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Demand for Gasoline in United Arab Emirates

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Abstract

Despite being ranked30thworld high in terms of the HDI, the demand for gasoline in the UAE is increasing every year, aided by a very high per-capita income that ranks UAE as high as 6th in the world. The number of autos operating in the country is almost approaching the number of population causing carbon dioxide emissions to be alarming. The demand for gasoline in UAE was analyzed by utilizing log-log and ARIMA models for the 1995-2012 period and forecasted up to the year 2020. In the log-log model, quantity demanded of gasoline was regressed on its own price, population, and per-capita income, number of vehicles in UAE, HDI, and a lagged dependent variable. Results showed that population, real income per capita, and number of vehicles had positive impacts on gasoline consumption. On the other hand, real gasoline prices, human development index (HDI), and lagged dependent variable had negative effects on the demand for gasoline. Forecasting analysis showed that gasoline demand for the years following 2012 wills not significantly change. However, because of high standard deviation for each additional year, the estimated confidence interval of gasoline demand amount grew wide.

Keywords: Gasoline Consumption, Log-Log Model, ARIMA Model, Human Development Index (HDI), UAE

1. Introduction

United Arab Emirates (UAE) is made up of seven emirates; namely, Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al-Quain, Ras Al-Khaimah, and Al-Fujairah. UAE is a member of the Gulf Cooperation Council (GCC). Its GDP per capita was estimated at $39,623 in 2011. The population of the country is nearly 8.1 million and its human development index (HDI) is a very high 0.846 (30th world rank) [1]. The country is considered one of the world's major oil producers ranking 6thworldwide in terms of proven oil reserves and 7thin terms of natural gas reserves. Revenues from oil is a major funding source for the UAE economy[2].

The country, however, suffers from high carbon dioxide rates in its air because of excessive use of petroleum products, mainly gasoline, and natural gas[3]. The main objective of this study is to analyze the demand for gasoline in UAE and to identify the factors that affect its consumption. In addition, the paper aimed at obtaining a clue on the future demand for this important product through forecasting. Based on the results obtained, suggestions are lined up.

2. Literature Review

Price elasticity of gasoline demand has been one of the most analyzed topics in energy studies. Havranek, Irsova, & Janda[4]conducted a quantitative survey to determine the elasticity report-

ed for various time periods. By using a mixed-effects multilevel meta-regression it is found that while the long run elasticity of gasoline demand reached−0.31; the short-run elasticity reached only -0.09. By using household-level data, Kayser[5] realized a close relationship between household's car-portfolio and gasoline demand decisions. Since there was only short-run price and income elasticities in gasoline demand, gasoline tax was not likely to result in large decreases in gasoline consumption.

Lise and Van Montfort [6] used a cointegration analysis to unfold the linkage between energy consumption and GDP for Turkey with annual data over the period 1970–2003. Results showed energy saving would not harm economic growth in the country. Nugroho et al.,[7]developed a model of household energy consumption based on in-home and out-home activities.It is found that household vehicle fuel consumption was mostly dominated by the use of cars in Jakarta. Model showed positive influence of vehicle fuel consumption on in-home energy consumption. Sene[8] estimated the aggregate demand for gasoline in Senegal from 1970 to 2008. Results indicated to having short run elasticity smaller than long-run elasticity and that gasoline demand was inelastic with respect to both price and income for both the short and long runs. Shittu et al.[9] examined a cross-section survey of 90 Nigerian households in estimating a system of energy demand equations and elasticities. Income, household ownership of electrical/electronic appliances and automobiles, and household head's age showed significant influence on the relative shares of some of the seven energy commodities in household budgets. Demand for petrol, diesel, and domestic gas were income elastic. Wadud et al. [10]used more flexible semiparametric techniques in studying USA gasoline demand. It is shown that price responses vary with demographic variables such as income, multiple vehicles holding, and presence of multiple wage earners in rural or urban residential locations. Households' responses to a price change decreased with higher income. Dilaver[11] estimated an industrial electricity demand function for Turkey by applying the structural time series technique to annual data over the period 1960 to 2008. Results suggested that output and real electricity prices had an important role to play in driving Turkish industrial electricity demand. The output and price elasticities were estimated to be with low values of 0.15 and −0.16, respectively. In addition to the above, there have been a lot of energy demand studies in the literature. However, the researchers were not aware of any studies that have been conducted in the UAE on the subject matter. In addition, the researchers were unaware of any gasoline-demand study which used HDI in demand analysis. Forecasting has rarely been used in gasoline demand studies. The study in hand took into consideration some of the shortcomings of the published research to cover the topic in the UAE from a socioeconomic perspective.

