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FUEL DEMAND IN SWISS BORDER REGIONS: A Spatial Econometrics Approach

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Overview

In this paper an empirical analysis on fuel demand in Switzerland's border regions is presented. The price differences of gasoline and diesel across the border between Switzerland and its neighbouring countries (the gasoline price in Switzerland is generally lower) has encouraged the phenomenon of fuel tourism to develop. For this reason, the own-price elasticity of Swiss gasoline demand is expected to be generally higher in municipalities close to the border compared to municipalities which are more distant from the border. The goal of this paper is to estimate the Swiss and the foreign price elasticity of Swiss gasoline demand and to provide information about its spatial variation.

For this purpose a gasoline demand function is estimated for a representative fuel station at the municipal level. The data used in this paper cover 315 Swiss municipalities located within 40 km of the border over the period 2001 to 2008. From the econometric point of view, a random effects model (RE) and a spatial two-stages least squares approach (S-2SLS) is utilised, which assumes that the spatially weighted average sales in adjacent municipalities affect fuel demand in each municipality.

Methods

A static panel data approach is utilised to estimate average annual gasoline sales in a municipality *i* in year *t,* using a log-log linear functional form:

$$ln(S_{it}) = \alpha_0 + \alpha_1 ln(PG_{CH,bt}) + \alpha_2 ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right) + \alpha_3 ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right) \cdot ln(dist_i) + \alpha_4 ln(dist_i) + \alpha_5 ln(CarsG_{it})$$

$$+\alpha_6 ln(CarsD_{it}) + \alpha_7 ln(POP_{CH,it}) + \alpha_8 ln\left(\frac{Y_{CH,it}}{POP_{CH,it}}\right) + \alpha_9 ln(Commu_{it}) + \alpha_{10} dummy + \sum_{j=1}^{11} \beta_j g_j$$

where $b=1\text{-}4$ represents the border regions; $i=1\text{-}315$, represents the municipalities; $t=2001\text{-}2008$ represents the years; and $j= 1\text{-}11$ represents the cantons (one being the reference canton).

Furthermore, S_{it} denotes average annual gasoline sales measured in litres and $PG_{CH,bt}$ is the Swiss gasoline price in border region in real Swiss franc cents. The second variable on the right hand side of the equation is the ratio of the foreign gasoline price ($PG_{F,bt}$) to the Swiss gasoline price and the third term is an interaction term between the price ratio and the distance to the closest border crossing point ($dist_i$). The fifth and sixth terms on the right hand side ($CarsG_{it}$ and $CarsD_{it}$) represent the stock of gasoline and diesel vehicles respectively per municipality. $POP_{CH,it}$ is the Swiss population and the eighth term on the right hand side is Swiss per capita taxable income in the respective municipality ($YC_{H,it}$). $Commu_{it}$ denotes the number of daily commuters and the dummy variable (*dummy*) accounts for the presence of a gasoline company in the municipality with a highly different development of sales over the years compared to the other gasoline companies. The last eleven dummies, g_j, are regional cantonal dummies.

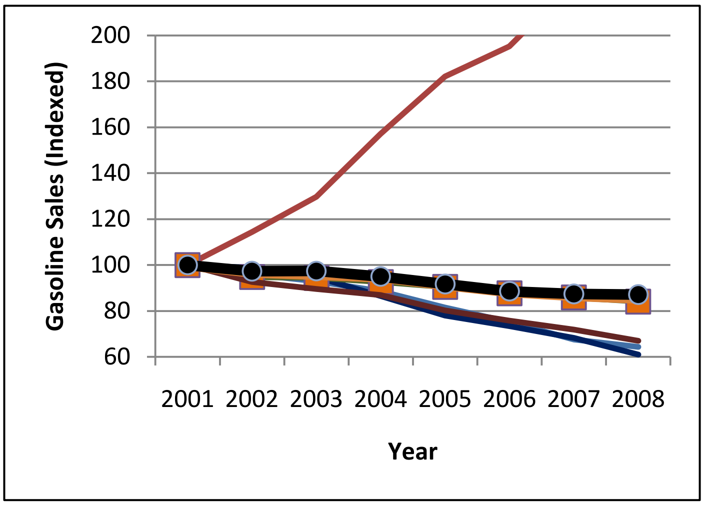
In addition, in order to take account of any the spatial autocorrelation, the equation above is augmented with a spatial lag as proposed in the spatial econometrics literature (Anselin 2003). The same equation is therefore estimated with a spatially lagged dependent variable, as follows:

