IMPACTS OF HGV TOLLS ON TRANSPORT LOGISTICS

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ABSTRACT

In this article, basic characteristics of HGV toll systems are described. Based on that, these systems' impacts on entrepreneurial processes and resulting changes in business choices are discussed. Furthermore, a case study on hauliers' reactions on the German HGV toll is presented. The results show that the haulage industry only has to deal with marginal impacts since costs are usually passed along to the customer, this is why operational changes do not seem necessary.

Keywords: Road pricing, heavy goods vehicles, HGV tolls, impacts, transport logistics

INTRODUCTION

Heavy goods vehicle (HGV) tolls are strongly debated throughout politics, society and business. Although some countries specifically decided not to implement HGV tolls or were not able to pass a haulage charging scheme (e.g. Netherlands and Great Britain), more and more countries, especially in the EU, are implementing HGV tolls. From the consideration to let users pay for infrastructure and ecological costs to the believe that the national transport business has to be protected against foreign competitors by road charging, there are a lot of different reasons for implementing HGV tolls. However, it is beyond question that the introduction of a toll system has impacts on different actors and systems.

Depending on the type of toll system, the business activity of companies, either transporting goods on the road or shipping them, is influenced by price increases. Particularly, transport logistics companies are forced to modify their processes since they are worst affected due to the high share of transport costs of overall costs. Thus, this paper‘s focus lies in the

gathering of different impacts of HGV tolls on transport logistics, that is on the question of how carriers and logistics service providers react on toll-induced price increases.

Accordingly, first of all, a general overview of HGV toll systems is given. The subsequent section deals with microeconomic impacts of such systems. Furthermore, the German toll system is explained in detail and outcomes of a case study on German haulier's reactions on HGV tolls are presented. Finally, the findings are summarised.

HGV TOLL SYSTEMS

To charge road users, manifold different HGV toll systems are in use. Descriptions of existing toll systems can be found in McKinnon (2006), European Parliament (2008), Broaddus and Gertz (2008) as wells as Conway and Walton (2009). To give a structured overview of the most important characteristics of (HGV) toll systems, a morphological box is applied (see Table 1).

Initially, two main toll systems can be distinguished. The time-based system allows the user to use certain infrastructure for a predetermined time span, in which the user can travel as far as he wishes. By contrast, the distance-based system charges the distance travelled, that is every single kilometre. In both systems the toll charged can be limited to certain road sections (e.g. in Italy), certain types of roads (e.g. in Germany) or to the whole country (e.g. Switzerland). Beyond that, some toll systems even work across borders. For isntance, in 2013, Belgium, Denmark, Luxembourg, Netherlands and Sweden jointly apply the Euro Vignette. Another example is the German on-board-unit that can be used in the Austrian toll system, as well.

With HGV toll systems different truck sizes can be targeted. In general, the differentiation between small and large trucks is made at a gross weight of 12 tons. However, for HGV tolls implemented in Europe the EU-Directive 2006/38/EC targets all trucks from 3.5 tons gross weight only if the effort to implement small truck charging does not exceed possible revenues.

System architectures can be differentiated into open systems in which one can move freely and is charged on the way and closed systems with check in/check out barriers. Additionally, either single lane systems with dedicated lanes for toll charging or multi lane systems with free lane choice are in use. The driving speed at which vehicles are detected or charged is very important for the interference with the traffic flow. The faster vehicles can travel the slighter the interference is. Detection in free flow does not require vehicles to slow down at all. Some systems require vehicles to pass with a medium speed, and others that collect the charge at toll booths, force vehicles to come to a complete stop. Moreover, the slower vehicles have to pass these points the wider this area has to be constructed to allow simultaneous charging of many vehicles.

In addition to the vehicle type, the amount of tolls paid in cash, prepaid or post paid can depend on further influencing factors. Existing systems consider the number of axles, the

maximum gross weight and/or the emission class of the vehicle. By contrast to static toll systems which are typical in Europe nowadays, more dynamic setups such as the ones planned in the UK and the Netherlands are possible. These systems charge depending on the time of travel, real time congestion levels or even the local emission situation (as implemented for some motorway sections in Tokyo and Osaka).