3. Data and Methods

As a result of the unavailability of UAE monthly or quarterly time series data, annual data was used for this study. Further, appropriate data could not be found before 1995. Consequently, the series was taken after 1995 until first 5 months of 2012. Some of the published data for 2011 and 2012 were estimates of the sources.

The data was collected from different sources such as UAE National Statistical Bureau (UAENSB) [12], Gulf Corporation Council (GCC)[13],Food and Agricultural Organization (FAO)[14],U.S. Energy Information Administration (EIA)[3], International Energy Agency (IEA)[15], and United

Nations Development Program (UNDP)[1]. In order to get real value of per capita income and gasoline prices, the variables have been deflated by the consumer price index (2000=100).

Since the emphasis was on gasoline demand elasticity, the log-log model seemed to be the most appropriate one to use. Following Judge, et al.,[16] the model could be written as follows;

$$logY_t = \beta_0 + \beta_K logX_{tK} + \varepsilon_t \quad (1)$$

Where Y_t the annual amount of gasoline demanded is, X_{tK} stands for the independent variables such as per capita real income, population of the country, the real price of gasoline per gallon, Human Development Index, and lagged values of demand for gasoline. The last term of the equation, $\varepsilon_t \varepsilon_t$, is error term which assumed to have "0" expected value and σ^2 variance. The calculated elasticity of gasoline demand (β_K) in such a model is constant. That is why the equation can be named as constant elasticity model, which is very convenient for economists.

In addition, a forecasting of the demand for gasoline for the next 8 years until 2020 was made. The reason for choosing just 8 years was because of having relatively short time series data and the need to obtain more meaningful estimation. The forecasting of gasoline demand was done by conducting a simple time series model in which the demand for gasoline was regressed on time as follows;

$$Y_t = \beta_0 + \beta_1 t + \varepsilon_t \quad (2)$$

Where tt is time which takes value of "0" for the base year and increases by "1" for each additional year up to the end of time period.

In addition to the simple time series model given in equation 2, an autoregressive integrated moving-average model (ARIMA) was used to forecast the demand for gasoline in UAE. The ARIMA model includes autoregressive (AR), moving average (MA) and nonstationary integrated (I) time series models. That is why the model is more efficient than the AR, MA, and I; and provides more reliable results[17].FollowingJudge, et al., [16]the ARIMA model can be written as follows;

$$Y_t = \delta + \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + e_t + \alpha_1 e_{t-1} + \cdots + \alpha_q e_{t-q} \quad (3)$$

Where pp order is for AR, qq is order for MA part of equation 3.

By using the Box-Jenkins methodology with equation 3, forecasted future values of gasoline demand could be obtained. The Box-Jenkins methodology is more useful for short term forecasting[17]. Since we relatively have short term predictions, the methodology could be said to be appropriate.

The data used in this study coveredthe 1995-2012 periods. The variables and their coding in regression analysis could be briefly explained as follows:

Demand for Gasoline (=LNGASDMD): is the total annual quantity demanded of gasoline in UAE.

Income (=LNINC) :is per capita real income.

Population (=LNPOP): is the annual total population of the country.

Price (=LNPRICE): is real price of gasoline per gallon.

HDI (=LNHDI): is human development index of UAE.

CARS (=LNCARS): is the total number of passenger cars in the country for a given year.

LNGASD-1: is the lagged value of quantity demanded of gasoline.

