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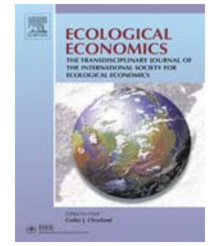

ANALYSIS

Sustainability impacts of car road pricing: A computable general equilibrium analysis for Austria

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ABSTRACT

Nationwide car road pricing schemes are discussed across Europe. We analyse the impacts of such schemes with respect to environmental, economic and social indicators of sustainability, also quantifying the trade-offs among these three dimensions under different charging principles and revenue recycling options. In our analysis we employ a computable general equilibrium (CGE) approach, develop a modelling structure for private transport and provide detailed empirical analysis for the case of Austria. Regarding the social dimension, it has often been argued that poorer households (and commuters) would have to bear a disproportionate share of the road pricing burden. We find the contrary, i.e. a stronger negative policy impact on richer households, and on a small group of intensive car users. The choice of revenue recycling is able to ameliorate the negative social and economic effects of road pricing, without reversing the desired positive environmental effects. For political feasibility, questions of distributional impacts are most urgent and therefore we address them systematically within a quantitative framework.

1. Introduction

Environmental challenges in transportation occurred repeatedly in history, an early example in modern times being the concern in the 1870s in London that, with a further growing population, the horse manure (an earlier form of transport-derived pollutant) would overwhelm the city.[1] For the current transport system, environmental concerns have become increasingly important since the 1970s. Transport is now responsible for at least a quarter of world primary energy use and for a comparable share of CO_2 emissions (Berechman, 2002).

While initial responses to the environmental challenge in transport were primarily technological, there has since been a focus also on reducing and re-structuring transport demand (Berechman, 2002) and on using transport pricing policies (Hensher and Button, 2000; Viegas, 2003). However, most of present transport policies still mainly centre on vehicle emission and safety standards, annual license duties and parking fees and thus may be classified as out-dated or, in the economist's jargon, "second-best" (see, e.g., Calthrop and Proost, 1998; Nash et al., 2001; Ubbels et al., 2002).

Road pricing, a vehicle user charge based on distance travelled, is clearly highly suitable in addressing transport-

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[1] The impact on daily life is captured in an example quoted by Weightman and Humphries (1985: 36): "But with all the horse traffic, there was an awful amount of dirt on the streets, some of them were in a dreadful state. There were crossing sweepers, rather oldish men, and if one gave them a coin they would be very pleased to sweep a path across the street in front of one."

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related environmental problems since it allows differentiation of charges across location, time, vehicle type etc. (see, e.g., Johansson and Mattsson, 1995; Button and Verhoef, 1998; Sterner, 2002; Santos, 2004). It combines the ability to untie congestion, to reduce air pollution, and to raise revenues for new infrastructure and other investment (Jakobssen et al., 2000; May et al., 2002; Parry and Bento, 2002).

For trucks, kilometre based road pricing systems have been introduced in Europe at various levels of sophistication, i.e. from section-charging on highways in various countries, and electronic charging on highways in Austria (2004) and Germany (2005), up to charging for use of the full road network in Switzerland (2001). In Sweden, a mileage tax for diesel trucks was in place from 1988 up to 2004.[2] For private cars, charging in Europe has been introduced either section-wise for highways or for urban areas mainly in the form of toll rings, e.g. in Scandinavian countries and more recently in London (and similar as in other parts of the world, such as in Singapore). The discussion of nationwide kilometre based charging also for private cars has slowly taken off in various European countries (see e.g. Nash et al., 2001; Ubbels et al., 2002).

The introduction of extensive, nationwide road pricing also for passenger transport requires careful impact analysis. In terms of sustainability impact assessment, the European Union (EU), for example, asks for "careful assessment of the full effects of a policy proposal [that] must include estimates of economic, environmental and social impacts" (EC, 2001). As set out in Böhringer and Löschel (2006) in some detail, the quantification of trade-offs in such an impact assessment analysis calls for the use of numerical techniques and that one of these approaches, CGE modelling, "can incorporate several key sustainability (meta-)indicators in a single micro-consistent framework, thereby allowing for a systematic quantitative trade-off analysis between environmental quality, economic performance and income distribution." (Böhringer and Löschel, 2006: 50-51). As passenger car road pricing remains a field of national policy responsibility, also within the EU,[3] we develop a CGE model for a sustainability impact assessment at the national level of such policy.

