


Fig. 7. Development of the proportion of vehicles with green stickers among the vehicles registered in Berlin (adapted from SenGUV 2011)

4.4. Assessing Berlin's environmental zone

The figures for the observation period from 2002 to 2010 (SenGUV 2011) indicate that other trends have a stronger influence on traffic volumes than the environmental zone. The planning analysis for the environmental zone in Berlin confirms that European environmental legislation plays an important role in Germany today for ensuring the implementation of traffic planning measures. The measure outcome analysis also revealed that the Air Quality Directive partly served as a justification for enforcing further measures, including anchoring the city terminal concept in the ICTC. This measure offers far-reaching potentials for influencing the structure and composition of commercial traffic in the city. This prediction is supported by an examination of other clean air plans in Germany (cf. e.g. clean air plans for Munich, Bremen, Dresden).

Likewise, the implementation conditions underline that. Without the restrictive EU threshold values introduced, planning of logistics nodes would have been scarcely feasible at the local authority level alone. Yet they created the preconditions for freight flows in Berlin to be reorganised by securing or setting up bi- or trimodal sites in the city centre. It remains to be seen whether there will be any bundling of commodity flows on the last mile, as this measure has not yet been implemented.

The findings of the measure outcome analysis show that setting up the environmental zone seems to be sufficient to meet the objectives as formulated alone. The annual mileage of vehicles with a lower environmental standard was reduced more drastically than would have been the case without the environmental zone. The environmental zone is also seen to be an effective lever by which to achieve reductions in air pollutants is faster possible than in other action areas. But the measures in the action plan and the integrated concept presented start with the existing structural characteristics of the commercial traffic system and seek to achieve improvements in manageable steps. Optional measures for a reorganisation of the freight transport system in general were not identified as yet.

5. Conclusion

With regard to action outcome, both measures confirmed the major role EU legislation plays today in initiating and giving concrete shape to local measures. The two measures differ inasmuch as the autobahn toll for HGVs was discussed before there was a legal basis for it at the EU level. Discussions on the implementation of an environmental zone in Berlin emerged only after breaches of the critical values that are prescribed by the Air Quality Framework Directive (96/62/EC) and related directives. An action plan needed to be put into place and the implementation of an environmental zone seemed to be a suitable measure (mainly due to a lack of alternatives).

Also, for the first time in many years there was a political window of opportunity to implement restrictive measures successfully in the traffic sector by using environmental-related directives (implementing of action plans).

The resulting opportunity to implement the environmental zone on short notice occurred alongside a change in the framework conditions for the conceptual issue of planning and politics concerning goods traffic in Berlin. By means of the EU directive it proved possible to anchor further flanking measures in the ICTC. That said, the traffic analysis reveals a much better situation in the German capital, Berlin, than in many other large German towns. The pressure to take actions was, and continues to be, too low for restrictive measures such as bundling consignments via a regional forwarding concept.

The road toll for HGVs, which at first glance might not be relevant for urban traffic, does indeed affect the city, yet especially in an unintended way. Transport chains continue to originate and to have their destination in cities or agglomerations. The trend toward mega liners, that are exceptionally long vehicles, must be considered problematic. Large lorries increase the risk of congestion and lead to an increase in fine dust emission by abrasion and dust scattered by additional braking and acceleration manoeuvres.

From the point of agglomeration, another interesting issue could be observed: In the first phase the HGV toll has merely been slight shifts in some places from the autobahn to minor roads. In the second phase after extending the toll system to a further 1,000 kilometres of roads there was a shift back. While federal and state trunk roads have experienced a daily decrease of 300,000 vehicle-kilometres, the related scores for motorways indicated an additional 400,000 vehicle-kilometres (Deutscher Bundestag 2014).

However, the system adopted in Germany offers a fundamental opportunity to extend toll charging to other types of road and user groups, such as HGVs in cities. The lower vehicle capacity utilisation in local traffic might indicate that introducing road tolls for HGVs in urban areas could generate further efficiency and HGV mileage savings in cities.

Neither the EU nor Germany nor Berlin governments seem to be prepared for achieving fundamental changes of freight traffic patterns in terms of transport volume and modal split. Only environmental standards combined with measures addressing the quantity of goods movements and the distances seem to be successful at creating incremental changes in the freight flow system. Here, people's consumption behaviour can become a crucial factor. Finally, politicians have to put regulations and values in place.

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