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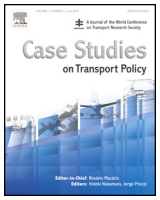

Impacts of road user charges on individual welfare—A pre-inauguration exploration for Germany

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ABSTRACT

This paper analyzes different road pricing schemes concerning their equity and social acceptability for Germany. Two pricing scenarios (time- vs. distance-based) and two compensation measures are assessed. The analysis is based on individual mobility diaries. In contrast to other studies, households are grouped by their equivalized disposable income levels as proxy for the household's social status and as recommended by the Organization for Economic Co-operation and Development (OECD). It is found that the distributional impact varies significantly depending on the implemented pricing scheme and the compensation measures. Assuming unchanged behavior patterns, the present study shows the potential benefits of implementing mileage-based user charges combined with compensation measures on social equity.

1. Introduction

Road pricing as a mechanism for infrastructure financing, for the internalization of external costs as well as for congestion reduction has come into public focus for the last decades. The motivation for the introduction of road pricing has changed over time. In the late 1990s, the main question was to achieve efficient capacity utilization by introducing first best pricing based on short term social marginal costs. These days, the connection between public budget and infrastructure expenses and the precarious public household situation as well as the current debt crisis of many OECD countries with still public and free of charge road infrastructures has further brought road pricing into discussion as additional revenue source. In the general case, pricing schemes aiming at achieving cost recovery are second best solutions. When designing and appraising such second best pricing schemes, a multi-dimensional goal system including efficiency and equity effects aspects could be applied.

Discussions on road user charges are always very controversial and a fundamental disagreement about their potential regressive or progressive impacts is still observed: Proponents argue for higher quality infrastructures, reduced travel times as well as the implementation of the cost-by-cause principle. Opponents point out social exclusion, rip-off of automobilists and restrictions in the freedom of mobility. The present paper develops a general approach to measure the distributional impact of road pricing schemes on households. In addition to other studies, which are based on a classification of households by income, this paper also considers the detailed composition of the households when calculating the effects of road pricing and compensation schemes on individual welfare.

The methodology is applied to the case of Germany where several road pricing schemes especially for the motorways (Autobahn) are currently discussed. Real data of a German household and mobility survey are used and can serve as guideline also for other countries.

The paper is organized as follows: after these introductory remarks, Section 2 gives a brief review of literature on road pricing issues. The third section describes the methodology and data sources utilized for the analysis of welfare impacts on German households. Section 4 presents the results of the analysis and discusses them with respect to previous studies. Final conclusions and recommendations for further work are given in the last section.

2. Literature review

The economic foundation of road pricing dates back to Pigou (1920) and Knight (1924): free access to public roads leads to a misallocation of resources because of external effects where drivers do not have to pay for the additional costs he imposes on others (Rouwendal and Verhoef, 2006). Following the ground-breaking works of Pigou and Knight, numerous publications on road pricing issues emerged in literature. Among the many topics which are treated by researchers and practitioners are the relation between

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investments in infrastructure and optimal tolling (see Mohring and Harwitz, 1962; Keeler and Small, 1977). Surveys of the literature can for example be found in Small (1992) and Verhoef et al. (1997). Only very few publications analyze distributional impacts of road pricing on households. Especially social research questions on equity and fairness of road pricing initiatives are seldom discussed in scientific publications. Hence, the question whether road pricing schemes have a regressive or progressive impact on households welfare is still not sufficiently answered. Small (1983) analyzes the welfare effects of urban road pricing on income groups using an equilibrium model of modal choice. He argues that road pricing has regressive effects because, although higher income groups are charged more, they have a higher value of time and hence benefit more than lower income groups. However, if there is a redistribution of toll revenues, there are benefits for all income groups. Anderson and Mohring (1996), studying the effects of congestion pricing in Minneapolis and Saint Paul, and Fridström et al. (2000), analyzing the introduction of marginal cost transport pricing in Edinburgh, Helsinki and Oslo, come to the same conclusion.

Further studies analyzed the effects of implementing road user charges on selected user groups who are particularly affected. A study on the welfare effects and distributional impacts on commuters in Dresden, Germany, was carried out by Teubel (2000). The results of the different scenarios show that congestion pricing without revenue distribution affects the poor more than the rich, but differences are rather small. Bonsall and Kelly (2005) tested the effects of six different cordon pricing schemes on selected groups in the city of Leeds using a transport demand model and synthetic populations as a basis for modeling (Popgen-T methodology). They conclude that the groups who are most affected by charges are in most cases the low income, car-captive groups. Santos and Rojey (2004) tested cordon schemes in three cities in the United Kingdom, Cambridge, Northhampton and Bedford. They examine that road pricing can be both regressive and progressive depending on the transport structure of the city, where people live and work, which travel mode they use and to what extent compensation measures are used. This hypothesis is also supported by Eliasson and Mattsson (2006) who analyze equity effects of congestion pricing in the city of Stockholm, using a sample enumeration model.

