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Research Article

ESTIMATION OF RESIDENTIAL NATURAL GAS DEMAND FUNCTION IN RAMHORMOZ CITY

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ABSTRACT

Natural gas is considered as a clean energy that our country enjoys a relative advantage in that because after Russia, Iran is the second largest country in terms of gas reverses. Though, this advantage does not justify consumption without planning and recognition. Analysis of residential gas demand is crucial in recognizing this energy carrier and how it should be used in various regions. In the present study, variables such as natural gas price, average household income, and average temperature are used on a monthly basis over the time period of 2001-2011. This study attempts to evaluate the factors affecting residential gas demand in Ramhormoz City. Coefficient of temperature variations shows that natural gas consumption in Ramhormoz is strongly affected by temperature in the long run and by increasing temperature, gas consumption shows a great reduction. Also, results indicate that in the long run, coefficient of price variation would be negative and by increasing the price a reduction is observed in the gas consumption. Diagnostic tests verify lack of any problem in the estimated function.

Keywords: *Demand Function; Natural Gas; Price Elasticity; ARDL; ECM*

INTRODUCTION

Having huge natural gas resources, Iran enjoys the second largest gas reserves in the world after Russia. The importance of gas in providing the energy requirements of future is obvious. Since fossil fuels like oil and coal will soon reach their end, gas can compensate for this concern for a while. The present study tries to show that a planned usage of this energy resource is required and managers and planners have to be familiar with the consumption management of this valuable commodity. They have to be able to control the consumption based on the factors affecting residential gas demand and make decisions for gas provisions and even for foreign markets. To this end, we try to evaluate the natural gas demand in Ramhormoz City to pave the way for further researches in the energy field. Lotfalipour (2002) performed a study entitled, "estimating demand function of residential natural gas in Tehran." This study estimated the total demand function coefficients of residential consumers and average consumption of each household in Tehran using quarterly observations from spring 1995 to winter 1999. They used ordinary least squares method with two types of linear and logarithmic functions.

Bagheri (2003) estimated the demand faction of natural gas for residential consumption in Tehran City using quarterly data from 1995 to 1999 and evaluated the consumption behavior of natural gas in residential sector of Tehran. Results indicated the reduced elasticity of natural gas demand in residential sector of Tehran and the importance of these energy carriers for households in Tehran.

Mirbagher (2007) examined the country's gas demand in a study entitled, "study of natural gas demand (residential and commercial) in Iran." The quarterly component was random in nature and elasticity of per capita consumption of natural gas with respect to temperature was 26 percent. Long term income and price elasticities were computed as 17% and 13%, respectively.

Gudarzi (2006) studied residential gas demand. This study evaluated the sensitivity of consumers to the price variables of natural gas, average air temperature and the number of subscribers.

Sultan-al-ulamai (2009) studied the natural gas demand in his master's thesis entitled "estimating demand function using Kalman filter: case study of natural gas demand in residential sector of Tehran City".

Zulfaqari (2009) in his study, development of a new model for prediction of power and natural gas demand, studied the power and gas demands. Through development of a new method with a combination of linear and non-linear models, this study evaluated the trends in country's daily demand of power and natural gas and influential factors on daily demand of these energy carriers. Results indicated that the suggested method tends to have less error and higher accuracy in prediction of natural gas daily demand in residential sector.

Amani (2012) In his thesis entitled application of day-degree method in estimation of natural gas demand in residential sector of Iran: a panel data approach, studied gas demand. This study suggested that through affecting natural and human systems, global climate changes have induced increased concerns about the adverse effects of this phenomenon.

Sarak and Setman (2003) consider the energy consumption changes for heating in residential sector as a function of climate change and demographic trends and model the residential heating natural gas consumption in Turkey using degree-day method (Dehbashi, 2010).

Another study entitled “forecasting residential natural gas demand in Turkey” was performed by Aras (2004). This study uses a time series structure and emphasizes on the relationship between gas consumption and temperature degree of the area (Abunouri, 2010).

In their study, supply model of crude oil and natural gas in Middle East, Chadid *et al.,* (2006) introduce a model which predicts a double gas supply during 10 years with a 5 to 10 percent increase in the crude oil supply during the same period (Abunouri, 2010).

Huntington (2006) studied the industrial natural gas consumption in the US to develop an empirical model for evaluation of future trends. This study develops a statistical model of industrial natural gas consumption in the US based on the data from 1958 to 2003 and particularly studies the possibility of using intermediate fuels and changes in the industrial economy bases.