Furthermore, the reasons why HGV tolls are implemented have to be taken into account, especially when the effectiveness of toll systems is discussed since the motivation mainly influences the toll system design. Amongst other things, the aim to lower truck emissions led to an emission class adaptive toll charge in Germany for instance.

Basis	Time-based				Distance-based	
Type of roads	Whole country		Certain type of road(s)		Single motorway/ road stretch(es)	
Gross weight threshold	3.5 t				12 t	
System architecture	Open system				Closed system	
Lane choice	Multi lane				Single lane(s)	
Driving speed for charging/detection vehicles	Free flow		Slow down		Stop	
Charging method	Cash		Prepaid		Prepaid (single trip)	Post paid (bank account)
Additional specifications influencing charge	No. of axles		Max. gross weight		Emission class	
General price adaption independent of vehicles	None	Congestion	Time of day		Day of the week	Local emissions
Reason for implementation	Collect revenue	Reduce congestion	Improve multi-modal haulage	Charge external users	Recover truck costs	Improve environment

Table 1: HGV toll system characteristics (filled gray for the example of the German toll system)

Regarding traffic management measures, it can be stated that a distance-based approach to toll systems seems to set better incentives than the time-based approach. In general, a distance-based toll scheme leads to more efficiency in the freight business since the user has an incentive to reduce the distance driven and thus, he has the motivation to optimise processes resulting in reduction of empty truck kilometres. Further opportunities to manage traffic are possible by a switch to dynamic toll charging schemes. For instance, while static time-depending systems do not have any impacts on the user's time choice, dynamic toll systems allow to manage traffic congestion-dependently.

MICROECONOMIC IMPACTS OF HGV TOLLS

In the following, reactions on HGV tolls of different actors along the supply chain, i.e. carriers, logistic service providers as well as manufacturers, are presented and resulting business decisions are discussed.

Transport logistics' reactions on HGV tolls

In general, toll systems show several type-depending macroeconomic impacts. Doll and Schaffer (2007), Vasallo and López (2010) as well as Evangelinos et al. (2012) describe a slight increase of the consumer prices due to higher transports costs. Likewise, Doll and Schaffer (2007) state marginal employment effects, too. Furthermore, HGV tolls may influence accessibility negatively (Condeço-Melhorado et al., 2011). Additionally, due to the price dependencies on emission class, positive impacts on pollution and noise emissions can be seen (Roth, 2009). However, in the following the light is shed on microeconomic impacts, that is impacts of HGV tolls on single companies.

Indeed, it is out of the question, that higher transport costs have an effect on every industry sector, in which goods are transported with trucks. However, studies concerning the economic impacts of the increase of the German HGV toll by Doll and Schaffer (2007) and Evangelinos et al. (2012) show significant price increases for transport logistics while there are only marginal price effects on other industry sectors. In general, this is due to the marginal ratio of transport costs to overall revenues. Accordingly, a price effect on the whole economy of only 0.1 % occurred for the case of Germany (Doll and Schaffer, 2007; Evangelinos et al., 2012), compared to about 15 % increase in transport costs. Vasallo and López (2010) state similar results for Spain. Therefore, also the increase of consumer prices can be seen as marginal.

As mentioned before, with its high ratio of transport costs to overall revenues, the transport sector is hit the hardest by HGV tolls. While logistics costs in other industry sectors are usually less then 5% of complete turnover, in the case of logistics service providers they stand for roughly three-quarters (Einbock, 2006). According to Doll and Schaffer (2007), these costs increases are rather observable in the bulk than in the unitised goods market. Likewise, the costs for long-distance transports increase stronger than for short-distance transports.

Thus, in the following, primarily transport logistics' reactions on cost increases due to HGV tolls and their impacts on the traffic system are discussed. Furthermore, since enterprises may react with long-term decisions which go far beyond the logistics processes, also these reactions are considered.

