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Fuel Demand in Swiss Border Regions

A Spatial Econometrics Approach

Massimo Filippini[*♠], Fabian Heimsch [♠], Lester C. Hunt[#]

[♠] Swiss Federal Institute of Technology, Centre for Energy Policy and Economics (CEPE)
[*] Università della Svizzera Italiana, Istituto di microeconomia e economia pubblica
[#] Surrey Energy Economics Centre (SEEC), Department of Economics, University of Surrey

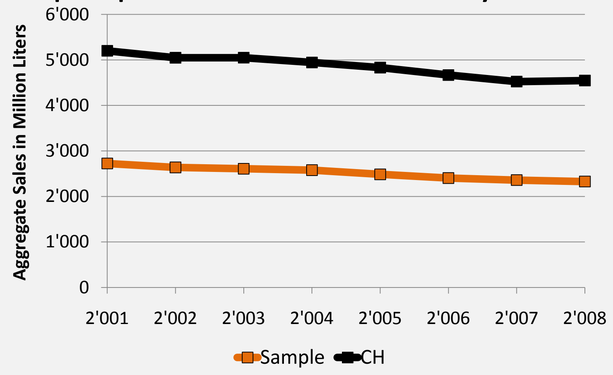
Problems and Goals

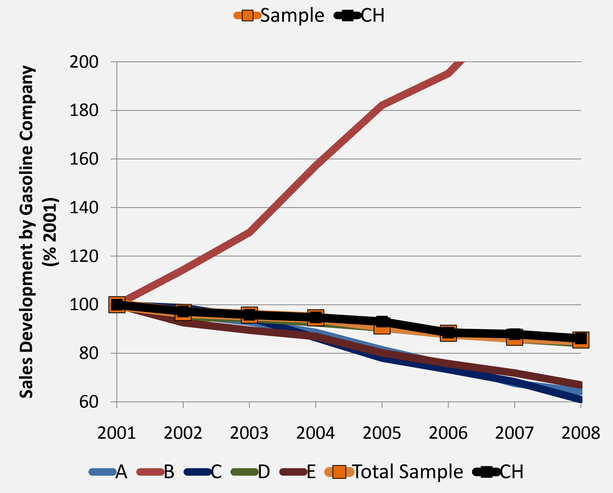
The demand for gasoline in the Swiss border regions is strongly affected by cross-border gasoline purchasing by foreign car owners. Accordingly, Swiss municipalities located closely to the border experience far higher gasoline sales compared to those more distant from the border. The price differences of gasoline across the border between Switzerland and its neighbouring countries have encouraged the phenomenon of gasoline tourism to develop and is supposed to account for an important share of overall Swiss gasoline sales. For this reason, the own-price elasticity of Swiss gasoline demand is expected to be generally higher in municipalities close to the border. The goal of the present work is to estimate the Swiss and the foreign price elasticity of Swiss gasoline demand and to provide information about its spatial variation using a *spatial-lag econometric approach* for panel data.

Data

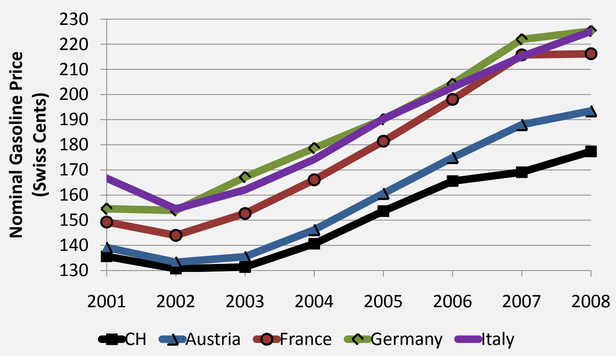
The data sample used to estimate the impact of gasoline tourism consists in a balanced panel data set for average gasoline sales of 315 Swiss municipalities located closely to the border over the period 2001 – 2008.

GASOLINE SALES data were collected from the Swiss Oil Association for gasoline stations of the five biggest gasoline companies located in Switzerland's border cantons. The sample represents sales data of 760 gasoline stations in 315 municipalities. In total, there are supposed to be some 1500 gasoline stations in the border region. The data cover approximately 55% of aggregate gasoline sales in Switzerland. Considering the relative development of gasoline sales of all 5 gasoline companies and comparing that to the development of sales in the whole of Switzerland, it becomes obvious that the sample represents the actual situation very well.





