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An Overview of Residential Energy Demand Elasticity Estimates for Canadian Provinces – A Multi-Model Approach

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Overview

Canada is a mosaic of diverse and evolving energy systems. The fuels Canadian households consume varies greatly across provinces. Hydro-rich provinces generally use more electricity to heat their homes, while provinces with broad natural gas distribution networks generally use more natural gas than those with limited or no natural gas distribution networks. This diversity also means that household energy demands across Canada respond differently to changes in natural gas or electricity prices, or the introduction of new energy policies and technologies.

Understanding how households respond to these factors, as well as how households respond differently across provinces, is becoming increasingly important when attempting to estimate the effect energy polices could have on energy consumption. Currently, a major challenge for this type of analysis is the lack of studies focusing on estimating energy demand elasticities across multiple Canadian provinces. Furthermore, when forced to collect results across numerous studies to compare elasticities, one must to compare estimates obtained using different data and methodologies, which introduces additional concerns.

This study seeks to explore this by estimating residential energy demand elasticities across all Canadian Provinces using a single database - the Energy Futures database. This study also applies two popular functional forms, the Almost Ideal Demand System (AIDS) and an Unrestricted Error Correction (UEC) model. By estimating two functional forms, we are able to compare residential energy demand elasticities from a single model for all provinces, as well as compare elasticities across two fundamentally different functional forms.

Methodology and Data

- This study utilizes the Canada Energy Regulators Energy Future's database of annual energy demands from 1990 to 2018.
- Residential energy demand elasticities are estimated for electricity and natural gas demands (where possible). Other fuels are incorporated in the analysis, such as heating oil, but are not the primary focus of the analysis.
- This study estimates the UEC and AIDS models. These two models were chosen for a few reasons. First, they are two of the most popular types of functional form employed in the academic literature. This allows comparison to larger sub-section of the current literature. Secondly, the two models estimated are fundamentally different and this difference has been shown to have significant impacts on elasticity estimates. Lastly, these two models allow one to obtain various types of elasticity estimates. The UEC model estimates both long-run and short-run elasticities, while the AIDS model estimates long-run compensated (Hicksian) elasticities, as well as uncompensated (Marshallian) elasticities.

Initial Results

- For the AIDS model, results are broken down for each type of elasticity estimated, as well as by type of controls included or price index chosen.[1]
- Natural gas demand elasticities estimates align with estimates from the literature. The average long-run natural gas elasticity was roughly -.85 for the AIDS model (compared to -.81 in the literature), and roughly -.09 in the UEC model (which was the same as the literature).

[1] The linear AIDS model was estimated using the Stone, Laspeyres, and Paasche price indexes. The non-linear AIDS model was also estimated.

- The average electricity demand elasticity for the AIDS model was roughly -.95 (compared to -.75 in the literature). However, there was significant variation in the estimates across provinces, ranging from -.65 to -1.4. The average elasticity using the UEC model was -.25 (compared to -.41 in the literature).
- Very few short-run elasticity estimates from the UEC model were statistically significant. A likely reason for this is the use of aggregated annual data and the lack of short-run price variation.
- Consistent with economic theory, household income had a robust impact on energy demand across models. Controls for household income in the UEC model and expenditure share estimates in the AIDS model were found to consistently impact energy demand, having a positive and statistically significant impact for most functional forms estimated.

Initial Conclusions

- Elasticity estimates from the AIDS model were consistently higher than comparable estimates from the UEC model. This result supports the literature and the notion that demand system models tend to provide more elastic estimates.
- There is significant variation in elasticity estimates across provinces. For instance, looking across the Prairie Provinces, the AIDS model estimated electricity (natural gas) elasticities of -1.2 (-1.45) in Manitoba, -.95 (-1.1) in Saskatchewan, and -.62 (-.9) in Alberta.
- For the AIDS model, the choice of a linear price index, or the non-linear price index version, had a significant impact on elasticity estimates. Similarly, which controls were included in the estimation (e.g. no controls, degree days, degree days and time trend) had a significant impact on the results.