ESTIMATING RESIDENTIAL NATURAL GAS DEMAND IN UKRAINE

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Overview

Despite its importance for policy purposes, evidence about the price elasticity of natural gas demand in the residential sector is very limited and based on inference from situations with modest variation in prices. We focus on a locale and time when price changes were extreme and presumably salient to consumers, namely Ukraine between 2013 and 2017. We exploit the tariff reforms and detailed micro-level household consumption records to estimate the price elasticity of the demand for natural gas. To isolate behavior, attention is restricted to those households that made no structural energy-efficiency upgrades to their homes, and thus kept the stock of gas-using capital fixed. We further examine the short-run elasticity by restricting the sample to a few months before and after the tariff changes. Our results suggest that under extreme price changes, households are capable of reducing consumption, even without installing insulation or making any other structural modifications to their homes. The price elasticity is about -0.16. Wealthier households, people living in multifamily buildings, and heavy users have more inelastic demands. Households reduced consumption even when they received "subsidies," namely lump-sum government assistance. We also find some evidence that the stronger the salience, the stronger the responsiveness to price, although this effect is modest and may partly overlap with that of income or baseline consumption. We conjecture that the consumers with the lowest uptake of energy efficiency improvements might be those who—by necessity or through skills—are the most productive at reducing energy use through behaviors.

Methods

In this paper, we focus on a locale and time when price changes were extreme and salient to consumers, namely Ukraine between 2013 and 2017. From one month to the next (March 2015 to April 2015), the tariffs tripled, and by the subsequent month (May 2015), they were seven times as high as in March. The tariff hikes were accompanied by a restructuring of the tier system, and later (April 2016) by the complete removal of the block system. Since 2016, the rate has increased several times during the heating season.

We assembled a panel dataset documenting monthly consumption from January 2013 to April 2017 for a sample of households in the Uzhhorod metropolitan area, and use it to examine the price elasticity. We wish to isolate changes in consumption due to behaviors, holding the structural characteristics of the dwelling and gas-using capital stock fixed, and, based on this notion, in our empirical work we restrict attention to those households that did not do any energy efficiency upgrades to their homes during our study period. These households did not install insulation, or changed windows, put in a new boiler, or switched to a different heating fuel, for last six years. To identify cleanly the short-run elasticity, we further limit the analyses to a few months before and after the tariff changes.

Unlike in Auffhammer and Rubin (2018), in Ukraine tariffs are not adjusted monthly to reflect the higher or low cost of acquiring natural gas for the utility: They are simply set exogenously by the regulator for a period of about one year at a time. Because for part of our study period there was an increasing block tariff scheme, we are concerned with endogeneity of prices and quantity consumed at the consumer level, which we address with instrumental variable estimation. During our study period a number of households received "subsidies," namely lump-sum government assistance to help pay the gas bills. We wish to see whether the subsidies offset the incentive to reduce consumption.

We estimate panel model with household-specific effects and time fixed effects. The former account for unobserved heterogeneity among households, capture the effect of any pre-existing insulation measures, and are the appropriate way to handle our sampling frame, since the analysis is conditional on the fixed effects. The latter control for economy-wide events that could have affected consumption or seasonal effects that might explain natural gas consumption in any given month. Our time fixed effects are month dummies plus "tariff regime" dummies. We estimate the model in the first differences and the standard errors are clustered at the household level.

In the presence of (increasing) block pricing the marginal price is endogenous with consumption. Unless properly addressed, the positive correlation may result in the appearance of a positively sloped demand function. To circumvent this problem, we instrument for log price. Our excluded instruments are the log tariffs in each block

(Nieswiadomy and Molina, 1989; Mansur and Olmstead, 2012), changed at a different rate over time, plus the log allowance and log discount off the regular tariff if the household receives benefits. The latter two are exogenous, alter the rates and hence the marginal price faced by that household, and should not directly influence consumption.

Results

We find that the demand is not completely inelastic: Even without structural modifications to their homes, consumers were able to reduce usage meaningfully as tariffs were raised. When price doubles, consumption is cut, all else the same, by 7-22%. The reduction is however disproportionately small compared with the extent of the price hike, and implies a short-run price elasticity of -0.16, which falls in the low end of the range from earlier studies. Wealthier households and people living in multifamily buildings have less elastic demand functions.

Households with income below the sample median tend to exhibit more pronounced price elasticity (-0.20), as do households who live in single-family homes (-0.22). By contrast, households living in units in multi-family buildings are less sensitive to price. The subsidies—an income transfer—have a negligible effect on consumption. The elasticity of demand with respect to the subsidy is positive, as expected, and around 0.02 but statistically insignificant.

Those who had not done some energy efficiency improvements 1-7 years before the study period exhibit a stronger elasticity (-0.23) than those who had done some improvements (-0.15); although these coefficients are not significantly different from one another.People seem to respond to current prices and not to future prices. We find modest evidence that households likely to hold different levels of "salience" have different price elasticities, about -0.21, but this effect may partly overlap with that of income and/or baseline consumption.

Conclusions

All in all, our results suggest that in the face of extreme tariff changes, households were able to reduce their natural gas consumption, even without installing (new) insulation or making any other energy efficiency investment. All else the same, a price change of the magnitude that was observed between March and April 2015 (230% for a 200 m3 customer), would have resulted, all else the same, in a reduction in consumption by 18-37%

Taken together, these findings suggest that in this and similar settings (cold winters, no viable alternative to gas heat, a compliant population, price salience, relatively low effort required to monitor consumption), increases in natural gas prices would have limited effects on residential consumption and CO2 emissions, raising the question whether measures aimed at improving efficiency might be more (cost-) effective. The offsetting effect of the subsidies is very modest. If both prices and subsidies were to double, consumption would still be reduced by about 10%, and consumption would still be reduced even if the proportional increase in the subsidies was greater, as long as it does not exceed a five-fold hike. This has important implications for the design of schemes that help low-income families. In our sample, the tax revenue from the gas sales to the wealthiest households in the sample would be sufficient to cover the subsidies to the poorest households in the sample.

References

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