Socio-economic and environmental determinants of the spatial distribution of fuel efficiency and SUV in Switzerland

Master Thesis

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Extended Summary

The objective of this thesis is two-fold. One goal is to provide an overview of the Swiss passenger car fleet and its composition, focusing on regional differences in the car fleet and the role of topography as well as socio-demographic conditions. Another goal is to assess the effect of topography, income and additional socio-demographic and environmental factors on the presence of sport utility vehicles (SUV) in the car fleet. Thus, data on the matriculated passenger vehicles merged with socio-economic and environmental information on municipal level was analyzed. The data was collected within the framework of the project Economic analysis of policy measures to reduce CO₂ emissions of passenger cars in Switzerland at CEPE, ETH Zürich. First a descriptive analysis of the passenger vehicle (PV) fleet was performed to get an overview of the Swiss car fleet and reveal regional PV preferences. Second an econometric analysis was conducted on the share of SUV for testing different working hypotheses. The SUV car fleet is analyzed using two types of models: a linear regression model (LRM) fitted by ordinary least squares (OLS) and a generalized linear model (GLM) estimated with quasi-maximum likelihood (QML).

Descriptive analysis

In 2012, roughly 4.26 million passenger vehicles were matriculated in Switzerland, of which about 83% could be included in the descriptive analysis.

The average car in Switzerland weighs 1'435 kg, has an engine capacity of almost 2 liters and an engine performance of 103 kW. The average CO₂ emissions rate across the fleet is 185 grams of CO₂ per km, which corresponds to an overall average fuel consumption of 7.8 gasoline-equivalent liters per 100 km. The data indicates that fuel consumption per 100 km and thus CO₂ emissions are generally inversely related to engine size, curb weight and engine performance. In regard of the fuel type and impulsion system, three quarters of the vehicles on Swiss roads are gasoline-powered. Diesel accounts for 24% of the total whereas alternative fuels and hybrids together make up for just about 1% of the total. The Swiss car fleet is relatively young. The average age of a PV is 6.7 years and about 22% of the cars on the road are equal or younger than two years. The most numerous vehicle type driven is the compact car class (20.2%), followed closely by the subcompact (19.7%) and midsize car classes (17.7%). The
trendy SUV segment constitutes 12.8% of the total car fleet in Switzerland and averages 9.2 gasoline-equivalent liters per 100 km and 219 grams CO₂ per km, indicating that SUVs consume more fuel and respectively emit more CO₂ per driven kilometer than average passenger vehicles.

It is important to understand whether there are geographical patterns in the adoption of the especially heavy and high-emitting vehicles. A number of maps – used in the descriptive analysis to display the geographical distribution of vehicle characteristics – indicate that cars owned by residents of the Canton of Ticino and the cantons along the border to France, tend to be on average smaller as well as lighter and have better fuel economy and lower CO₂ emissions than in other parts of the country. Further, these areas tend to have larger shares of A-label and B-label vehicles. The maps also provide preliminary evidence of correlation between vehicle characteristics and the regional topography and income preconditions. In the mountainous areas as well as the wealthier areas of the country, e.g. Graubünden, Zug or Schwyz, cars tend to be larger, heavier, emit higher rates of CO₂ and consume more fuel per 100 km. However, regardless of income or topography, the maps indicate that the emissions and fuel economy profile of the car fleet follow closely the language divides within Switzerland.

**Econometric Analysis**

In general, the simplified models used in the econometric analysis perform rather well in explaining the share of SUV. The coefficient signs are all as expected and most of the variables are statistically significant at a 95% confidence interval. The estimated marginal effects of the two models are very similar, indicating that the findings are robust and the independent variables well chosen. From the econometric analysis three conclusions can be drawn:

Firstly, as expected income and environmental preconditions have a strongly significant and positive effect on the share of SUV. However, topography and weather conditions play a more prominent role than income. A one percent increase in elevation and snowfall at the means – keeping all other variables constant – amounts to an overall change in the SUV fleet by 0.52%. Surprisingly, the share of SUV increases by only 0.20%, if the average taxable income per capita in the municipalities were to increase by one percent. Therefore the econometric analysis suggests that the rational criterion of challenging topography has more explanatory power and
thus is more influential than the income-effect and the emotional criterion of fortifying one’s own social status when driving a SUV. This conclusion attenuates the public opinion of SUV opponents, that SUVs are first and foremost used as status symbol.

Secondly, a more environmentally aware community drives less SUV. Based – amongst others – on the fact that SUVs are above-average inefficient, as illustrated by the descriptive results, the national anti-SUV movement receives a lot of solidarity from the Swiss Green Party (GPS). Hence, it isn’t surprising that the share of votes for GPS in the municipalities has a statistically significant and negative impact on the share of SUV. The effect is of the same magnitude as the topography effect. A one percent change in the share of GPS, while keeping all other variables constant, causes the share of SUV at the mean to decrease by -0.47 %.

And thirdly, the desire of car owners for safety, roominess and comfort is the main driver of the SUV share. Identifying large family household and elderly people as consumers with high safety, roominess and comfort concerns, these two population groups are used as instruments to assess the impact of the desire for safety and comfort on the share of SUV. A one percent increase in the two instrumental variables, while keeping all other variables constant, causes an overall increase of 3.48 %\(^1\) in SUV at the mean. This is by far the largest observed effect and thus, there is suggestive evidence in the data that the desire of car owners for safety, roominess and comfort plays a major role in explaining the share of SUV.

Note that the data is aggregated on municipal level and the modeled relationships based on group averages. Thus, any individual or household behavior inferred from the estimation results should be viewed with caution. Another limit of both model approaches is that unobserved factors, like life-style and network effects, may slip by the model or be wrongly interpreted. Further research using either a spatial regression model or a multiple discrete-continuous extreme value (MDCEV) model could allow capturing intangible neighborhood effects that might have a significant impact on the share of SUV.

\(^1\) This elasticity seems too high and should be viewed with caution. Multicollinearity problems or other unobserved interactions could be causing this high elasticity.