GASOLINE PRICES in Switzerland are substantially different from those in its neighbouring countries. Price data were collected from the Swiss Customs Authority and accordingly, there are four gasoline prices for Switzerland (one for each border region) and four foreign gasoline prices (Austria, France, Germany and Italy). On average, the Swiss gasoline price was 150.5 Swiss cents, whereas the foreign gasoline prices averaged to 177.5 Swiss cents – a saving potential of more than 15%.



Spatial–Lag Econometric Model

When estimating gasoline tourism on the municipal level for such a small country like Switzerland, spatial autocorrelation should be taken into account.
Gasoline sales are estimated using the Swiss gasoline price[1], the ratio of the foreign gasoline price to the Swiss gasoline price[2], the price ratio weighted with the distance from the border[3], the distance from the border alone[4], the stock of gasoline and diesel powered vehicles respectively[5,6], the municipality's population[7], the per capita income[8], the number of foreign commuters[9], a dummy variable indicating the presence of company "B"[10], a spatially lagged dependent variable for gasoline sales[11] - to account for spatial auto-correlation - and dummy variables for the cantons.

$$ln(S_{it}) = \alpha_0 + \alpha_1 ln(PG_{CH,bt}) + \alpha_2 ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right) + \alpha_3 ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right) \cdot ln(dist_i) + \alpha_4 ln(dist_i) + \alpha_5 ln(CarsG_{it}) + \alpha_6 ln(CarsD_{it}) + \alpha_7 ln(POP_{CH,it}) + \alpha_8 ln\left(\frac{Y_{CH,it}}{POP_{CH,it}}\right) + \alpha_9 ln(Commu_{it}) + \alpha_{10} dummy + \alpha_{11} ln(S_{it})_{sl} + \sum_{j=1}^{11} \beta_j g_j$$

***b=1-4* represents the border regions; *i=1-315* represents the municipalities, *t=2001-2008* the years and *j=1-11* the border cantons with one being the reference canton.**

ENDOGENEITY OF THE SPATIALLY LAGGED VARIABLE
A two-stages least squares approach is utilized, assuming that the spatially weighted average sales in adjacent municipalities affect fuel demand in each municipality. In a first step, the spatially lagged dependent variable is regressed on all independent variables *X* and the spatially weighted set of instruments *W·X* with *W* being the spatial weighting matrix. In the second step, average gasoline sales per gasoline station in the municipalities are regressed on the independent variable and the spatially lagged dependent variable.

Results

Coefficient	Variable	Value	z
α_0	Constant	13.9666	(13.77)***
α_1	$\ln(PG_{CH,bt})$	-0.21087	(-1.95)**
α_2	$\ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right)$	1.464429	(5.15)***
α_3	$\ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right)\ln(dist_i)$	-0.435696	(-4.62)***
α_4	$\ln(CarsG_{CH,it})$	0.108557	(2.09)**
α_5	$\ln(CarsD_{CH,it})$	-0.1820859	(-5.64)***
α_6	$\ln(POP_{CH,it})$	0.1508826	(2.71)***
α_7	$\ln\left(\frac{Y_{CH,it}}{POP_{CH,it}}\right)$	0.0308299	(0.38)
α_8	$\ln(dist_i)$	-0.057868	(-1.33)
α_9	$\ln(Commu_{it})$	-0.006789	(-0.74)
α_{10}	$DummyB_{it}$	0.6640159	(22.76)***
α_{11}	$\ln(S_{it})_{sl}$	0.0194339	(2.78)***
γ_1	Zürich (ZH)	-0.4269879	(-1.31)
γ_2	Baselstadt (BS)	-0.2481961	(-0.46)
γ_3	Baselland (BL)	-0.386076	(-1.31)
γ_4	Schaffhausen (SH)	0.0457661	(0.12)
γ_5	St. Gallen (SG)	-0.3419118	(-1.04)
γ_6	Aargau (AG)	-0.5104977	(-1.56)
γ_7	Thurgau (TG)	-0.6936646	(-2.05)**
γ_8	Tessin (TI)	-0.2238035	(-0.68)
γ_9	Waadt (VD)	-0.1202397	(0.37)
γ_{10}	Neuenburg (NE)	-0.4226184	(-1.05)
γ_{11}	Genf (GE)	0.1021827	(0.29)

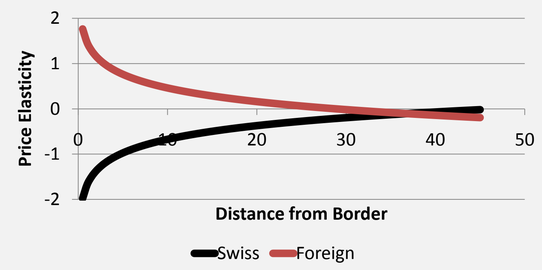
THE ESTIMATED COEFFICIENTS of interest such as the Swiss gasoline price, the price ratio and the weighted price ratio, the distance from the border, the stock of gasoline and diesel powered vehicles and especially the spatially lagged dependent variable bear the expected sign and are significant.

