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Charging versus rewarding: A comparison of road-pricing and rewarding peak avoidance in the Netherlands

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ABSTRACT

The aim of this paper is to compare two congestion management schemes – road-pricing and peak avoidance rewarding – and their impact on commuter behaviour, based on two studies that were conducted in the Netherlands. The road-pricing study is based on stated preference data, whereas the study involving rewards was conducted in the context of a longitudinal field experiment. Given the substantial differences in data sources and analytical techniques applied beforehand, the comparison is made at an indicative level. It can be cautiously concluded that, as psychological theory predicts, rewarding is more effective in diverting commuters from peak periods. In both cases, the most popular alternative to peak-driving is off-peak driving. Most of the change in behaviour is attributed to introducing the new measure, whereas the impact of different price/reward levels is marginally decreasing in sensitivity and effectiveness. The short-term and long-term policy implications of these findings on the implementation of both measures are further discussed.

1. Introduction

Traffic intensity is increasing every year and existing roads can often not handle the increase in demand, resulting in traffic congestion (Bovy, 2001; Bovy and Salomon, 1999). This is a trend that can be seen in urbanised areas all over the world (European Commission, 2006a, 2006b). Time losses due to congestion have a negative economic effect. Moreover, congestion has an impact on road safety, emissions and noise (ECMT, 1999; Mayeres et al., 1996). The main problem is that too many drivers are under way at more or less the same time periods (e.g. the morning rush hour). In the past, peak demand was accommodated primarily by building new infrastructure and thus by increasing supply. However, it has also been recognised that building more roads alone causes an increase in demand, resulting in a cyclical process of additional capacity increases (Goodwin, 1996). An alternative approach is to try and modify the behaviour of travellers to a certain extent (i.e. the demand side). Spreading peak demand over a larger time interval could result in considerable time savings and may reduce the uncertainty and external costs of congestion. However, convincing travellers to change their daily schedules is far from easy. Experimental studies suggest, for instance, that providing more accurate pre-trip information results in changes in departure time (e.g. Mahmassani and Liu, 1999; Srinivasan and Mahamassani, 2003). However, incomplete information can also result in an increase in overall travel time and user costs, when too many people change their behaviour at the same time (Arnott et al., 1999; Ettema and Timmermans, 2006; Ben-Akiva et al., 1991).

Demand-based solutions, such as road-pricing, have also been suggested (Shiftan and Golani, 2005). Pricing policies have been considered and even implemented in different urban areas around the world, one of the main objectives being to reduce congestion (costs/effects) (see e.g. Ministry of Transport, Public Works and Water Management, 2006; European Commission, 2001; Tfl, 2003; Phang and Toh, 1997). Examples of attempts to implement road pricing include the electronic road-pricing scheme in Singapore, the congestion charge in London, the introduction of the German *Maut* system for lorries and the congestion charge in Stockholm (see also Ubbels and De Jong, 2009). Today, the introduction of some kind of road-pricing scheme is considered in many European countries, either on an urban scale or at a national level. In 2007, the Dutch government decided to implement a nationwide kilometre charge, starting with a charge for lorries in 2012, followed by a differentiated (i.e. by time, place or environmental costs) kilometre charging system for cars and trucks in 2018. Because the system was meant to be budget neutral, indicating that the road pricing system was not meant to generate additional revenues, the plan was to gradually

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phase out fixed car taxes. Moreover, by means of a differentiation of the road pricing measure, for instance with respect to time (i.e. higher peak charge), the government hoped to spread peak demand more evenly and thus reduce traffic congestion problems. Model computations indicated that such system would have an influence on traffic congestion. The reduction in the number of kilometres driven would amount to 15% and vehicle loss hours would decrease by approximately 40% (Van Mourik et al., 2005). However, in 2010, a new government was installed, which mothballed the initiative for a nationwide kilometre-charge because of a combination of high implementation costs, relatively low public acceptance and an apparent naive belief in their ability to solve the problems just by building new roads.

In the context of commuters' behavior, which has been to the most part analysed using microeconomic theories (McFadden, 2007), it is not surprising that the behavioural rationale of many demand based strategies to manage traffic congestion is based on negative incentives that associate driving with punishments such as fines, tolls or increased parking costs (Rothengatter, 1992; Schuitema, 2003). Conversely, people may respond differently when they are rewarded rather than punished (Kahneman and Tversky, 1984; Geller, 1989).[1] Both rewards and punishments constitute types of incentives that influence human motivation. Maximising pleasure and minimising pain is a very basic rule in human and animal behaviour. Although there is no agreement in the behavioural literature which measure is more effective in motivating change of behaviour, psychologists tend to prefer positive rewarding measures over negative punishment ones. A considerable volume of empirical psychological evidence (e.g. Kreps, 1997; Berridge, 2001) supports the effectiveness of rewards to reinforce desirable behaviour. Thus, the potential of rewards as a base for congestion management policy is well worth considering, provided it is based on robust behavioural foundations. In the Netherlands, the notion of using rewards to change people's driving behaviour has been recently implemented in the context of the "Spitsmijden" (translated freely as peak avoidance) programme (Ettema and Verhoef, 2006; Ettema et al., 2010; Ben-Elia and Ettema, 2011a), thus far the largest systematic effort to analyse the potential of rewards as a policy instrument in this regard.

