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Can low emission zones be managed more dynamically and effectively?

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ABSTRACT

Cities in Europe are introducing green zones, or low emission zones, with the purpose of improving the local environment for residents and travelers. The research project Green Activity Zones (GAZ) presents a technical concept on how charging for driving within a low emission zone can be based on the vehicle's real activity inside the zone. The amount to be charged is computed as a function of continuous measurements of emissions from the vehicle. The purpose of this paper is to investigate stakeholder influences on decisions in the urban distribution chain, and their potential responses to the GAZ regime. These issues are investigated by surveys conducted among retailers, wholesalers and carriers. The surveys show great variations between stakeholder groups regarding the influence over transport and logistics decisions, and that their individual influence largely determines potential stakeholder responses to the GAZ regime.

1. Introduction

1.1. Background

European cities are introducing low emission zones (LEZ), with the purpose of improving the local environment for residents, workers and travelers. These zones are organized as access restriction schemes (ARS) in order to improve air quality and reduce the traffic volume into city centers. A major reason for the increased implementation of LEZ is EU Directive 1999/30/EC, which requires cities with populations over 250,000, or with high population densities to establish an alert threshold for when concentrations of emissions pose a risk to human health. Member states should establish action plans aimed at reducing concentrations to safe levels. The directive encourages member states to establish zones or agglomerates where emissions are monitored and controlled.

National legislation and local regulations on urban access limitations differ widely across Europe. Some regulations completely exclude access to certain vehicles, while in other cases access is allowed upon payment of entrance fees, sometimes differentiated according to locally defined classification schemes, typically based on weight and/or Euro standard.[1] On the background of this heterogeneity, and the risk of a fragmented patchwork of urban access regulations being created across Europe, the EC-DG MOVE funded a study to investigate the state-of-the-art and identify possible actions (TREN, 2010). The study finds that there is limited and little available data on the impact of implementing ARS. Existing findings point, however, to benefits in terms of traffic reduction and improvements of air quality and the overall performance of transport systems. Most stakeholder groups regard ARS as a powerful policy instrument, and ARS are considered more effective if they differentiate between vehicles according to Euro standards.

However, the heavy reliance upon Euro standards in ARS renders current low emission zones static in nature and implies assumptions regarding the relationship between certain vehicle characteristics and actual emission levels: vehicles with a higher Euro standard are assumed to have lower emission levels. However, recent research shows that real NO_x emission factors for driving in city streets are actually similar across all Heavy-duty Vehicle (HDV) Euro standards I through V (Velders, Geilenkirchen, & Lange, 2011). Thus, Euro standards are not necessarily an effective tool for reducing the most hazardous local pollution in European cities.

1.2. Green Activity Zones (GAZ)

In order to meet the need for a more effective tool for reducing emissions from HDVs, the GAZ research project explores the potential for developing a green zone in which charges are based on vehicles' real activities inside the zone. This principle is already known from road pricing concepts based on distance-based charging. GAZ suggests that the amount to be charged is computed as a function of continuous measurements of emissions from the vehicle. The technology and algorithms for these types of calculations are more or less available and the project will develop these further to a new application called GAZ.

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[1] European emission regulations for new heavy-duty diesel engines are commonly referred to as Euro I–VI. Euro I dates from 1992, and the latest Euro VI takes effect from 2013. The maximum permitted limit measured in g/kWh of emission of CO, HC, NO_x and PM has been decreased by each new Euro class.

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The GAZ concept can be considered the next generation for the regulation of low emission zones in cities. The fee is calculated using a differentiated pricing of local pollutants (NO_x, PM, HC and CO), and emission costs can be calculated for every link and for every hour and for each direction. Links can be weighted differently, e.g. to reflect specific environmental sensitive areas in the city. An important effect of GAZ is the ability to respond to variations in the seriousness of local pollution, caused for instance by unfavorable weather conditions like inversion problems during winter periods. The GAZ application will also make it possible to design a charging system that is more just, and at the same time provides incentives for reducing the external costs of freight transport. Additionally, users of the GAZ application will be able to document their environmental profile in competition with other transport service providers (Foss, 2011).

The main objective of GAZ is thus to introduce a more dynamic and accurate pricing regime than current low emission zones based on static criteria. By creating incentives for behavioral change in urban freight transport, this is assumed to be more effective in terms of emission reduction. The more common type of LEZ is without user charges and characterized by a command-and-control type of regulation. Certain vehicles are restricted from entering LEZ based on technical standards or on other considerations. If user charges are introduced, the fees for entering LEZ are typically differentiated so that more polluting vehicles have to pay more for access. Thus, the charges are consistent with the Polluter Pays Principle, and have an incentivizing aspect (ECORYS, 2014).

Adaptations in terms of more environmentally friendly behavior are preconditioned by stakeholders recognizing their own influence and latitude, and the ultimate success of GAZ depends on ways in which stakeholders accept and respond to incentives inherent in the GAZ regime. Bjerkan, Nordtømme, Kummeneje, Sund, and Tretvik (2012) have previously shown that the acceptability of GAZ is higher among stakeholders who perceive GAZ to be fair and effective, and who have a high awareness of the environmental problems caused by emissions. The present paper explores the potential behavioral responses of GAZ, and how acceptability and other motivational factors might influence the willingness to adapt.