In general, there are many different ways to organise a supply chain. Below, the focus lies on a supply chain with two main actors: the manufacturer and the distributor (logistics service provider and/or carrier). For simplification matters, a manufacture is assumed to be any

company which ships goods. By contrast, carriers and logistics service providers organise and monitor the transport. They regulate the transport processes on behalf of the shipper in their own name. The transport and handling service is performed by the carrier or the logistics service provider using its own equipment or through the purchase of transport and handling services (Aberle, 2009). Carriers or logistics service providers often offer additional value-added services such as processing documents (including transport documents and customs formalities), warehousing or distribution. The self-conducted transport of a logistics service provider which operates as a carrier is designated as so-called own-name transaction. In addition, the carriers and transshipment companies sometimes take over the logistics service provider's function (Hildebrand, 2008). In this way, a distinction between carrier and logistics service provider is very difficult.

Time-dependent business decisions within supply chains

Assuming that avoiding or at least minimising the cost increase is always the aim of the actions taken, the following discussion is structured according to the other essential characteristics of a decision: What is decided? When? By whom? (see Table 2).

Decision			Actors in supply chain: Production	Logistics service provider	Carrier
short-term	Dispatching Choices	Route planning			
		Tour planning			
		Operational lot size			
	Lot size / frequency choices				
	Cost transfer				
	Mode choice				
	Supply path choice				
	Logistics location choice				
	Sourcing choice				
	Production process choice				
long-term	**Business location choice**				

Table 2: Reactions of supply chain actors on HGV tolls (corresponding range of decisions filled gray)
(Source: illustration based on Friedrich, 2010)

First, following Friedrich (2010), the entrepreneurial decisions leading to freight transport demand are distinguished into rather long-term strategic decisions (e.g. business location choice) and short-term decisions regarding the operations (e.g. dispatching choices). It is assumed that each of the decisions listed in Table 2 can be made to react on HGV tolls. Secondly, based on the previous remarks on supply chain design used in this paper, decisions can be made either by the manufacturer, the logistics service provider and/or the carrier. While the manufacturer can react with a change of business location choice or sourcing choice over the long term, the logistics service provider has the competence for mid-term decisions as altering the supply path. Since the toll costs firstly incur for the carrier, he will take short-term actions concerning its operations (e.g. dispatching choices).

Without doubt, the entrepreneurial reactions on HGV tolls and consequently, the observable impacts on the traffic system mainly depend on the implemented toll system. For instance, on the one hand, a distance-based toll only charged on motorways like in Germany may rather provoke toll avoidance traffic on lower rank roads than a toll for the whole network as in the case of Switzerland. On the other hand, a dynamic time-based toll system may allow traffic managers a better influence on time choice than a static system (Roth, 2009). Hence, if necessary, during the following discussion it is always referred to special cases.

Business decisions reacting on HGV tolls

Academia has already paid attention to toll-caused decisions of enterprises and observable impacts within the traffic system. While research in logistics has addressed the problem from the user's perspective, in traffic engineering sciences impacts are examined on a more aggregated level. Regarding the variety of decisions presented in Table 2 it can be stated that only Einbock (2006) addresses all decisions. McKinnon (2006) dwells on impacts on logistical systems, that is, LSP's and carriers decisions. The focus in other references is restricted to the carrier's decisions (Gustafsson et al., 2006; European Parliament, 2008; Link, 2008; Roth, 2009). Usually, the production-related decisions are only mentioned casually. Other references only focus on particular impacts. For instance, toll avoidance traffic and its negative impacts has been a topic of public debate in Germany, while it has been a popular research topic, too (see Kummer and Nagl, 2005; Henninger, 2006). Thus, in the following section, a comprehensive overview of possible reactions of supply chain actors and the interaction with the traffic system is given.