In this paper, we compare road-pricing and reward systems with respect to their impact on commuter behaviour, on the basis of two different and independent empirical data sets. As far as road-pricing is concerned, we use a stated preference study (SP) among car commuters that was carried out in 2004 (Tillema, 2007). With respect to rewards, we use the data collected in 2006 from a revealed preference pilot experiment called Spitsmijden, which investigated the potential impact of rewards on people's behaviour during the morning rush hour (Ben-Elia and Ettema, 2011b). More specifically, we focus on the effectiveness of these two measures during peak periods, look at the influence of the pricing measures on the alternatives that are chosen and examine to what extent changes are influenced by the price/reward level, with the aim of providing an initial insight into the impact of 'punishing' and 'rewarding' systems on commuter behaviour and to help improve the applicability of congestion management schemes, both in the Netherlands and abroad.

2. Literature review

Pricing policy is a popular research topic, especially in the field of economics. This is mainly due to the typical economic aspects, found in pricing theory, such as the pricing of a scarcity (in this case infrastructure). Since nearly all forms of transport are associated with externalities like congestion and emissions, there has been a great deal of interest in various ways of pricing and internalising these externalities. Among economists, a widely accepted benchmark solution in the regulation of road transport externalities is first-best pricing (i.e. Pigouvian marginal external cost pricing; Pigou, 1920). As outlined in the 1920s (Knight, 1924; Pigou, 1920), a toll that reflects the true marginal cost of travel is implemented on the congested facilities, resulting in a reduction in the number of travellers at peak periods, which improves traffic flows (Nijkamp and Shefer, 1998; Rouwendal and Verhoef, 2006; Small and Verhoef, 2007). From an economic point of view, first-best pricing can be seen as the most efficient/optimal type of pricing policy, whereby all road users at all times pay exactly what they 'cost' society as a whole. Examples of such external costs are emission costs and congestion costs. With first-best pricing, it is assumed (1) that optimal charging mechanisms are available, allowing regulators to set perfectly differentiated taxes for all road users and on all links of the network; (2) that first-best conditions prevail throughout the economic environment to which the transport system under consideration belongs and (3) that all road users as well as the regulator have perfect information on traffic conditions and tolls at their disposal (see also Verhoef, 1996; Ubbels, 2002). Apart from the fact that these assumptions create almost unsolvable difficulties in terms of technical implementation,[2] they also generate considerable resistance on the part of the actors involved. It is commonly acknowledged that the above-mentioned assumptions will hardly, if ever, be met in a real-life situation given the cognitive limitations, judgmental biases and bounded rationality that pertain to the common traveller (Simon, 1982; Tversky and Kahneman, 1974). That is why second-best pricing issues, based on less utopian assumptions, have received ample attention in the literature (Verhoef, 2002; Ubbels, 2006).

Second-best schemes have been suggested to circumvent the difficulties in implementing first-best solutions (Small and Verhoef, 2007). Policy-makers have different policy levers when it comes to constructing second-best transport pricing measures. Pricing measures can vary on the basis of the price level, the level of differentiation, the coverage of the measure, the revenue use and other supplementary policies (Verhoef et al., 2008). Differentiation of the measure can, for example, be based on time, place and/or type of vehicle. With respect to coverage, Verhoef et al. (2004) distinguish the following levels (with regard to implementation): single lanes, single roads and different geographical levels (local, regional, national or international). Furthermore, different categories for revenue use can be distinguished. Revenues can, for example, be used to lower certain taxes, to fund new (or maintain old) infrastructure, to manage/control road infrastructure or to finance particular (traffic) policies (ibid). Due to the different design options, numerous pricing alternatives can be designed in theory.

There is a considerable amount of empirical evidence regarding the effectiveness of implemented road pricing and toll schemes around the world (see, e.g., Verhoef et al., 2008; Tillema, 2007; Ubbels, 2002; TfL, 2003; May et al., 2010). Ubbels and De Jong (2009) examine the effectiveness of road pricing by reviewing studies involving fourteen road pricing cases worldwide. They define road pricing as "…policy regimes where drivers have to pay for their actual use of the roads" (Ubbels and De Jong, 2009, p. 1). Moreover, they focus on congestion pricing, excluding

[1] The interested reader can find more (general) information about how motivation works and the role of pleasure and pain in Higgins (2012).

[2] Technical implementation problems are the fact that tolls have to be able to vary constantly in a perfect way such that the external costs can be accounted for in a perfect way. Therefore, tolls have to vary constantly on the basis of traffic intensity, but also on the basis of, for example, the amount of pollution caused by individual vehicles.