ESTIMATING ENERGY PRICE ELASTICITIES WHEN SALIENCE IS HIGH: RESIDENTIAL NATURAL GAS DEMAND IN UKRAINE

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Overview

At an average content of 53.07 kilograms of carbon dioxide per million British Thermal Units (BTUs), natural gas is generally regarded as the cleanest-burning fossil fuel. In the US alone, it currently ranks as the most widely used fuel for space heating (OECD/IEA 2018) and its use for power generation has been increasingly steadily over recent years, just as coal-fired generation has been declining, due to a combination of market forces, technological innovation in extraction, and environmental concern pressures. The geopolitics of natural gas are complicated, as natural gas exporting countries have often been politically unstable or involved in conflicts, and delivering natural gas involves the construction of pipelines, sometimes from or through such nations.

We focus on residential demand for natural gas (for space and water heating, and cooking). In the US alone, such demand accounts for 16% of total consumption and in Ukraine, our study site, 36% (OECD/IEA 2018). We are specifically interested in its responsiveness to price. Traditionally, this information is summarized into the (own) price elasticity of demand, a key parameter for predicting how demand would change if a tax on each unit of natural gas was introduced (or revised) to correct for the externalities associated with gas usage (such as a carbon tax), computing the loss of welfare associated with disruptions in supply, and understanding the extent of the rebound effect (Sorrell and Dimitropolous, 2009) following improvements in the energy efficiency of buildings.

Identifying the price elasticity of demand depends crucially on the variation in prices over time and across the units of observation. When price changes are small, one wonders whether they are salient to people (Chetty et al., 2009; Finkelstein, 2009; Deryugina et al., 2017; Alberini et al., 2011). Salience refers to economic agents' ability to fully observe, retain and process the price of something, or changes in the price of something. Salience may be compromised by price labels that fail to report a portion of the price of the item, such as the sales tax eventually imposed on it (Chetty et al., 2009), by automatic billing schemes where charges go unnoticed (Finkelstein, 2009; Sexton, 2015), or by offering an incentive through a credit on the income tax rather than a rebate on the price of the good (Gallagher and Muehlegger, 2011).

In sum, how large do price changes have to be to be salient, or for any changes in demand to be appreciable? Do we observe small changes in consumption when the price changes are modest, and large changes when the price fluctuations are very pronounced, or the other way around?

Methods

We focus on a locale and time when a) price changes were extreme and b) these massive price hikes were 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.

We take advantage of the tariff scheme reform and tariff shocks to identify the short-run elasticity of residential gas demand in city of Uzhhorod in western Ukraine. The administrative region around Uzhhorod, Transcarpathia, had disconnected homes from district heating by 2012. By the beginning of our study period (January 2013), every dwelling had its own separate heating system, even in multifamily buildings, and was responsible for paying for its own consumption.

We argue that the tariff hikes were salient to people for at least seven reasons. First, people own and run their own heating system and are responsible for their own consumption. Second, the sheer magnitude of the tariff hikes, and the subsequent escalation of government energy assistance programs, suggest that the tariff reforms did not possibly go unnoticed. Third, each family receives the gas bill every month, with clear information about consumption for that month and the tariff(s). Fourth, Ukraine relies on one-part tariffs, which emphasizes the relationship between usage and the bill. Fifth, the gas bill is not combined with other utilities (e.g., electricity or water). Sixth, many households at our study locale maintained their own "utility book" where they manually recorded the same information that appears on the bill. Last but not least, direct debit payment is uncommon: Most people bring their bills to the post office or to the bank to pay them, suggesting that the effect documented in Sexton (2015) is absent here.

We assembled a panel dataset documenting monthly consumption (for up to 52 months) by a sample of households in the Uzhhorod metropolitan area, and use to examine the short-run price elasticity. We define the short run as the length of time when people have not yet adjusted their energy-using capital stock in the response to the new prices, and, based on this notion, in our empirical work we restrict attention to those households that did not do any heating-oriented energy efficiency upgrades to their homes during our study period. (In other words, these households did not install insulation, or changed windows, or put in a new boiler, etc. between January 2013 and April 2017.) We experiment with further limiting the analyses to a few months before and after the tariff changes.

We fit the regression

(1) $$lnG_{it} = \alpha_i + \tau_t + \mathbf{W}_{it}\boldsymbol{\beta} + \gamma \cdot \ln P_{it} + \varepsilon_{it}$$

where i denotes the household, t the month and year, G is monthly natural gas consumption, and P is the marginal price faced by the household. Vector $\mathbf{W}$ includes weather controls and other time-varying covariates. Because we have a monthly panel and the sample is restricted to those that did not do renovations and thus did not change their heating space-related capital stock during our study period, coefficient γ is the short-run price elasticity of demand. Equation (1) includes household and tariff-period fixed effects. We first transform it to its first differences to eliminate the household fixed effects and reduce serial correlation. We then instrument for the marginal price, because for much of our study period there was an increasing block tariff scheme, which makes price and quantity consumed endogenous.

Results

We find that the short-run price elasticity is about -0.11, and thus falls in the lower end of the range from earlier studies. Wealthier households and people living in multifamily buildings have more inelastic demand functions. Restricting attention to consumption levels from three (or four) months before and after the tariff reforms results in slightly lower (-0.09) price elasticity. We test whether people react to announcements about future tariff changes, but our results suggest that people seem to respond to current, not future, prices. We find modest evidence that households likely to hold different levels of “salience” have different price elasticities, but this effect partly overlaps with that of income.

Conclusions

We have used a unique dataset collected directly from households in Ukraine to estimate residential demand for natural gas, which people use for space heating, cooking and for heating water. We find that, even without investing in equipment changes or installing insulation or otherwise improving the thermal integrity of the their dwellings, people were able to reduce their use of natural gas. At the time of the first, very heavy tariff reform during our study period (in April 2015, when prices increased in real terms by 230%), people were capable of reducing usage by 18-25% (compared to a situation with identical weather and the old prices). Taken together, these findings suggest that a carbon tax imposed on natural gas would have little effect on residential consumption and emissions, raising the question whether measures aimed at improving efficiency might be more cost-effective.

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