NAVIGATING ENERGY PEAKS AND SUPPLY SHORTAGES: SHORT-RUN RESIDENTIAL ELECTRICITY DEMAND RESPONSES TO PRICE SHOCKS

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Overview

Peak demand periods, emergency situations, supply shortages, or budget constraints represent possible scenarios where policymakers need to temporarily reduce the energy demand. A popular lever for achieving this would be to utilize pricing mechanisms. In other words, one would like to exploit the short-run reduction in energy consumption when households face a price increase due to a transitory supply shortage. Nonetheless, empirical evidence concerning how electricity demand reacts to transient shocks is scarce, with most studies focusing on price elasticity (Labandeira, Labeaga, and Lopez Otero, 2017; Kestelman Borges, 2020), rather than examining the impact of a temporary price change.

In this paper, we estimate the short-run impact of a price shock increase on residential users' electricity consumption using a natural experiment in the province of Tucuman, Argentina. At the heart of this paper is a unique longitudinal database with administrative records of the universe of residential electricity users provided by the sole distributor company EDET S.A. The utility is the province's only electric power service provider and the fifth-largest electric utility in the country, with approximately 650 thousand users (more than 90% residential). The results reveal that users do not show a statistically significant response to the price shock in the subsequent two-month period.

Our paper contributes to a recent literature that uses experimental and quasi-experimental methods to estimate electricity and natural gas consumption responses to tariff changes. The closest to our paper is Bastos et al. (2015). The authors exploit a similar gas tariff schedule to estimate the short-run impact of price shocks on residential gas utilization. However, our paper includes some stark differences. First, we focus on the first period after households receive the bill with the new tariff schedule. This makes it more likely that users cannot react strategically to be assigned to their preferred fixed-cost tier, which is essential to the identification strategy of the parameter of interest (Lee and Card, 2008). Second, we test for behavioral responses using subsequent periods after the first bill to improve sample sizes and test for differential effects on high-season consumption. Third, we estimate the consumption response for low, medium, and high consumption households, while Bastos et al. (2015) only estimate for one of eight thresholds. As explained later, our conclusions will differ from those of the authors, who find an elasticity of roughly -0.15.

Methods

We exploit a natural experiment to estimate the short-run impact of a price shock increase on residential electricity consumption using a regression discontinuity (RD) design. In particular, our identification strategy exploits a new tariff framework that changes fixed cost determination for residential users and a suboptimizing response to nonlinear pricing documented by previous literature (Ito, 2014).

In January 2021, the provincial utility adopted a new tariff schedule whereby the fixed component of the tariff was organized into four tiers based on households' annual moving average consumption, while the variable component was linear and the same across the four tiers. Introducing the new tariff generates a discontinuity in both the fixed and average price for those users around three thresholds associated with the moving average annual consumption. Since the non-linearities are based on annual average consumption, this introduces a random price variation for consumers around the thresholds. The change in the fixed cost barely above and below the three thresholds ranges from 77% to 107%, while the corresponding change in total costs ranges from 26% to 36%.

Moreover, recent empirical findings argue that households derive their pricing perceptions from their recent past billing experiences (Borenstein, 2009). Specifically, (Ito, 2014) finds that residential consumers in the electricity market respond to lagged average prices, rather than marginal or expected marginal prices.

Both facts define our identification strategy. Despite households being exposed to the same tariff structure, we can estimate the short-run demand responses to price shocks in the period following the implementation of the policy using a regression discontinuity design for users just above and below the three thresholds in the previous bill, which generate a random average price shock from 26% to 36%.

We first provide evidence that households cannot precisely manipulate the assignment variable (Lee and Lemieux, 2010). No household has a smart meter at home, there are no kinks on the histogram of annual moving average consumption around the thresholds, and treatment and control units in a close neighborhood around the cutoffs are balanced in the observable variables. This evidence is crucial since the average treatment effect is identified if the treatment and control units in a close neighborhood around the cutoff are comparable.

In summary, our method exploits a sharp RD design where the score variable is the annual moving average consumption, the treatment variable corresponds to a binary indicator of whether the user has received a low or high price (fixed and total bill) in (t −)1 bill, and the outcome variable is the bimonthly electricity consumption on bimester t.

Results

In our main results, we estimate the effect of the price shock of bill 0 (issued in March 2021, the first period of the new tariff schedule), on electricity consumption in bill 1 (issued in May 2021) for three different thresholds (150 kWh/month, 250 kWh/month, 550 kWh/month) allowing for different slopes around the discontinuity and 5% bandwidth.

The results reveal that users do not show a statistically significant response to the price shock in the subsequent two-month period. This lack of statistically significant response is consistent across the three thresholds and robust to alternative functional forms and bandwidths. These results remain consistent whether we aggregate users with bills issued in May and June 2021 to augment the sample size or when examining different outcomes for consumption response during the bimester with the highest consumption following the introduction of the new tariff schedule.

Conclusions

The lack of demand response to prices suggests that price instruments may not effectively influence residential electricity consumption during these circumstances and other instruments should be chosen.

One potential explanation for the lack of consumption response could be attributed to the inclusion of a period during which energy prices in Argentina were significantly low. Throughout our analysis period, the average monthly bill amounted to less than USD 25, representing 3.3% of the average household income in the province of Tucumán. We examine treatment heterogeneity responses for low, middle, and high-income households. We use a vulnerability index, provided by OFUT, which identifies three types of vulnerability zones (high, medium, and low) at radio level. Once again, we find no response for either of these groups of households. We expect to deepen this hypothesis in future research exploiting current energy price actualization reform in Argentina.

Our favored hypothesis for the lack of price shock response is linked to the parameter identified by our data-generating process. This parameter does not represent a short-run price elasticity; rather, it reflects a transitory price shock created by the natural experiment. Consequently, we anticipate a smaller response than a permanent price change. It is noteworthy that our identified parameter serves as the sought-after response when an economy requires temporary measures to mitigate the demand for electrical energy.