THE PRICE ELASTICITY with respect to the Swiss gasoline price and the foreign gasoline price can be computed and vary spatially due to the model specification.

$$\varepsilon_{PG_{CH,bt}} = \frac{\partial \ln(S_{it})}{\partial \ln(PG_{CH,bt})} = \alpha_1 - \alpha_2 - \alpha_3 \ln(dist_i)$$

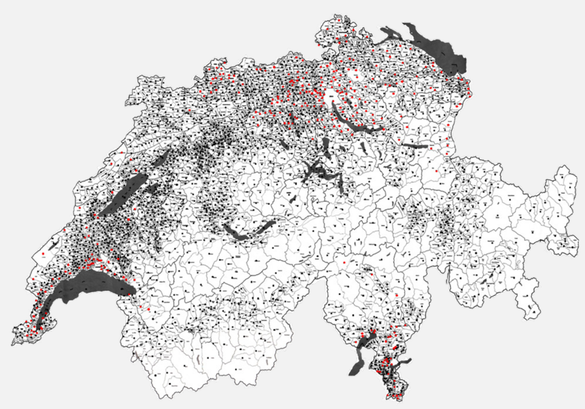
$$\varepsilon_{PG_{F,bt}} = \frac{\partial \ln(S_{it})}{\partial \ln(PG_{F,bt})} = \alpha_2 + \alpha_3 \ln(dist_i)$$

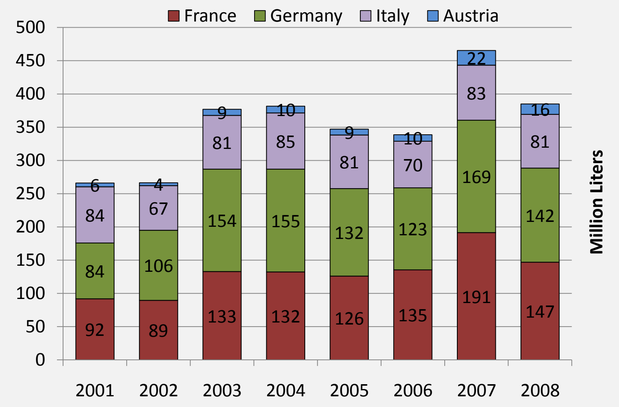
This in turn allows to quantify a critical distance from the border where gasoline tourism is supposed not to occur.



The development of the price elasticities over the distance range of the sample looks decent. The elasticity of Swiss gasoline consumption with respect to the foreign gasoline price is zero at a distance of some 30 km from the border, meaning that Swiss gasoline sales are no more affected by foreigners at this distance. The mean of the Swiss price elasticity is -0.64 over the whole 45 km distance range, the mean of the foreign gasoline price elasticity is 0.43.

GASOLINE TOURISM can be computed by setting the price ratios equal to unity which would correspond to a situation where the Swiss price is equal to the foreign gasoline price and hence no gasoline tourism would take place. With the model, a predicted value for municipalities' gasoline sales without gasoline tourism can be computed. The difference between this hypothetical value and the originally predicted model value then corresponds to estimated gasoline tourism per gasoline station in the respective municipality. The share of gasoline tourism a Swiss municipality experiences compared to its total sales heavily depends on the price ratio between Swiss gasoline and adjacent foreign gasoline as well as on the distance from the border. In order to calculate a projection for the whole area affected by cross-border gasoline sales (within 30 km from the border), distance ranges of some 5 km can be formed and then sales to foreigners can be projected by the total number of known gasoline stations in this distance band (the red dots on the Swiss map indicate municipalities which report sales in the sample).





Gasoline Tourism in Switzerland accounts for on average 350 Million liters of gasoline sold within the period 2001 – 2008, which correspond to a ratio of almost 10% of the overall Swiss gasoline sales. In the year 2001, gasoline tourism accounted for 6% of the gasoline sales at the representative Swiss gasoline station, whereas this value increased to 11% in the year 2007 and slightly decreased to 9.8% by 2008. The mean value over the whole period is 8.4%. The 95% confidence interval ranges from 2.4% up to 14.4%.