Within the different dimensions of sustainability, the economic one has been most broadly discussed for road pricing. The initial focus was the optimal pricing in the transport sector to combat congestion (e.g. Lindsey and Verhoef, 2001). Increasingly the environmental impacts of transport have been taken up in co-determining the optimal price (e.g. Mayeres et al., 1996).[4] In our view least effort has been devoted to the social dimension. However, social questions of distribution and equity are of major importance for the acceptance of road pricing (see also Mayeres and Proost, 2001). The low public acceptance for car road pricing derives from the perception of road pricing as intrinsically unjust (Oberholzer-Gee and Weck-Hannemann, 2002) and as infringing on personal freedom (Jakobssen et al., 2000). Since income constraints can be identified as the key determinant for transport demand reductions when travel costs increase (Jakobsson et al., 2000), the burden of road pricing is likely to fall on poor households (see also West, 2004) and on households living in peripheral regions (Hammar and Jagers, in press).

This article therefore aims to not only quantify economic and environmental impacts of road pricing, but to investigate the effects on those groups perceived as bearing the main burden of road pricing. A passenger transport focused computable general equilibrium (CGE) model is developed for this purpose. To better understand the distributional effects of road pricing, we distinguish four classes of income in our model. Thus, the present model goes beyond existing ones in several respects. First, and in some way parallel to earlier transport policy discussion, most of the models used so far to analyse road pricing are either limited to freight transport (e.g. Steininger, 2003; De Jong et al., 2004) or they target urban road pricing or toll ring pricing only (e.g. Mayeres et al., 1996; Proost and van Dender, 2001). We focus on nationwide car road pricing. Second, while an increasing number of papers addresses the welfare effects of a tax suitable for internalising external transport costs (e.g. Jansen and Denis, 1999; Nash et al., 2001), distributional aspects have hardly been considered in economic transport policy models. Third, in methodological terms, our approach unites modules from the sciences of transportation and economics to a consistent integrated assessment of economic, environmental and distributional impacts. The core ingredient in this merging is the calibration method of the economic passenger transport focused CGE model, integrating results of the pure heuristic passenger mode choice model.

The paper proceeds in four steps as follows. In Section 2, the passenger transport focused CGE model is developed. In Section 3, transport and consumption databases are merged, a social accounting matrix is constructed which differentiates sufficiently between the various cost components of private car transport, and transport elasticities of substitution are calibrated for this model. Section 4 reports on the simulation results of nationwide car road pricing in various implementation schemes. Section 5 discusses the distributional, economic, and environmental impacts of this policy. A final section summarises the main conclusions and outlines key factors for increasing acceptability prior to the introduction of a car road pricing system.

2. Transport demand CGE model

In order to analyse the economic, environmental and distributional impacts of car road pricing, we develop a CGE model which is a standard small open economy CGE model in many respects, but obviously with more detailed passenger transport modelling.

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[2] The Swedish mileage tax for diesel trucks was introduced to counterbalance low diesel relative to gasoline taxes, with the former reflecting the practically identical composition of diesel and (also low-taxed) fuel oil. When Sweden joined the EU, this mileage tax was replaced by a diesel tax (Sterner, 2002).

[3] See EC (2006), Article 1, 1.e.

[4] E.g., for trucks EC (2006) asks for road pricing on the basis of external costs. Article 11 states, that "[...] the Commission shall present, after examining all options including environment, noise, congestion and health related costs, a generally applicable, transparent, and comprehensible model for the assessment of all external costs to serve as the basis for future calculations of infrastructure charges, and this model will be accompanied by an impact analysis on the internalisation of external costs for all modes of transport [...]".