Demand for electricity

INTRODUCTION

If future demand for electricity is to be matched by adequate supply, then it is essential that models are built for estimating accurately, what the future demand for electricity is likely to be. In order to accomplish this, it is necessary that the factors affecting electricity demand are clearly indentified and quantified. It is even more crucial in the case of energy industries because, future energy demand requires investment spending today (due to their huge capital investment requirement and long lead time).[1] In other words, if a country should underestimate its future electricity demand, then it would most likely not make adequate capital investment in the present time which would then result in a shortage of electricity supply (when compared to demand) in the future.

One of the most influential factors affecting the demand for electricity is the price of electricity.[2] The price of electricity has since been incorporated into the majority of electricity demand models.[3] This paper tries to examine the effects of the price of electricity in the UK on its own electricity demand. The focus here is to determine the price elasticity of demand for the period 1980-2008 (annual time series data) by the use of a loglinear regression model.

The research paper will take the following format. Chapter one is the introduction, chapter two will be the literature review, chapter three will focus on the modelling approach and data analysis and chapter four will be the conclusion and findings.

LITERATURE REVIEW

Price Elasticity

According to economic theory there is an inverse relationship between the price of energy and the quantity of energy demanded. As energy prices rise the quantity of energy demanded falls and vice versa. Given that all other factors are held constant[4]. Economic theory further postulates that the demand for energy is not as responsive to the changes in energy prices as compared to other commodities that are more responsive to their individual prices[5]. Economists define price elasticity as consumer's sensitivity to price changes or the degree of responsiveness of changes in quantity demanded to changes in prices and is given by the formula below as:

Since price elasticity is the ratio of two percentages, we therefore do not express it in any unit. Price elasticities are usually negative this is due to the inverse relationship between demand and price. Demand elasticities are mainly of two types which are; elastic and inelastic. If the values of elasticity of demand fall within the absolute values of 0 to 1 then demand is said to be inelastic and this can be interpreted thus as a change in price results in a less than proportionate change in quantity demanded. On the other hand if the values of elasticity of demand equals to the absolute value of one or above one, then demand is said to be elastic. In the case where elasticity of demand is equal to the absolute value of 1, it is interpreted as; a change in price leads to a proportionate change in quantity demanded. If the elasticity of demand is greater than the absolute value of 1 then it is interpreted thus as: a change in price results in a more than a proportionate change in quantity demanded. For example in the inelastic range, if price increases by 10 percent on a commodity with a price elasticity of -0. 3 then the demand

for the good falls by only 3 percent. However, in the case of the elastic range, a commodity with an elasticity of -2. 0 would face a fall in demand of 20 percent, if price was to increase by 10 percent. This relationship can be further illustrated in the figure below.

Figure 1: Relationship of supply and demand with two demand curves

Figure 1 shows a supply curve (S1) and two demand curves which have different elasticities of demand (D'1 and D1). D'1 is more elastic than D1 (i. e. less steeper). At equilibrium, the supply curve S1, with both demand curves D'1 and D1, have a common equilibrium price and quantity at P1 and Q1. Now, let us now assume that the supply curve shifts to the left due to say an increase in the cost of production (i. e. the price of coal used to generate electricity). Then, the new equilibrium point will depend on the nature of the demand curve that is used as shown in figure 2. If the demand curve is relatively elastic at (D'1), then prices will rise and demand will fall by a much larger amount when compared to the more inelastic demand curve (D1). Note here that with the inelastic demand curve, the price and quantity demanded (P2 and Q2) are much larger than in the case of a more elastic demand curve at (P'2 and Q'2). In reality this can be explained by the fact that, if the demand for a commodity is inelastic then, any increase in costs (for example generation costs as mentioned above) can easily be passed on to the consumers without much reduction in supply, hence the larger price. On the other hand if the demand for the commodity were to be elastic then only a much smaller portion of the cost increase would be passed on to the consumer.

Figure 2: Shows the effects of a shift in the Supply Curve

We can also see the effects of a shift in the demand curve on price and quantity. If we assume that demand curves were to shift outward to the right (i. e. increases) from (D1 to D2) and (D'1 to D'2) while supply is held constant then with a more elastic demand curve the equilibrium price and quantity (P'2 and Q'2) would be much lower than if demand were to be inelastic (i. e. P2 and Q2).

