Price and Cross Price Elasticities of Energy Carrier Specific Demand in the Residential Sector

Anita Thonipara, Institute for Small Business Economics at the University of Göttingen, +49 551 3917 4888, anita.thonipara@wiwi.uni-goettingen.de

Overview

Energy efficiency has become an integral part of the EU environmental policy as a means of addressing climate change. The residential sector plays in this regard an important role since residential buildings account for around 25% of the European Union's energy use according to Eurostat. Thus, the Green Deal sees to make Europe carbon neutral by 2050. In order to achieve this goal, member states of the European Union increasingly make use of carbon taxation or other price policies and recent studies conducted by Runst / Thonipara 2020 or Shmelev Speck 2018 point towards carbon taxation being particularly effective if set on a high enough level as it is the case in Sweden. With carbon taxation becoming a more and more used policy instrument to reduce carbon emissions in the residential sector insights are necessary on how different levels of pricing or taxation may affect energy demand.

So far studies on price elasticities of energy demand in the residential sector are limited. Nässen et al. (2005) qualitatively find that increasing oil prices lead to decreasing energy use in 1-2 dwelling buildings. Nässén et al. (2008) look at price elasticities of total energy demand and find that price elasticities do not change markedly over time even though prices changed vastly over time. Since only the price elasticities of the total energy demand is considered it would be of interest to look at elasticities of substitution between various energy carriers. Ó Broin et al. (2015) have a look at non-price and price policies and find that energy prices indeed have a significant impact on energy demand for space and water heating. However, since price elasticities of demand are very low, it would require a strong increase of prices in order to cause a considerable decrease in energy demand.

All these studies have added valuable contributions to the literature. The limitation of these studies is, however, that price elasticities were calculated using total energy use or total energy use for space heating as the dependent variable. This means that the use of different energy carriers such as coal, district heating, biomass, oil or electricity is aggregated. Using aggregated demand as a dependent variable brings along two main disadvantages. Higher prices due to the carbon tax would usually lead to decreasing demand of the respective energy carrier. Demand of energy carriers poor in emissions would on the other hand increase since their prices are not as strongly affected by the carbon tax. The aggregated demand, however, does not picture this inter-fuel substitutional effect. Equally, energy prices usually vary across different energy carriers but are put into one price and are treated as if they were equal.

Thus, the aim of this research is to assess comprehensively the varying price elasticities (price and taxes) of the different energy carriers and to explore patterns of substitutions. A further focus of this paper are differences in price elasticities between one and two family houses and multi-dwelling houses.

Methods

As a first step, I use a standard dynamic constant elasticity function of demand in order to capture short and long run price elasticities. The analysis is limited to the time period from 1990-2016 and to a number of European countries both due to data availability. ***The*** dependent variables (consumption of the respective energy carrier α = gas or oil) includes water heating, space heating (and cooling) as well as appliance use. As net energy prices are likely to be affected by energy demand, we use an instrumental variable approach in order to rule out endogeneity caused by reverse causality. Besides net prices of the respective energy carrier α *I* use the energy carrier specific tax per ton of oil equivalent in order to capture the effect of energy taxes on energy consumption. *As I use logarithms I can interpret the coefficients as the price elasticities as long as a lag of the dependent variable is included as well as a number of explanatory variables. The explanatory* variable*s include* Heat Degree Days (HDD) in order to control for year specific weather effects, population as more people use more energy as well as GDP per capita since *I* expect that with higher income energy use increases due to lower energy price intensities as well as more appliances used as well as larger homes. Furthermore the other energy carriers' (μ) end user prices are included in the model.

For each model I use a second specification which includes an interaction term of energy taxes and per capita income (IntTI) in order to capture the effect that an energy tax increase may be more important if energy expenditure takes up a large part of a household's budget. Finally, hetereoskedasticity and autocorrelation robust standard errors are specified.

The econometric model takes on the following form:

First specification

$$Consumption(\alpha)_{it} = \beta_0 + \beta_1 log(\widehat{netprices}(\alpha))_{it} + \beta_2 \log(tax(\alpha))_{it} + \beta_3 HDD_{it} + \beta_4 population_{it} + \beta_5 GDPpC_{it} + \beta_6 energy\ prices\ (\mu)_{it} + \varepsilon_{it}$$

Where:

$$\widehat{netprices}(\alpha)_{it} = \gamma_0 + \gamma_1 (\log(netprices(\alpha))_{it-1} + \gamma_2 exogenous\ regressors_{i(t)} + \varepsilon_{it}$$

Where:

$$\gamma_2 = 0$$

Second Specification

$$Consumption(\alpha)_{it} = \beta_0 + \beta_1 log(\widehat{netprices}(\alpha))_{it} + \beta_2 \log(tax(\alpha))_{it} + \beta_3 HDD_{it} + \beta_4 population_{it} + \beta_5 GDPpC_{it} + \beta_6 energy\ prices\ (\mu)_{it} + \beta_7 IntTI_{it} + \varepsilon_{it}$$

Besides this, I pay close attention to cross price elasticities which measures the change of demand for energy carrier B in the case that prices of energy carrier A change. Inter-fuel substitutional effects can be analyzed more precisely in this part

$$E_c = \frac{P_1^A + P_2^A}{Q_1^B + Q_2^B} * \frac{\delta QB}{PA}$$

Both models each have two further specifications. Besides the above defined original models in which I use data for the whole residential sector, two specifications are added which use data for 1-2 dwelling buildings and for multi-dwelling buildings. By doing this, it is possible to identify differences in the way the increases in prices or taxes affect owners of different types of buildings.

Results

First results from the regression analysis show that price elasticities of oil and gas taxes are remarkably higher than elasticities of oil and gas net prices. Further results are still pending. As the implementation or augmentation of the carbon tax is lively debated at all political levels the findings of this studies may serve as a valuable contribution to the debate.

Conclusions

Still pending

References