Model-based assessment of financial policies in passenger road transport

Reinhard Hössinger and Christoph Link
Institute for Transport Studies, BOKU Vienna, Austria

Keywords:
Travel demand modelling, Transport economics, Transport policy analysis, Discrete choice modelling

1 Introduction

GHG emissions of road transport are a stubborn challenge for climate change mitigation. In 2011, 26% of total GHG emissions in Austria stem from road transport, 56 % of which originate from passenger road transport (Environment Agency Austria, 2013). Other climate relevant areas have elaborated promising mitigation strategies, but GHG emissions in road transport still increase (55% since 1990). Reversing this trend would require a substantial change of mobility behaviour – either in mode shares, spatial trip patterns, or vehicle purchase and vehicle fleet composition. The charming about the latter option is that it allows people maintaining their mobility behaviour while reducing local and global emission and saving money and finite resources at the same time (Austrian Federal Government, 2009; Steinkemper, 2010; Hacker et al., 2011; Brady and O'Mahony, 2011). Regulatory policies such as speed limits, emission standards, and financial policies could stimulate these shifts (Pischinger et al., 1997; Steininger et al., 2007; Eriksson et al., 2008). Financial policies are supposed to be the most promising alternative. They can be distinguished by the aspect they refer to: a consumption-based registration tax focuses on car purchase, road pricing addresses driving distances, and fuel tax refers to current consumption (Rogan et al., 2011; Beuermann and Santarius, 2006; Timilsina and Dulal, 2008; Ryan et al., 2009). All of them impact mobility behaviour, but have also further direct and indirect effects – some of which are unwanted. Areas of concern are economic growth, labour costs, employment, and disposable income – but the impacts to be expected are subject of an ongoing discussion.

2 Objectives

Our contribution provides new answers on the effects of financial policies addressing climate change mitigation in passenger road transport. We analysed and comparatively assessed a broad set of financial policies in order to identify promising approaches of limiting GHG emissions from road transport while keeping economic and societal costs as small as possible.

3 Methodology

This task requires a comprehensive modelling approach at both the individual and the aggregate societal level. The individual level includes trip-related decisions on modes and destinations as well as car ownership and vehicle purchase. The societal level must account for developments in vehicle technology and passenger car supply. In order to meet this challenge, we adapted and combined three existing models (2, 3, 4) with a newly developed model (1). The methodological kernel consists of the following models and their linkage to each other in an integrated approach:

(1) Car market supply-side model: predicts the development of technical and financial car features such as engine power, range, and purchase price for different types of cars.
(2) Car market demand-side model: estimates the probability of selecting a car out of a set of alternatives. It is based on a stated preference survey on car purchase (Link et al., 2012).
(3) Car ownership model: predicts the probability that a given car is sold, kept, or replaced by a new car. The model is based on a stated-preference survey facing different aspects of mobility behaviour (Link, et al., 2012).
(4) Travel demand and mode choice model: estimates the probability that a given trip is made by a specific mode or is omitted. The model is based on the same survey as the car ownership model.

All models except the car market supply-side model are disaggregated choice models derived from representative samples of Austrian households. The models were linked to each other in hierarchical manner (see figure 1) and in time series manner on a monthly base. The input factors are provided by specific scenarios and by upstream models; they run through a cascade of models, that way generating output factors, some of which serve as input in the next time interval.

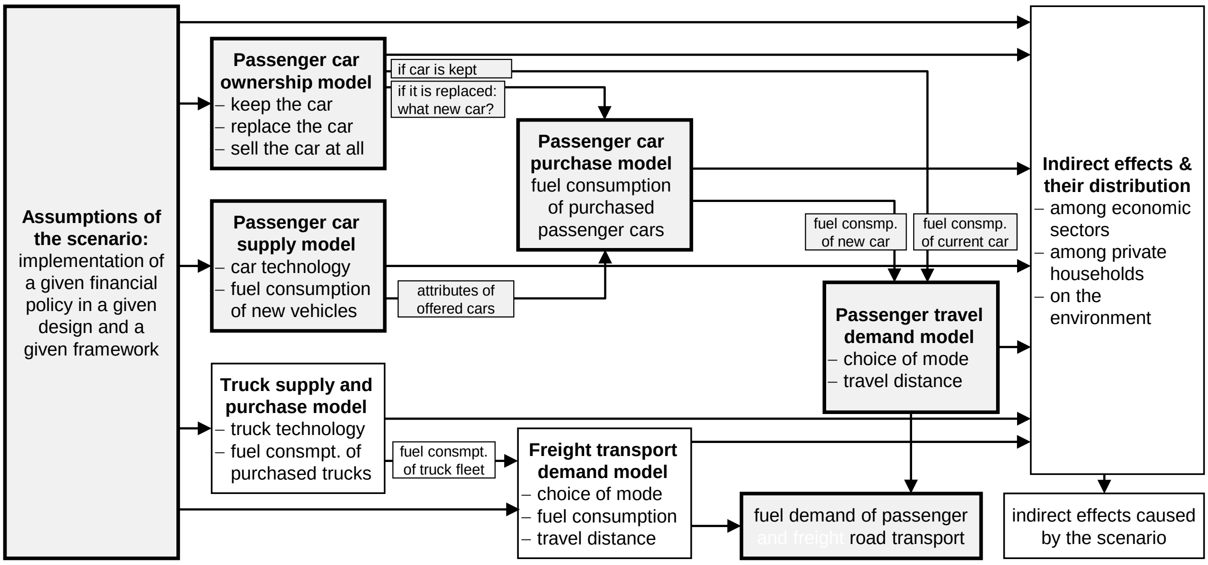

Figure 1: Integrated model for the assessment of direct and indirect effects of financial policies in passenger and freight road transport (only grey boxes are addressed in this article; white boxes are addressed in research, but not in the article)