Due to the fact that the carrier is confronted with the tolls in the first instance, he will make short-term decisions on dispatching choices to avoid or soften the toll's impacts. That is, adapting the route or tour planning or changing the operational lot size respectively. In the German case with a motorway toll system with toll-free roads in the lower rank network, the carrier's first obvious opportunity is to de-route, i.e. to shift off the motorways. By contrast, systems covering all roads like the one in Switzerland prevent avoidance traffic (European Parliament, 2008). At the time of the toll system implementation, Doll and Schaffer (2007) estimated for an amount of 3-4 % of the total heavy goods traffic on German motorways to shift off. But meanwhile, the amount of toll avoidance traffic in Germany decreased again. On one side, this is traceable to the trade-off between time and costs (Maier and Busch, 2011). ,

Especially in long-distance traffic, higher costs due to tolls are rather accepted than time losses as a result of detours. Thus, rather short-distance traffic is shifting off motorways as observed by Kummer and Nagl (2005). On the other side, enacted bans on trucks for popular toll avoidance routes have a visible impact. Thus, according to Link (2008), only 25 % of German hauliers tend to use non-tolled roads. Likewise, in the short term, carriers and LSP will think of changes in tour planning or lot sizes, since HGV tolls may motivate to reorganise transport processes. For instance, increasing load factors, e.g. by horizontal or vertical cooperating with competitors as well as making use of freight exchanges, or avoiding empty runs could help to save costs (Einbock, 2006). In general, distance-based toll systems are better to provoke route optimisations than time-based systems not charging per kilometer travelled (McKinnon, 2006). However, there are certain saturation points for route optimisation due to unavoidable empty runs as well as limits for the increase of load factors, e.g. caused by the standardisation of loading units (Evangelinos, 2009). Nonetheless, the strong competition on the transport market has already made for a high degree of optimisation (European Parliament, 2008). In case of a time-depending toll charging, a logistician may have a reason to shift deliveries to less-tolled times. Though, such a change would go in line with still uninvestigated deep interference of entrepreneurial processes upstream as well as downstream the supply chain (McKinnon, 2006). According to Holguin-Veras (2010), it is not enough to incentivise carriers to shift off peak hours but to include receivers into an appropriate policy approach also since the reciever decides on the delivery time and thus, also on the carrier's time choice. Therefore, due to a lack of knowledge about interactions between production, logstistics and traffic, it is questionable whether heavy goods traffic can be shifted in time.

In the medium term, depending on the contract situation either the carrier or the logistics service provider can pass along the additional costs not to be left with them. Thus, 92% of German hauliers plan to pass costs along to their customers (Link, 2008). That is why the logisticians normally agree appropriate contract clauses with their customers. According to McKinnon (2006), it seems that shippers in Germany, Austria and Switzerland take over the toll costs.

Also in the medium term, another modal choice by transport logistics companies would be possible, that is a switch to toll-free vehicles or even another transport mode. For instance, enterprises can force investments in the transport fleet to reduce the emission-based part of HGV tolls. However, it has to be kept in mind that the renewal of the fleet will follow the regular replacement process (Gustafsson et al., 2006). Thus, the specific effect of HGV tolls on the fleet modernisation is difficult to quantify (Maier and Busch, 2011). While, for the case of Germany, more acquisitions of low-emission trucks than of vehicles with less than 12 tons had been expected (Link, 2008), a disproportional growth of the number of trucks with a gross weight slightly below 12 tons was observed (Maier and Busch, 2011). Meanwhile, logistics service providers have specialised on a market segment of transporting high volume goods with a weight slightly below 12 tons.

Alternatively, a switch to rail might be possible. In this case, because of the totally different characteristics of the rail logistics network, increasing transport distances with, likewise, longer transport times have to be accepted. But in consequence of the HGV toll implementation in Germany, there have only been slight modal choice effects from road to rail. Thus, road freight traffic approves to be inelastic for transport cost increases (Evangelinos, 2009). This goes in line with the findings of Einbock (2006) as well as the European Parliament (2008). Both also only expect a very limited number of enterprises to switch the mode.