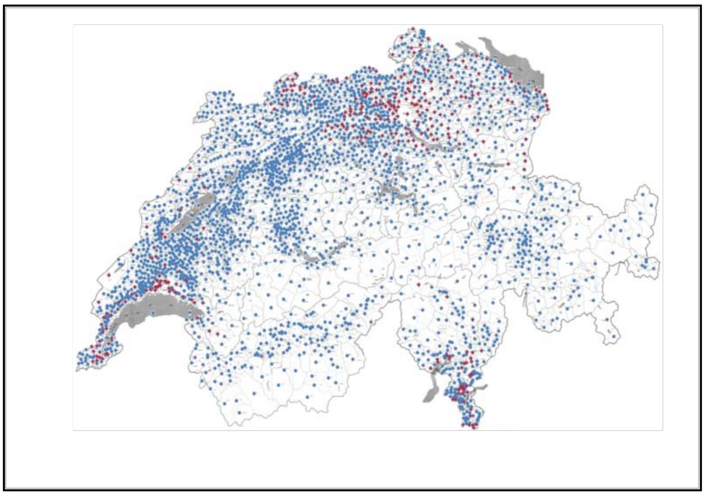
$$ln(S_{it}) = \alpha_0 + \alpha_1 ln(PG_{CH,bt}) + \alpha_2 ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right) + \alpha_3 ln\left(\frac{PG_{F,bt}}{PG_{CH,bt}}\right) \cdot ln(dist_i) + \alpha_4 ln(dist_i) + \alpha_5 ln(CarsG_{it})$$
$$+\alpha_6 ln(CarsD_{it}) + \alpha_7 ln(POP_{CH,it}) + \alpha_8 ln\left(\frac{Y_{CH,it}}{POP_{CH,it}}\right)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

where the last term is the spatially lagged dependent variable, which in a first step is regressed on all the right hand side independent variables, ***X*,** and the spatially weighted set of instruments, ***WX***; where ***W*** is a spatial weighting matrix.

Data

Compared to the work presented at the 2nd EMEE, new data have been collected, which contains a gasoline company that had, in contrary to the other companies, strongly increasing sales over the sample period. Accordingly, the data now consist in sales of 730 fuel stations located within 40 kilometres from the Swiss border. The final data hence appears as a balanced panel data set over eight years with 315 values of average fuel sales per year.





The first graph shows the index-linked development of gasoline sales for all gasoline companies from which data was collected. It clearly illustrates that one company shows a highly untypical development of gasoline sales compared to the others. Moreover, the sample average (orange line with square markers) fits the Swiss average (black line with circle markers) very well which points out that the sample is unbiased in terms of gasoline sales development – due to the inclusion of the untypical gasoline company in the sample.

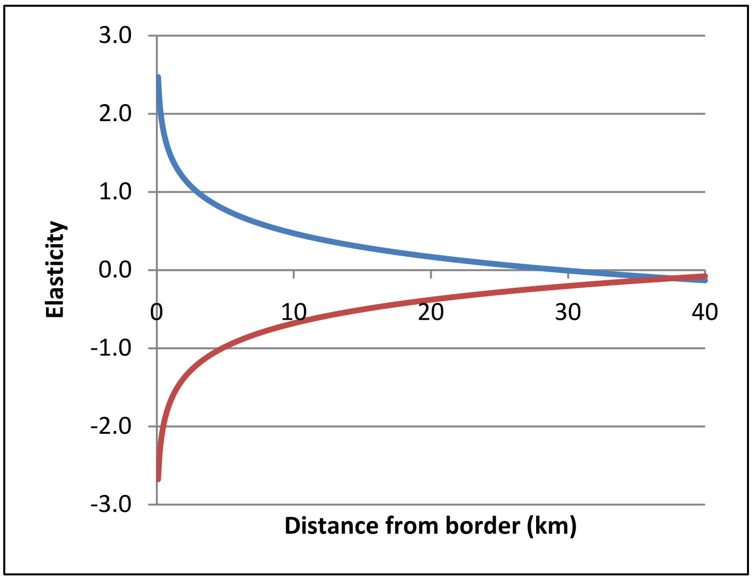
A further new point which is investigated is checking for spatial autocorrelation given it is reasonable to assume that fuel sales in a certain municipality (red dots in the Swiss map above) affect sales of neighbouring municipalities to a certain degree. Gasoline sales with respect to the presence of spatial autocorrelation are estimated using a two-stages-least-square approach (2SLS), where in the first step, gasoline sales data are regressed on the independent Variables X and a set of instruments $\hat{X} = W \cdot X$ where W is a spatial weighting matrix. In the second step, gasoline sales are regressed on the independent variables and on the spatially lagged dependent variable from the first regression.

Results and Conclusions

Preliminary empirical results show a significant impact of the gasoline price differential on demand. The foreign and own price elasticity is obtained by taking the derivative of the demand equation with respect to the logarithm of the foreign gasoline price and the Swiss gasoline price respectively; this results in:

$$\varepsilon_{PG_{CH,bt}} = \alpha_1 - \alpha_2 - \alpha_3 ln(dist_i) \quad \text{(red line)}$$ [1]

$$\varepsilon_{PG_{F,bt}} = \alpha_2 + \alpha_3 ln(dist_i) \quad \text{(blue line)}$$



The foreign price has an impact on Swiss gasoline consumption up to some 30 kilometres from the border. Since Swiss residents do not react on the foreign price as long as it is higher than the own price, this means that fuel tourism occurs within a distance of 30 kilometres from the border. The own price elasticity of Swiss gasoline demand gets higher the more close the municipality is to the border since not only domestic but as well foreign car owners react to changes in the Swiss gasoline price. The coefficient α_1 can be interpreted as the own price elasticity without gasoline tourism and is -0.21.

In terms of spatial autocorrelation, the spatially lagged dependent variable is found to have a positive influence on gasoline sales in the municipalities and is significant. However, there is no discernable effect on the other estimated coefficients; hence these estimation results are not presented here.

[1] The estimated coefficients α_1, α_2 and α_3 have the expected signs and are significant.

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