Today, everyone is aware of the role and importance of energy in production and consumption of various goods. Economic growth is impossible without energy and producers are seeking ways to reduce their production costs, particularly energy costs. Using clean and cheap energy is one of the producers’ purposes in order to increase their production. From consumers’ point of view, they also seek similar purposes in order to reduce their energy costs and also increase their utilization. Natural gas is the superior energy of the century and Iran is considered as having the second largest gas reverses following Russia. Given the abundance of gas reserves in Iran, lower cost of its extraction, refinement and transmission than oil, durability and applicability of natural gas reserves,relatively cheap price and competitiveness with other fuels, providing the welfare of households and enterprises due to the ease and continuity of access to it, lower environmental contamination relative to other fuels, huge exchange savings due to substitution of natural gas for other fuels such as kerosene, fuel oil and gasoline and many other advantages, one can conceive the important role of natural gas at present and particularly in future as one of the major providers of energy required by various consumption sectors of country.

With respect to the targeted subsidies law and increased price of energy carriers, major energy management programs in the country level include the substitution of cheap and eco-friendly energies through enhancing the gas distribution network, using natural gas as the main fuel of plants and major industries, application of compressed natural gas and liquid gas as the fuel of automobiles and supply management in distribution of oil products. Given the works accomplished in supply management, some comprehensive programs are also needed for energy consumption and demand.

Evaluating the demand pattern of natural gas and its influential factors can be a major movement towardplanning for proper management of energy demand and consumption. Using the study results of natural gas demand and through proper management of demand, energy planning sector can cause a huge saving in energy consumption and also correct the energy consumption patterns. Generally, the purpose of the present study is to evaluate the residential gas demand in Ramhormoz City through estimation of residential gas demand function.

MATERIALS AND METHODS

Econometric approaches are the oldest modeling methods. Econometric models are of a deductive type. These approaches are exclusively applicable when there are enough historical observations for the model variables. In these models, the past behavior of variables is extrapolated using historic data and extended to the future. Since in econometric methods, future relationship between variables is based on their past relationship, application of these methods requires stability in the economic behavior reactions. These models are most suited for short term predictions.

It was previously mentioned that structural econometric models are based on economic theories. A significant proportion of energy demand models are based on the optimization of consumer behavior. Linear expenditure system of Stone, Rotterdom demand model, translog indirect utility system, and almost ideal demand system are considered as most well-known energy demand patterns. Since these demand systems are obtained by constrained optimization of utilization functions in a time period, all of them are static. These models include linear expenditure system of stone, translog demand system, Rotterdom demand system and almost ideal demand system.

Non-structural econometric models are based on causality between macroeconomic variables regardless of economic theories. In these models which are also called time series patterns, the behavior of a variable is described based on its previous values. Since these models are not based on economic theories, they are not much suitable for analysis of economic policies and are mostly used for prediction.

In cases where exploitation of structural models is not possible due to lack of specific economic theories, one can predict the economic variables using non-structural models. In univariate non-structural models, current values of a variable are expressed in terms of its previous values and current and past values of error terms. Vector autoregression and Error correction models are two examples of such models.

Error Correction Model

In the series of papers published from 1954 and 1957, Philips first introduced the vector error correction model to the economics literature. This model which was then used by Hendry et al in the analysis of money consumption and demand is considered as a dynamic model. Though, there are various types of dynamic models in the applied time series. In addition to the error correction model, other dynamic models include distributed lag model, adaptive expectation model, partial adjustment model, and rational expectation models including expectations of future values of exogenous variables and rational expectations models with expectations of future values of endogenous variables. Distributed lag models include simple distributed lag models (Almon or polynomial), rational distributed lag models and autoregressive distributed lag models (ARDL).

Data Analysis

The present study aims at exploring influential factors on residential gas demand in Ramhormoz City and also the type and level of their effects. Study area includes the geographical area of Ramhormoz City in Khuzestan Province and the time period was chosen based on the time series monthly statistics of 2001 to 2011. There is an indirect relationship between natural gas price (PR), as one of the main and influential variables on natural gas demand, and the level of gas demand. Income data (RE) were extracted from management and planning statistical yearbook and adjusted on a monthly basis. Temperature (TE) was measured in the morning, at noon and at night and an average temperature was chosen for each day. At the end of each month, these figures were added and divided on the number of days and the average temperature of each month was announced by meteorological department. Since estimation of long term and short term relationships between model variables in this study is performed based on the dynamic autoregressive distributed lag model (ARDL), the general framework of the model and its processes are explained after performing unit root tests. The aim of the present study is to empirically estimate the residential demand function of natural gas in Ramhormoz City.

Model Specification

In order to evaluate the natural gas demand, the used functional form is as follows:

$$CO=INPT+\beta_1 RE+\beta_2 PR+\beta_3 TE+u_t$$

The used variables in estimation of natural gas demand function in Ramhormoz City are income, temperature and the price of natural gas.