As described above, the literature deals a lot with short-term as well as middle-term toll-depending decisions in transport logistics. However, not much has been said about conceivable long-term reactions of actors upstream the supply chain. Generally, there is the possibility to make long-term changes concerning the supply path or even the logistics location choice to buffer the toll-caused cost increases with savings in the own logistics network structure, e.g. with the shutdown of warehouses not working to capacity. However, probably due to the manageable toll-caused cost increase, only a minority of enterprises tends to adapt its logistics network (Einbock, 2006). The marginal cost increase only offers little incentive for modifications of the logistics system design (McKinnon, 2006). Moreover, Einbock (2006) rather generally states that enterprises can counteract the cost increases with adaptions in procurement (f. i. intensified regional sourcing) or in distribution processes (f. i. withdrawal on certain markets). Furthermore, according to Evangelinos et al. (2012) increasing HGV tolls may influence the location choice of enterprises in the long run. Similar to the logistics network change, very few companies feel compelled to reconsider the business location choice (Einbock, 2006).

Notwithstanding the above, the impacts of long-term changes of logistics location choice or the business location choice of a single companie would have marginal effects on the overall traffic system. Indeed, a change in a single companies' location would show changes in traffic on a local scale however, the large scale would stay unaffected.

CASE STUDY

Below, using the structure introduced above, the German toll system is classified as shown in Table 1. Based on that, the results of a case study on haulier's reactions on the German HGV toll is presented.

HGV tolls in Germany

Germany was part of the group of European countries jointly using the Euro Vignette which is valid in all participating countries and available as day, week, month or year vignette. In the end of 2003, Germany quit the Eurovignette and finally introduced a distance-based toll system implemented and operated by the company Toll Collect 17 months later. In this time-span no tolls were charged (Broaddus and Gertz, 2008).

The German HGV toll system focuses on motorways. However, during the first years it was discovered that toll avoidance traffic occurred. To reduce these traffic flows several stretches of federal roads were added to the toll road network. The system was implemented with trucks heavier than 12 tons gross weight in mind and will not be extended to lighter trucks in the foreseeable future (Dahm, 2006). A multi lane, free flow system was implemented in which the distance travelled is tracked via GPS. Toll bridges along the motorways are used to enforce charging with license plate recognition and matching. Hauliers using German roads a lot can install an on-board-unit for tracking the distance travelled and pay automatically via bank account. Whereas, single time users have the option to book and pay their route via toll-station terminals or internet in advance. The charge depends on the number of axles and the emission class. No additional price adaption is implemented so far.

The main reasons for implementing a distance-based HGV toll scheme in Germany were to allocate infrastructure costs as well as external costs better to the user and to implement sustainable financing of road infrastructure. Another reason was the hope of a change in modal split towards rail and ship. It was assumed that the efficiency in the transport sector would rise, especially cutting down on empty runs. One last, seldom mentioned reason was to get Germany into a leading position in the field of satellite technology (Evangelinos, 2009). The overall amount in tolls needed is calculated depending on the estimated infrastructure costs (Dahm, 2006).

Haulier reactions on HGV tolls

As described above, the literature review revealed that in consequence of an HGV toll implementation most likely decisions concerning cost reductions are made by carriers since they are confronted with the toll in the first instance. Thus, in a student project interviews with experts from four haulier companies regarding their company's reaction on HGV tolls were conducted (see Kolks, 2012). For this purpose, to cover the wide spread of the haulage market, on the one side, companies from each size class defined in the recommendations of the European Commission (2003/361/EC) were selected. On the other side, it had been paid attention to choose companies that compete on different submarkets (see Table 3).

The mircro-sized Haulier 1 is a moving company solely operating regionally with its two rather old vehicles. Due to short distance transports its vehicles run not more than 20.000 km per year with full-truck-loads. By contrast, the medium-sized Hauliers 2 and 3, transporting consumer goods/textiles or steel/metal goods respectively, primarily serve international markets. As a consequence, due to longer distances and shorter replacement cycles either of their fleets is of quite young age. Haulier 4, the biggest of the interviewed companies, operates all over Europe serving customers from several industries. With about 200.000 km mileage per vehicle and year, the fleet is renewed in short cycles, so that its average vehicle is not more than two years old and, therefore, state-of-the-art.

