Price premium for energy efficient cars: A hedonic price approach

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Overview

The CO_2 emissions and the air pollution in terms of PM10 emissions due to the combustion of gasoline and diesel in the transport sector are an example of negative external costs. In fact, CO_2 emissions are one of the main causes of climate change (IPCC, 2007) while PM10 emissions are causing severe health problems. In Switzerland, the yearly external costs caused by air pollution are estimated to be more than five billion Swiss francs. A large proportion of the overall CO_2 and PM10 emissions in Switzerland arise from road traffic, especially passenger cars. In order to promote a sustainable development and to reduce the external costs from private road transport, the state can introduce an ecological tax, fuel efficiency standard, fuel efficiency label or a combination of these measures. The Swiss government, in order to reduce the external costs and promote the security of supply of the energy system, introduced a minimum level of energy efficiency standard and in 2003 a system of energy efficiency label. This system classifies the cars in seven energy efficiency categories, A to G. This Swiss energy efficiency label gives information on the level of the average fuel consumption in liter per 100 km and the CO_2 emissions in grams per kilometer. The efficiency categories are calculated by a combination of relative fuel efficiency (fuel consumption per curb weight) and absolute fuel efficiency (fuel consumption). Therefore, this label system should also promote a reduction of the so called energy efficiency gap, i.e. situation where investments in energy efficient cars that are economically worthwhile are not undertaken.

The focus of this paper is to estimate the price premium paid for the most energy-efficient labels in the Swiss car market using the hedonic price technique. The Hedonic Price Method (HPM) belongs to the group of revealed preference approaches which can be used for the valuation of a change in environmental quality by analyzing the impact of different energy efficiency standard and, therefore, different level of CO_2 and PM10 emissions, on car prices. HPM is an indirect method, where the basic idea is that a car's price reflects the value of its attributes to the consumer. Of course, the marginal willingness to pay (or price premium) for the attributes represented by energy efficiency labels reflects the willingness to pay for the public good of reducing emissions gives as well the reduction on the operating transport cost due to the reduction of fuel consumption.

There have been different studies which analyze the impact of energy efficiency on car prices (e.g. Berry et al., 1995; Goldberg, 1995; Goodman, 1983; Greene, 1983; Nair & Espey, 2004; Witt, 1994; Matas & Raymond, 2009). Most of these papers use miles per gallon (MPG) as a proxy for fuel economy. Because MPG is heavily correlated with other car characteristics like engine size, curb weight or horse powers, there has been a debate about the model and estimation technique that needs to be used. The novelty of this paper is to use the energy efficiency label defined by the Swiss government as a proxy for the level of fuel efficiency of a car. The advantage of these variables is that they are less likely to be correlated with other car characteristics. The energy efficiency label is well known to customers and therefore it is assumed that it influences their willingness to pay.

In order to estimate the price premium for the car attributes represented by energy efficiency labels, we will estimate hedonic price functions (see Atkinson and Halvorsen, 1984 or Triplett, 2004) using data of new passenger cars on offer in Switzerland from 2003 to 2011.

Methods

Following the model specifications used in previous studies and taking into account the availability and quality of data available on the Swiss car market we specify the following semi-log hedonic price model:

$$\ln P_{it} = \alpha + \beta_{1t} LABEL_{it} + \beta_{2t} PS_{it} + \beta_{3t} AUT_{it} + \beta_{4t} CLASS_{it} + \beta_{5t} FUEL_{it} + \delta_t + \varepsilon_{it} \quad (1)$$

where *t* is the time index, *i* the index for a car, *P* is the price of vehicles in Swiss Francs (CHF), *LABEL* is a vector of dummies for the efficiency categories with category G as the reference, *PS* is the horse power, *AUT* is a dummy which is equal to 1 if the car has an automatic gearshift and zero otherwise, *CLASS* is a vector of dummy variables for the car class (like compact car, cabriolet, SUV etc.) with micro car as the reference, *FUEL* is vector of dummy variables for the fuel type (hybrid, diesel, flex-fuel, ethanol) with gasoline as the reference, d is a time dummy variable and ε is the error term.

