Authors	Ismir Mulalic, Stefan Mabit
Title	Car ownership and use taxes as pollution correcting instruments
Track	General Papers
Director	Mark Wardman

Abstract

Ismir Mulalic
Department of Transport,
Technical University of Denmark,
Bygningstorvet 116, Building 116 Vest, 2800 Kgs. Lyngby

Stefan Lindhard Mabit
Department of Transport,
Technical University of Denmark,
Bygningstorvet 116, Building 116 Vest, 2800 Kgs. Lyngby

Keywords: car ownership, car usage, two-part tariff, fuel consumption.

Extended Abstract
The use of cars offers great mobility to individuals and freedom in the choice of residence and place of work. However, the increasing amount of car traffic entails a number of externalities, including carbon dioxide (CO_2) emissions. This problem involves a significant economic burden for society. Driving a car is the most polluting act an average citizen commits. Emissions from passenger vehicles are increasing despite the fact that technological developments have led to a reduction in energy consumption per km. The main factor behind this is the increasing use of cars.
The consumption of fossil fuels of personal vehicles is made up of at least three components: (1) size of car fleet; (2) total Vehicle Kilometres Travelled (VKT); and (3) consumption of fossil fuels per km. It is important to analyse interactions among these three components with the purpose of evaluating the impact of changes in car taxation on car traffic related CO2 emissions. There have been many attempts to alter the taxation of cars to obtain more energy-efficient car transport. To study the effect of such policies it is necessary to model the interaction between car ownership and car use. A general framework for the modelling of ownership and use of durable goods was presented in Dubin and McFadden (1984). They developed a framework based on the link between demand for the durable and use of the durable as described by Roy's identity and show that, in reaction to increasing fuel prices, consumers switch to more fuel efficient varieties and decrease the use made of the durable to some extent. This type of framework allows for a theoretically based evaluation of car taxation policies and studies of rebound effects both of which are important elements to understand on the road toward a society with less pollution from the use of cars.
The taxation of car often involves nonlinear two-part tariff, see e.g. Kunert and Kuhfeld (2007). A two-part tariff structure is quite common in situations where ownership and consumption can be separately taxed, as for cars. In Denmark car owners pay an annual vehicle tax as well as a user tax, mainly in the form of a fuel tax. In this paper we study effects of change in two-part tariffs on vehicle related CO_2 emissions and energy consumption in a joint model of car ownership and car usage. Our model consists of a discrete choice model that captures the composition of the household vehicle holdings combined with a

model for demand for kilometres driven in the vehicle(s). Various approaches have been presented in the literature on car ownership and use, see e.g. Mannering and Winston (1985), De Jong (1990), Hensher et al. (1992), and Gillingham (2011). The model in this paper builds upon de Borger (2000) that showed how to analyze two-part tariffs using a discrete choice framework and West (2004) that developed an econometric model for car ownership and usage.

We use a large sample of detailed Danish data to estimate the joint demand for vehicles and kilometres. Our results show that it is important to control for the endogeneity of the car use model conditional on the vehicle holdings model. The bias term introduced by Dubin and McFadden (1984) to control for the endogeneity is significant. This inclusion of the bias term shows that OLS estimation leads to a significantly biased estimate of the effect of operating costs per km.

The last significant reform in Denmark was completed in 2007. The reform was similar to what has been done in many other European countries within the last decade, see e.g. Rogan et al. (2011) and Zimmermannova (2012). The main objective was to improve fuel efficiency and consequently to reduce emissions related to car transport. We apply our estimated model to analyse the effects of such a reform.

REFERENCES

Dubin, J. and D. McFadden. 1984. An Econometric Analysis of Residential Electric Appliance Holdings and Consumption. *Econometrica*, 52(2), pp. 345–362.

Gillingham, K. 2011. How do consumers respond to gasoline price shocks? Heterogeneity in vehicle choice and driving behaviour. Working paper; www.yale.edu/gillingham/research.htm (accessed 8-1-2014).

Hensher, D.A., N. C. Smith, F.W. Milthorpe and P. Barnad. 1992. Dimensions of automobile demand: a longitudinal study of automobile ownership and use. North-Holland, Amsterdam.

de Borger, B. 2000, Optimal two-part tariffs in a model of discrete choice. *Journal of Public Economics*, 76, pp. 127-150.

de Jong, G. C. 1990. An indirect utility model of car ownership and car use. *European Economic Review*, 34(5), pp. 971–985.

Kunert, U. and H. Kuhfeld. 2007. The diverse structures of passenger car taxation in Europe and the EU commissions proposal for reform. *Transport Policy*, 14, pp. 306-316.

Mannering, F. and C. Winston. 1985. A Dynamic Empirical Analysis of Household Vehicle Ownership and Utilization. *RAND Journal of Economics*, 16(2), pp. 215–236.

Rogan, F., E. Dennehy, H. Daly, M. Howley and B.P. Ó Gallachóir. 2011. Impacts of an emission based private taxation policy – First year ex-post analysis. *Transportation Research A* 45, pp. 583-597.

West, S.E. 2004. Distributional effects of alternative vehicle pollution control policies. *Journal of Public Economics,* 88, pp. 735-757.

Zimmermannova, J. 2012. Ex-post analysis of impacts of the car registration fee in the Czech Republic. *Transportation Research A,* 46, pp. 1458-64.