	Haulier 1	Haulier 2	Haulier 3	Haulier 4
Revenues (mill. €)	0.3	20	110	270
Number of employees	8	185	400	2580
Size class	micro	medium	medium	big
Number of vehicles	2	50	100	962
Vehicle age (years)	18	3 - 4	6 - 8	2
Vehicle distance / year	20.000	125.000 - 200.000	150.000 - 200.000	200.000
Vehicle emission standard	Euro I	Euro IV, Euro V	Euro V	Euro V
Type of transport	moving company	consumer goods, textiles	steel, non-ferrous metal	automotive parts, plastics, beverages
	short distance	short + long distance	short + long distance	short + long distance
	full-truck-load	less-than-truck-load, full-truck-load	less-than-truck-load, full-truck-load	less-than-truck-load, full-truck-load

Table 3: Characteristics of the interviewed haulier companies
(Source: illustration based on Kolks, 2012)

Subsequently, the main results of the four interviews are briefly described, following the same structure introduced in the previous chapter.

While the tolls obviously do not influence the route choice of the Hauliers 1 and 3, Haulier 2 tries to avoid tolls on local journeys. By contrast, in long-distance traffic his route choice is rather made from a temporal point of view, too. Haulier 4 stated that his route planning is changed as agreed upon with the customer, in other words, depending on whether it is a matter of time. Thus, in summary, a hauliers' route choice is a trade-off between costs and time.

In the long term, each of the four hauliers always plans to pass along the cost to its customers. Thus, three of them pointed out that prompt renegotiations of existing contracts are required in case of the announcement of a toll increase, since customers pay higher fees not before a contractual amendment. Otherwise, the haulier risks to be left with the accruing costs. Solely, Haulier 1 does not see any problem in passing cost along. This is reducible to its different customer structure. While the other hauliers rather have long-term customers, the moving company most likely serves one-time customers.

Concerning the modal choice, it is worth mentioning that the usage of state-of-the-art vehicles becomes contractual, demanded by the customers. In doing so, the hauliers' customers hedge against unnecessary price increases. Accordingly, if the haulier used vehicles with an emission class lower than Euro V, he would have to bear the potential extra costs. Due to short replacement cycles and thus, a state-of-the-art fleet, the Hauliers 3 and 4 score low on that. By contrast, despite its old fleet, Haulier 1 can pass along the costs.

In summary, it can be assumed that, in fact, the haulage industry has to deal with challenges due to the higher costs. But hauliers only seem to be slightly influenced by the tolls, since all

of them are able to pass along costs and therefore, hardly have to change own processes, e.g. the route choice. However, one remarkable aspects is the fact that fleet renewal is triggered by hauliers' customers by expecting operations with state-of-the-art vehicles.

Thus, our findings correspond to the results of a study done by Forss and Ramstedt (2007), who pre-estimated a toll system's impacts on the haulier industry in Sweden. According to them, in fact, the introduction of a kilometre tax for HGV in Sweden would lead to increasing costs for the haulage industry. But they assume that these cost increases would either be compensated in terms of improvement of efficiency or by passing the costs along to the transport buyers.

CONCLUSION

To charge road users, based on the two different system types – time-based as well as distance-based toll systems – manifold different HGV toll systems are in use. Depending on the underlying system type, each of the toll systems influences entrepreneurial processes by increasing users' costs in different ways. As a consequence, to avoid or minimise cost increases carriers and logistics service providers as well as manufacturers as their customers can take action. While transport logisticians rather react with short-term and mid-term modifications of the logistics processes, manufacturers have the opportunity to interfere with long-term decisions such as a change in business location choice. The presented case study only shows marginal impacts of the German HGV toll on the haulage industry since costs are usually passed along to the customer, that is why operational changes do not seem necessary. Changes in less-than-truck-load traffic might occur without the stakeholders' notice since the strong competition in this market segment might have driven hauliers to optimise their processes already. By contrast, in the single run there might still be big differences between pre toll times and now.

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