4. Results

In this paper, mainly two different analyses were conducted. The first one was the utilization of log-log model for estimating UAE demand for gasoline by using time series data covering the years from1995 to 2012. The second analysis was forecasting the amount of gasoline that will be demanded for the next 8 years by using simple time series and ARIMA models.

Variables	Estimated Coefficients	Standard Error	T-statistic	Significance Level
Constant	-46.046	11.485	-4.009	0.0001
LNINC	2.202	0.587	3.751	0.0002
LNPOP	1.901	0.643	2.956	0.0031
LNPRICE	-0.242	0.108	-2.239	0.0251
LNHDI	-5.761	2.124	-2.712	0.0067
LNCARS	0.949	0.239	3.968	0.0001
LNGASD-1	-0.107	0.957	-1.118	(0.2636) Insignificant
RHO	-0.418	0.220	-1.900	0.0575

Table 1. Estimation Results of UAE Gasoline Demand

The regression results of the log-log model for gasoline demand model are given in Table 1. Results showed that the estimated coefficients (which are at the same time elasticities) are mostly significant on their effects on the quantity demanded of gasoline as anticipated. As per capita income, population of the country and the numbers of cars increase the quantity demanded of gasoline increases as well. On the other hand, as real price per gallon of gasoline, HDI, and the gasoline demand for the previous year increase the quantity demanded of gasoline decreases as expected, as well.

Variables	Estimated Coefficients	Standard Error	T-statistic	Significance Level
Constant	8036.690	804.145	9.99	< 0.0001
Time	1745.540	80.752	21.62	< 0.0001

Table 2. Forecasting of UAE Gasoline Demand for the Next 8 Years Using Simple Time Series Model (Thousand Barrels per Year)

R^2=0.97, F Ratio = 467.26

The second step was to forecast the demand for gasoline for the next 8 years. The results of simple time series and ARIMA models are given in Tables 2 and 3. The results of the simple time series model showed that the quantity demanded of gasoline increases by 1745.54 thousand barrels for each additional year, as indicated in Table 2.

Variable	Observed Demand for Gasoline	Forecasted Demand for Gasoline	Standard Error	95% Confidence Interval for Forecasted Demand
1995-1999	11325.86			
2000 -2004	19913.06			
2005-2009	29851.59			
2010-20012	35425.09			
2013		36639.2177	3042.5505	30675.9283 - 42602.5070
2014		36639.6372	4263.3769	28283.5721 - 44995.7024
2015		36639.6295	5205.9406	26436.1735 - 46843.0855
2016		36639.6297	6002.2611	24875.4141 - 48403.8452
2017		36639.6297	6704.6597	23498.7382 - 49780.5212
2018		36639.6297	7340.1488	22253.2024 - 51026.0570
2019		36639.6297	7924.8412	21107.2264 - 52172.0329
2020		36639.6297	8469.2639	20040.1775 - 53239.0818

Table 3. Forecasting of UAE Gasoline Demand for Next 8 Years Using ARIMA (Thousand Barrels per Year)

The results of ARIMA model are given in Table 3. The first 3 rows in column 2 are the average gasoline demand for a five-year period. The following row in the same column is the average for 3 years. The forecasted values for gasoline demand are given starting from the year 2013. The forecasted values arevery close to each other and for the majority of years are almost the same. Because of high standard deviation, confidence intervals are getting larger values for each additional year of forecasting.

5. Summary and Conclusion

In this study, the demand for gasoline in the UAE, an oil producing country, has been analyzed. Having positive effects of income, population growth, and number of vehicles and negative effects of the prices on gasoline demand was expected. On the other hand, the negative effect of HDI on the demand for gasoline consumption was considerably important. HDI is an indicator of the country's development. So as the country develops, the awareness of negative impacts of gasoline on the environment is realized. This result is in favor of sustainable development concept. According to the international energy agency, CO_2emissions from the consumption of petroleum were 75.7208 Million Metric Tons in 2009. The country is one of the leading economies which suffer a lot from CO_2 emission. Developing policies to increase environmental awareness and decrease demand for gasoline in the UAE will help enhancing sustainable development.

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