

Regression Home Work: Case Study on Modelling Demand of Natural Gas

One of the cornerstones of economic decision making is the price that ought to be set for a product. Several factors play a role in determining the price: the demand for the product and, marginal cost of manufacturing play a crucial role in determining the price of the product. The demand for the product, in turn, depends on several other factors: what is the end-use of the product (derived demand), what are the prevailing competitive conditions, etc. It is well-known that monopoly yields best possible profits from the sellers' perspective; however, whether or not a case for monopoly can be made or not depends on the definition of market boundaries. Presence of substitutable products significantly curtails the exhibition of monopoly power by the seller. The main purpose of this exercise is to estimate the demand function for one such industry: natural gas.¹ While there is only a single supplier of natural gas in the region under consideration, it does not have the flexibility of increasing the prices in tandem with the increasing costs because of the presence of alternative fuel. Given the escalating costs of producing and acquiring natural gas, it is essential to understand to what degree the company can increase the prices in the market without experiencing further attrition in the market space.

In this exercise, the challenge is to develop a regression model to understand the importance of various factors in determining the demand for natural gas. More specifically, you are to model the demand for natural gas by the industrial consumers in one of the major Indian states. In this state, gas supply is through contracts, and for any given region, only one firm is allowed to operate. Therefore, as far as only natural gas market is concerned, this company is the monopolist.

In the industrial consumer segment, natural gas is not consumed for the sake of itself, but as a factor of production (especially for the fuel). Therefore, the price of natural gas will influence the marginal cost of production of final good, which in turn influences the quantity of natural gas consumed. Moreover, there are several other fuels available in the market: furnace oil, light diesel oil, coal, liquefied petroleum gas, etc. that can act as alternative fuel sources. While in the short run it is difficult to envisage easy manoeuvrability across various fuels, it is not necessarily the case in the long run. A firm can invest in appropriate technology and switch over to a relatively cheaper fuel if the cost difference warrants such move. There are other macroeconomic variables like exchange rate which influence the demand for natural gas.

We use several sources of data: both primary and secondary, for this study. The first source of data is the quantity and price data obtained from the oil and gas company during a period spanning 28 months. It further provides data of alternative fuels in the market like furnace oil, light diesel oil and liquefied petroleum gas. In order to make the prices across fuels comparable, they have been converted to price per 8350 kilo calories of energy. It is clear that piped natural gas (PNG) is one of the cheapest among the fuels considered. However, there is another fuel that

¹ Data confidentiality reasons forbid me from revealing the name of the company.

is pertinent in this market – coal. While the prices of coal are available from Coal India website, they change only sporadically. Moreover, since most of the coal is imported, it is difficult to get the final imported price of coal and the associated quality. That said several other inputs are also imported. Since there were no major fluctuations in prices of those imported inputs in the international market, but the exchange rate is widely fluctuating, exchange rate is a good proxy for the price of other inputs.

We also look at data on possible demand shifters like construction index. This is because the downstream industry provides a valuable input for the construction industry and any fluctuations in the construction activity in the country should impact the demand for the downstream product. These macroeconomic variables are obtained from the statistics published on the RBI website. Because of lack of availability of the construction index for the state, we use the construction index of a large metro city in a neighbouring state as a proxy.

Finally, for the demand estimation, we also need to consider exogenous shifts to demand not attributable to these factors alone. For example, during the Diwali season in India, several manufacturing units in India shut down either for the holiday season or maintenance reason, and the consumption of natural gas is lowered exogenously. An ideal demand model should take these factors into account. Even in this current case, there are two months every year, where this artificial dip in fuel consumption is observed. We capture this using a dummy variable approach. The dummy variable, titled “problem month” that takes value 1 if the month under question is the month where there is an exogenous dip in the consumption of natural gas (due to maintenance or plant shut-down issues).

Exercise: Prepare a short managerial report (less than six pages, excluding codes, plots and outputs) for someone who understands statistics but does not understand technical details.

- a) Develop a suitable regression model to predict the demand of natural gas for the concerned state. Interpret your findings.
- b) Among the other competing models you considered but ultimately rejected, discuss the two best. Is it physically meaningful to choose your model over these two models? Justify.
- c) Discuss the goodness of fit of your model. Are there any limitations that we should know about?
- d) Is there any scope to improve upon the model? If yes, can you think how can that be possibly achieved?

The report should not assume that the reader knows R. Provide your R codes and outputs **at the end in the form of an appendix**. Do not directly copy-paste output in the main body of the report.