Figure 3: Effects of a shift in the Demand Curve

From the three above illustrations it is quite clear that the resulting impact of changes in supply or demand on equilibrium price and quantity will vary in accordance to the nature of product elasticity.

Price elasticities can be used to show how consumer demand responds to changes in price as well as the ease at which individuals can switch over to a substitute, when commodity prices go up. A consumer who has a fixed income has three options of responding to price changes in the short term; (a the consumer can switch over to a substitute; b) they can purchase less of the commodity without any additional purchase of a substitute; or (c he or she can still buy the same quantity of good while reducing his or her consumption of other commodities that make up their total expenditure.

In the case of electricity the degree at which it can be substituted is very limited. Electricity can be used mainly for heating, lightening or a wide range of electric appliances such as (computers, television sets, printers, irons etc.). In the case of heating, a consumer may substitute the use of electricity for natural gas (and in the case of less developed countries may even substitute it for it for kerosene or firewood). However, the consumer also has

the option of switching over to an appliance that uses a more energy conserving source. For end uses such as power supply for television sets, electricity has no substitutes. The consumer also has the option of purchasing a more efficient television set and maintaining the same level of service while using less electricity. Replacing appliances such as television sets may involve the change of a relatively expensive appliance and as such would take some time to do so. Since, this will involve a first initial capital outlay which in turn depends on the income of the consumer, frequency of wage payment and payment of bills schedules etc. The time period required by consumers to substitute a relatively expensive appliance in response to higher energy prices is usually referred to as the long-run adjustment time period.

On this the basis of this analysis, it is expected that the price elasticity of demand is usually inelastic in the short run and more elastic in the long run. This is because in the short run the consumers options of responding to higher electricity prices are limited i. e. he is restricted to reactions such as, reducing his or her level of appliance utilisation (for example running the heater for lesser hours of the day) or reducing his expenditure on other commodities to maintain the same level of electricity consumption. In the long run however, his options of responding to high energy prices are increased compared to the options he had in the short run. In the long run the consumer can fully respond to price changes by the purchase of appliances that are more efficient and/or the purchase of appliances that use a cheaper energy source. That is why in the long run elasticities tend toward a more elastic range than in the short run.

Earlier Literature on Price Elasticity of Electricity Demand

Earlier literature on electricity demand has revealed that the price elasticity of demand for electricity is relatively inelastic in the short run and tend to be relatively more elastic in the long run. The previous works written on price elasticity of demand are far too much to be fully discussed in this research. Therefore we shall focus on only the summary of a few.

Taylor (1975) wrote one of the first literatures on electricity demand surveys. After carrying out reviews on various existing studies of commercial, industrial and residential electricity demand, he reported the following: (a in the case of residential demand for electricity, short term price elasticity ranged from -0. 13 to -0. 90 while long run price elasticities ranged from near 0 to -2. 0. In the case of commercial demand, price elasticities were valued at -0. 17 for the short run and -1. 36 for the long run[7].

Boone kamp (2007) using the bottom up model on an annual data series for the period 1990-2000 reported that the household long term price elasticity ranged from -0. 09 to – 0. 13[8].

Pouris (1987) conducted an analysis for the elasticity of demand for electricity for South Africa using data for the period (1950-1983) and determined that the long term price elasticity of electricity demand for the period was -0. 90.[9]

Bjoner and Jensen (2002) using a loglinear fixed effects model on panel data for the period of (1983-1996) discovered that short term price elasticity to be -0. 479.[10]

Filippini and Pachuari (2002) using a loglinear model on a monthly household panel data series discovered that the household short term price elasticity for electricity ranged from -0. 16 to – 0. 39.[11]

Zimmerman and Bohi (1984) carried out a detailed review of existing studies of energy demand. They reported that general consensus figures for residential price elasticity of electricity were -0. 2 in the short run and -0. 7 in the long run. The range of estimates in commercial electricity was too volatile to provide any consensus on values.[12]

Al Faris (2002) used an error correction model to estimate short term price elasticity for UAE, Kuwait, Oman, Qatar and Bahrain to range from-0. 04 to-0. 18.[13]

The analysis carried out was based on an annual time series data for the period 1970-1997.

Garcia Cerruti (2000) calculated the price elasticity for residential demand for electricity in California to have an estimated mean value of -0. 17.[14]

In summary, earlier literature show that price elasticity of electricity demand are normally inelastic in the short run and tends to be more elastic in the long run. However, on the whole price elasticity of electricity demand are usually inelastic (i. e. the absolute value of the co-efficient of price elasticity is usually below 1).