The data used were taken from the car list of the Touring Club of Switzerland over the period 2003 to 2011. In this lists all cars which were approved (homologated) in Switzerland in the last two years are listed, which makes around 5.000 cars per list. Using this data set it is possible to estimate equation (1) using single cross-section or by pooling the data. In our empirical analysis we use both approaches.

Results

The preliminary OLS estimation results obtained by using data for 2011 are reported on table 1. Generally, the coefficients have the expected signs and are statistically significant.

Table 1: Results of single cross-section hedonic equation in 2011

	Coefficient	Standard Error
A	0.1390***	0.0173
B	0.0923***	0.0158
C	0.1185***	0.0153
D	0.0916***	0.0151
E	0.0735***	0.0154
F	0.0139	0.0184
Horse Power	0.0045***	0.0001
Automatic	0.0922***	0.0051
Cabriole/Roadster	0.5175***	0.0175
Compact Car	0.0144	0.0141
Middleclass	0.3279***	0.0140
Minivan	0.2266***	0.0145
Higher Middleclass	0.4572***	0.0157
SUV	0.3398***	0.0155
Lower Middleclass	0.2148***	0.0139
Hybrid	0.1946***	0.0327
Diesel	0.1472***	0.0066
E85	0.1578***	0.0301
Gas	0.1578	0.1147
FlexFuel	0.0905***	0.0172
Constant	9.4393***	0.0226
Observations	4’985	
R^2	0.8711	

*** 1% significance level, ** 5% significance level, * 10% significance level

Table 1 provides preliminary results of the cross-section model using data for 2011 as an example of the different equation that will be applied. The coefficients show the expected signs. The positive coefficients of the category A to E signify that fuel efficient cars are more expensive than inefficient cars, ceteris paribus. The positive coefficients of the car classes show that bigger and more comfortable cars are (intuitively) more expensive than micro cars.

References

Atkinson, S. E., & Halvorsen, R. (1984). A New Hedonic Technique for Estimating Attribute Demand: An Application to the Demand for Automobile Fuel Efficiency. *The Review of Economics and Statistics , 66* (3), 417-26.

Berry, S., Levinsohn, J., & Pakes, A. (1995). Automobile Prices in Market Equilibrium. *Econometrica , 63* (4), 841-90.

Goldberg, P. K. (1995). Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry. *Econometrica , 63* (4), 891-951.

Goodman, A. C. (1983). Willingness to pay for car efficiency: A hedonic price approach. *Journal of Transport Economics and Policy , 17 Isuue 3*, 247-266.

Greene, D. L. (1983). A note on implicit consumer discounting of automobile fuel economy: Reviewing the available evidence. *Transportation Research Part B: Methodological , 17* (6), 491-499.

HYPERLINK "http://en.wikipedia.org/wiki/IPCC" \o "IPCC" IPCC AR4 WG1 (2007), Solomon, S.; Qin, D.; Manning, M.; Chen, Z.; Marquis, M.; Averyt, K.B.; Tignor, M.; and Miller, H.L., ed., HYPERLINK "http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html" *Climate Change 2007: The Physical Science Basis* , Contribution of Working Group I to the HYPERLINK "http://en.wikipedia.org/wiki/IPCC_Fourth_Assessment_Report" \o "IPCC Fourth Assessment Report" Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press.

Matas, A., & Raymond, J.-L. (2009). Hedonic prices for cars: an application to the Spanish car market, 1981-2005. *Applied Economics , 41* (22), 2887-2904.

Nair, S., & Espey, M. (2004). *Automobile Fuel Economy: What is it Worth?* 2004 Annual meeting, August 1-4, Denver, CO, American Agricultural Economics Association (New Name 2008: Agricultural and Applied Economics Association).

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Political Economy , 82* (1), 34-55.

Triplett, J. (2004). *Handbook on Hedonic Indexes and Quality Adjustments in Price Indexes: Special Application to Information Technology Products.* OECD Science, Technology and Industry Working Papers, OECD Publishing.

Witt, R. (1994). *The Demand for Car Fuel Efficiency: An Hedonic Price Approach.* Surrey Energy Economics Centre (SEEC), Department of Economics Discussion Papers (SEEDS), Surrey Energy Economics Centre (SEEC), Department of Economics, University of Surrey.