Compared to urban road pricing, literature on road pricing schemes for national networks, such as the federal trunk road networks, is very limited. Steininger et al. (2005) published a report in which they analyze, inter alia, the distributional effects across income groups of five different kilometer-based road pricing scenarios in Austria. The analysis is based on a passenger transport demand model. The macroeconomic impacts and individual effects on different household groups are analyzed with the Austrian Spatial Passenger and Income Transport (ASPIT) model, a computable general equilibrium model (CGE). Steininger et al. (2005) show that road pricing in general is progressive, since households in higher income groups are more affected by the charges than poorer households. This is because they have a higher car mileage and rarely show themselves willing to use public transportation. However, Steininger et al. (2005) also state that road pricing based on the cost-by-cause principle is more equitable than a tax-based financing system.

Graham et al. (2009) analyzed the impacts of the national road pricing implementation in the UK. They could identify neither a positive nor a negative correlation between the level of charges and the level of income, but they found out a strong positive relationship between the level of urbanization and the level of charges.

For Germany, very few studies exist on the distributional effects of car user road pricing schemes across different income groups. Some of the few studies, as Rothengatter and Krail (2009), Kalinowska and Steininger (2009a,b) and Kalinowska (2010), conclude that, when a distance-based road pricing scheme in combination with revenue redistribution (i.e. tax reductions) is implemented, households are on average not made worse off than before. Households in lower income groups are less negatively affected because of their lower annual mileages and they will benefit from compensation measures most. Baum et al. (2010) come to the opposite conclusion. Baum et al. (2010) analyzed the impacts of a kilometer-based road pricing scenario on different income groups. In this scenario, the entire road network is charged and a complete abolition of the motor vehicle tax to unburden households is assumed. The results show that road pricing has regressive impacts that cannot be compensated by tax reductions. The top income groups are less affected than the lower ones. The middles income groups with a higher number of household members experience the highest negative welfare effects which rise with increasing household size. Hence, Baum et al. (2010) assume that families are more affected than other groups because they are in general more mobile.

The ongoing discussion on the financial impacts of road pricing schemes on households (including social exclusion) and the often very simplified assumptions for household category determination in such studies is the first motivation for the present analysis. The second motivation is the still shrinking budget for maintenance and replacement of the aging road infrastructure that alternative ways of funding are required for future. Furthermore, shrinking fuel tax and motor vehicle tax revenues due to the trend to low-emission cars with low fuel consumption query sustainable road infrastructure financing based on taxes in the future. Finally, the unfairness that taxes burden tax payers whereas foreigners use the road network free of charge can be avoided by the cost-by-cause principle. The following sections introduce the present assessment methodology as well as possible road pricing schemes and discuss differences to the mentioned literature.

3. Assessment

The present paper analyzes the financial burden of German households caused by a road user charge compared to the present situation without a user charge. A simple individual welfare measure that takes account of the price increase, compensation measures and users' reactions is applied.

3.1. Methodology

3.1.1. Calculation of welfare changes

Every political decision on the implementation of economic policy measures should be based on the question in what way a planned scheme affects the welfare of society. Social welfare is closely tied to the well-being of each individual member of society. This is the principle of Pareto efficiency (Alisch et al., 2005). In reality, Pareto efficiency is difficult to apply as there will be always winners and losers as a result of any political decision. To decide whether a project should be implemented or not, interpersonal comparisons are necessary. So individual welfare measures, such as the consumer surplus (CS) or the compensating variation (CV), are used to measure how much a consumer is affected by a price change (see Ahlheim and Rose, 1989). The concept of consumer surplus dates back to Dupuit and Marshall (Ahlheim and Rose, 1989; Just et al., 2005). They assume that the utility of a consumer is cardinally measurable. CS is the difference between the total amount consumers are willing and able to pay for a good and the actual amount that they do pay. It is the area under the demand curve and above the market price as shown in Fig. 1 (Ahlheim and Rose, 1989):

$$CS = \int_0^{x_2^*} p(x_l)dx_l - p_1^a x_1^a. \quad (1)$$