MODELLING APPROACH AND DATA ANALYSIS

According to Lin (2003)[15] he identified that there were three major factors affecting the demand for electricity in any country which were, electricity

prices (tariff), GDP (Gross Domestic Product) and population. He went further to say that there were other factors as well contributing to the price of electricity which varied with different countries. Such factors includes nature of weather (i. e. people tend to use more electricity for heating purposes during cold seasons than in hot seasons) and changes in the structure of the economy.

Pouris (1987)[16] identified the two major factors affecting the demand for electricity as price and GDP.

Using the common independent variables identified by both Lin and Pouris, we have the following model;

Log EDt = a + b1LogPEt + b2 LogYt +μ————–Equation

Where:

EDt = Total electricity demand in period in a given year (Gwh)

PEt = Average price of electricity in constant terms for a given year (£/Kwh)

Yt = GDP of country for period t in constant Billion Pounds

a = Constant

b1 = Price elasticity of electricity demand

b2 = Income elasticity of electricity demand

μ= Disturbance term (represents all other factors affecting the demand for electricity)

We use the log functional form because it enables us easily determine the

price elasticity for electricity demand which is the regression coefficient of price. The price elasticity of demand for electricity is also assumed to be constant.[17]

The data used for the period is in constant terms and aggregated at the national level. We express our data in constant terms because we would like to take out the effects of inflation. The data used is aggregated at a national level because it tends to provide a more stable relationship between independent and dependent variables. Pouris (1987)[18] cited Ehrenberg's (1975)[19] work in which he (Ehrenberg) argued that the advances in physical sciences are to a great extent due to the fact that simple relationships (laws) are achievable because they usually account for the collective behaviour of million entities. Pouris (1987) then argued further that, the success of finding laws in social sciences would be in likely areas where behaviour of large individuals or objects can be aggregated.

From the above table we can see that the price elasticity of demand for electricity (for the UK) is approximately -0. 15 which agrees with economic theory that;

(a elasticities of demand are inversely related to price as shown by the negative coefficient of price elasticity and (b price elasticity of demand for electricity tends to be inelastic i. e. having an absolute value below one.

Also we do not reject the result due to the high R2 = 0. 9688 (co-efficient of determination) and the fact that the result is statistically significant i. e. the

absolute t values for real GDP and real electricity prices are above 2. While their (real GDP and real electricity prices) P values are below 5%.

The table below shows the data (for U. K.) used in carrying out the regression analysis.

The demand for electricity data and average electricity prices were sourced from the Economic and Social Data Services (ESDS) website. While the Real GDP and Consumer prices were obtained from the International Monetary Fund (IMF) website

CONCLUSION/FINDINGS

The price elasticity of electricity demand for the period (2008-2020) is about -0. 15, which is consistent with economic theory that the co-efficient of price elasticities tend to have negative values and that the price elasticities for electricity tend to be inelastic. If we assume that the price elasticity for all organization and individuals in the U. K. lies close to this value (-0. 15) and is constant through out time, then such information could have various implications for the economy.

Firstly, an inelastic demand for electricity, would mean that there would be little or no government intervention required on the supply side (existing producers and suppliers) to ensure that producers and suppliers of electricity are able to breakeven (recover costs from generated revenue). This is because an inelastic demand for electricity (with respect to price) would mean that whenever there is an increase in demand and producers have to increase their supply in order to match the rising demand, the costs associated with increasing supply can easily be passed on to the consumer.

As such, the government could be able to focus on other activities such as the provision and maintenance of public roads, hospital, and schools.

Secondly, it would enable the government easily achieve renewable energy targets set in the power generating sector, due to the fact that the potential increases in costs arising from setting renewable energy targets can easily be transferred to the consumer (due to inelastic nature of electricity demand). The government should however ensure that the targets are set in a fair main manner such that the impact of the targets are felt by all power generators in a similar way and that no undue advantage is given to any one single producer due to the implementation of such targets. Furthermore the government should ensure that the targets are set in such a way that it does not increase tariffs too much so that consumers cannot easily afford their bills. Which in turn would then reduce demand drastically (since the consumers in the short run have the option of turning of their appliances) and hence, adversely affect supply as producers may not be able to recover all their fixed cost. If this effect (rising prices drastically affecting demand) is unavoidable then the government should adopt policies that could assist in improving the disposable income of its citizens.

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