4 Results

The scenarios were developed in collaboration with relevant stakeholders. Each scenario is a combination of a specific financial policy (fuel consumption tax, car purchase tax, or road pricing) at a specific intensity, a spatial scope (Austria or total EU), a forecast period (2015–2026), and a specific use of revenues (budget consolidation, investments in transport sector, or compensation payment for households). Table 1 shows the estimated effects of an increase of the fuel consumption tax by one Euro per litre (or a revenue neutral increase of the other taxes) after an exposure time of 10 years. The fuel consumption tax would be most effective in terms of climate change mitigation. Our model predicts a 4% drop of travel demand and a 19% drop of fuel demand compared to the business as usual scenario. The car purchase tax has a similar effect on car purchase decisions, but it would not increase the marginal cost of travel, so that the effect on travel demand is missing. The road pricing, on the contrary, is most effective in reducing travel demand, but it provides no incentive for the purchase of more fuel efficient vehicles.

Table 1: Estimated travel demand and fuel demand in 2025 in % of the estimated level in 2015 without and with the assumed implementation of different financial policies.

	Business as usual	Fuel consumption tax	Consumption-based car purchase tax	Distance-based road pricing
Travel demand	116	111	116	103
Fuel demand	72	58	63	66

5 Contribution to the field

Studies on the effects of financial policies on mobility behaviour are often based on average elasticity estimates derived from revealed preference studies. They are limited to the small range of fuel price variation experienced in the past. These small changes are not sufficient to meet climate change mitigation objectives. Our approach is based on stated preference experiments. It allows forecasts covering a wide range of tax or fee variation. We are thus able to estimate the effects of much more rigorous financial policies, which could effectively limit GHG emissions from road transport. Moreover, we do not rely on average price elasticities, but are able to model the responses to the scenarios at the individual level. This disaggregated approach provides an in-depth view on the social and regional distribution of many different effects such as ecological effects and changes in labour market or social welfare.

References

Austrian Federal Government, 2009. Nationaler Entwicklungsplan Elektromobilität (*National Development Plan for Electric Mobility*). Austrian Federal Government, Vienna.

Beuermann, C. and Santarius, T., 2006. Ecological tax reform in Germany: handling two hot potatoes at the same time. Energy Policy 34, p. 917–929.

Brady, J. and O'Mahony, M., 2011. Travel to work in Dublin. The potential impacts of electric vehicles on climate change and urban air quality. Transportation Research Part D: Transport and Environment, March Volume 16, Issue 2, p. 188–193.

Environment Agency Austria, 2013. Klimaschutzbericht 2013 (*Climate Protection Report 2013*). Environment Agency Austria, Vienna.

Eriksson, L., Garvill, J. and Nordlund, A., 2008. Acceptability of single and combined transport policy measures: The importance of environmental and policy specific beliefs. Transportation Research Part A 42, p. 1117–1128.

Hacker, F. et al., 2011. Marktpotenziale und CO2-Bilanz von Elektromobilität (*Market potential and CO2 balance of electric mobility*). Öko-Institut, Frankfurt.

Link, C., Raich, U., Sammer, G. and Stark, J., 2012. Modeling Demand for Electric Cars - A Methodical Approach. Social and Behavioral Sciences, Volume 48, pp. 1958-1970.

Link, C., Stark, J., Sonntag, A. and Hössinger, R., 2012. Contribution of an Emission Trading Scheme to Reduce Road Traffic Induced CO2 Emissions in Austria. Social and Behavioral Sciences, Volume 48, pp. 1971-1982.

Pischinger, R. et al., 1997. Volkswirtschaftliche Kosten-Wirksamkeitsanalyse von Maßnahmen zur Reduktion der CO2-Emissionen des Verkehrs in Österreich (*Cost-effectiveness Analysis of Measures to reduce CO2 Emissions from Transport in Austria*). Heft 72, Mitteilungen des Instituts für Verbrennungskraftmaschinen und Thermodynamik, TU Graz.

Rogan, F. et al., 2011. Impacts of an emission based private car taxation policy – First year ex-post analysis. Transportation Research Part A 45, p. 583–597.

Ryan, L., Ferreira, S. and Convery, F., 2009. The impact of fiscal and other measures on new passenger car sales and CO2 emissions intensity: Evidence from Europe. Energy Economics, p. 365–374.

Steininger, K. B. S. et al., 2007. Klimaschutz, Infrastruktur und Verkehr (*Climate Protection, Infrastructure and Transport*). Scientific report no. 15-2007. Wegener Center Verlag, Graz, Austria.

Steinkemper, H., 2010. Wettlauf um die zweite Erfindung des Automobils (*Race to the second Invention of the Automobile*). Internationales Verkehrswesen 63 , pp. 17-19.

Timilsina, G. and Dulal, H., 2008. Fiscal Policy Instruments for Reducing Congestion and Atmospheric Emissions in the Transport Sector: A Review. Policy Research Working Paper 4652.