1.3. Existing knowledge and research

1.3.1. Stakeholder target groups

City logistics is a business characterized by complex interactions between numerous stakeholders. A stakeholder is an actor or group of actors who affects or is affected by the phenomenon under study (see also Freeman, 1984). Among stakeholders traditionally identified in logistics are receivers, carriers and forwarders (Ogden, 1992). Recent research also emphasizes the involvement of policy makers, decision makers and local authorities (Lindholm, 2012; Russo & Comi, 2010; Stathopoulos, Valeri, Marcucci, Nuzzolo, & Comi, 2011). Urban freight transport planning can be improved by involving a wider range of stakeholders (Ballantyne, Lindholm, & Whiteing, 2013).

The scope of this study is limited to a simplified logistics chain from shipper via carrier to receiver. In the context of this paper the shipper is represented by wholesalers, the provider of transport services is represented by carriers, and the receiver is represented by retailers.

1.3.2. Stakeholder responses

Research on the behavioral responses to road pricing for freight transport is very limited. Among those who exist, two main types of studies can be distinguished, depending on whether they are based on stakeholders' assessments of likely adaptations in the event of a planned or hypothetical pricing scheme, or studies of real adaptations after the implementation of a pricing scheme. Research in the latter category is especially lacking. The behavioral responses of other stakeholder groups than carriers to freight pricing schemes are also by and largely neglected in existing research. This is understandable, as the carriers are the first to be targeted by pricing mechanisms. Nevertheless it is important to include the viewpoints of other parts of the logistics chain to anticipate the full impact of pricing schemes.

One of the main objectives with charging regimes is to induce a more balanced utilization of the infrastructure (Quak & van Duin, 2010). More specifically, they are generally aimed at encouraging changes in travel times, route choices, mode choices, types of vehicle utilized, or at reducing the amount of transport (Steg & Schuitema, 2007).

Loukopoulos, Jakobsson, Gärling, Schneider, and Fujii (2004) maintain that different behavioral adaptation strategies to pricing policies aimed at passenger transport are ordered according to a cost-minimization principle for the individual. Accordingly, people will first make behavioral adaptations which involve the least inconvenience (trip chaining, route changes etc.). When such adaptations are not sufficient or feasible, they may adapt in more costly and burdensome ways (e.g. changing travel mode and reducing transport). An ordering of adaptation options can be assumed to be present also in freight transport, as private carriers seek to minimize transportation costs and maximize sales (Taniguchi & Tamagawa, 2005). This is confirmed by Rössger et al. (2009) who studied behavioral effects of price differentiation measures for road freight based on interview surveys in several European countries. Their study showed that the stated likelihood of different behavioral responses in the event of pricing schemes was significantly smaller for short-term changes than for long-term changes.

Quak and van Duin (2010) studied Dutch hauliers' anticipated behavioral adaptations to a road pricing regime by the use of surveys. The majority answered that there would be no change in their behavior, as they would pass on the extra costs to their clients or absorb the costs in their own profit margins. The authors argue that this option is not a long term strategy, and that other choices will have to emerge in the long term.

Findings from European cities show that targeted environmental regulations for freight transportation in general are among the most efficient ways to reduce emissions (Dablanc, 2008). According to Russo and Comi (2011), the primary benefit of low emission zones is that they provide incentives to utilize more environmentally friendly vehicles. In the coming of the low emission zone implemented in London in 2008, Browne, Allen, and Anderson (2004) found that adapting the vehicle fleet to the demanded Euro standard was by far the most likely anticipated effect in the view of freight companies. Other options such as changing routes, entering the zone without paying and switching to smaller vehicles were considered much less likely. A later effect study of the London low emission zone also shows that the fleet turnover did increase substantially in the immediate aftermath of implementation before returning to national average in the subsequent years (Ellison, Greaves, & Hensher, 2010).

Holguin-Veras et al. (2012) and Holguín-Veras, Pérez, Cruz, and Pollimeni (2006) maintain that in many cases policies designed to encourage off-hour deliveries (i.e. outside regular business hours) only induce behavioral change if they target the receivers. This is due to two mechanisms: 1) a balance of power in most goods segments where the customers of transport services determine delivery times, and 2) the high competitiveness in the transportation market which deprives the carriers of the ability to send a price signal to those who can implement behavioral change. Thus, the carriers have in many cases no choice but to implement strategies that help them cope with the impacts of pricing without affecting their customers.

The studies presented above focus mainly on managerial level effects in the freight companies, such as fleet renewal, change of delivery times, change of routes and load optimization. In recent years, another form of adaptation has emerged on the driver level—eco-driving. Driving style constitutes the most influential factor on fuel efficiency, and eco-driving can reduce fuel consumption by 10%, and thereby reduce emissions by an equivalent percentage (Barkenbus, 2010; McKinnon, 2008). Increased