INPT: constant coefficient, CO: natural gas consumption in Ramhormoz City, RE: household income, PR: natural gas price, TE: temperature in Ramhormoz, u: error term, parameters β_i (i=1,2,3)indicate the elasticity of demand function with respect to explanatory variables.

Checking Stationary of Time Series

To ensure reliability of estimated model coefficients, stationary of model variables should be verified by stationary tests. In order to check the stationary of time series, the conventional augmented Dicky-Fuller (ADF) test was used (table 1). To this end, an augmented Dicky-Fuller test for unit root is first performed in the variable level with the presence of intercept exogenous variables and time trends. Stationary check of variables was performed by Eviews 8.

By comparing computational statistic values with critical Dicky-Fuller values at 5 percent error level it could be said that: given the results of stationary test, all the model variables are not stationary. In order to obtain an efficient estimation, we used autoregressive distributed lag method (ARDL).

Table 1: Results of stationary Test

Differentiation	Level	t-statistics	Prob.	Variable name
-	Stationary	-9.7664	0.0000	TE
-	Non-stationary	-2.22067	0.4738	PR
-	-	-3.855928	0.0167	DPR
stationary	stationary	-10.52331	0.0000	CO
-	Non-stationary	5.365981	1.0000	RE
-	-	-6.978877	0.0000	DRE

**D represents that one differentiation operation has been carried out.*

Model Estimation

Estimation of Dynamic ARDL Model

In this section, in order to ensure the presence of a long term relationship, dynamic ARDL model has been estimated with lags determined by Schwartz Bayesian criteria.

According to the results in table 2, computed value of F statistic in comparison with its value in F table at 0.05 percent level of significance shows that the whole regression equation is not statistically rejected. Also, the adjusted coefficient of determination($\bar{R}^2$) was 0.89. This value shows that explanatory variables of model explain 89 percent of variations in natural gas supply. Therefore, the model is highly explanatory.

Table 2: Quantitative estimation results of dynamic model of natural gas demand function

Prob.	Explanatory variables	Estimated coefficients	Value of t statistic
0.000	12.7569	0.88614	CO(-1)
0.000	-8.9466	-0.50751	C0(-2)
0.000	4.8263	0.00604	RE
0.000	-8.9633	-35947.2	TE
0.041	2.0678	1772.7	PR
0.031	-2.1859	-1901.2	PR(-1)
0.000	8.50001	1159052	INPT
R^2=0.8992	$\overline{R^2} = 0.89434$	F(6.122)=118.5658(0.001)	D.W=2.1105

Source: study calculations

Table 3: Results of diagnostic tests for dynamic model of natural gas demand

F_{test} Prob.	$F_{statics}$	LM_{test} Prob.		Autocorrelation test
0.110	2.3659	0.124	2.6179	
0.158	1.9686	0.183	1.8514	Functional form
Not applicable		0.667	0.81134	normality
0.093	2.9259	0.084	3.4711	Hetero scedasticity

Source: study calculations

In order to ensure the accuracy and validity of estimated relationships, a diagnostic test is needed. Table 3 summarized the test results for the above dynamic model.

Given that in all cases the minimum probability value (prob) of accepting null hypothesis is more than 0.05 at the 5 percent error level, autocorrelation of error term and heteroscedasticity are rejected with the error term having a normal distribution. As it can be observed, the signs of estimated coefficients are consistent with the theoretical bases. All the coefficients are at the confidence level of 95 percent and the coefficient of determination is 92 percent which indicates the high explanatory power of model. Also, diagnostic tests verify that all classic assumptions (lack of autocorrelation, correct functional form, normal residual terms and homoscedasticity) hold for the model.

Estimation of Long Term Coefficients

Since the co integration relationship between variables was no rejected, coefficients of long term estimated model in table 4 are presented in this section.

Table 4: Quantitative results of model estimation in the long run

Prob.	$t_{statistics}$	Explanatory variables	Estimated coefficients
0.000	5.1051	0.0097	RE
0.000	-11.1559	-57851.4	TE
0.049	-3.68064	-207.036	PR
0.000	10.2985	1865313	INPT

Source: study calculations

Results of the above table indicate that:

1. Coefficient of income variable suggests that by increasing income, the consumption and tendency to consume gas increase. These results are consistent with the theoretical bases.
2. Coefficient of temperature variable variations suggests that in the long run, the consumption of natural gas in Ramhormoz is significantly influenced by temperature. Therefore, by increasing the temperature, there is a drastic reduction in gas consumption. The obtained results are consistent with the theoretical bases.
3. Results show that in the long run, coefficient of prices variations would be negative and by increasing the price, the natural gas consumption shows a reduction.

Estimation of Error Correction Model

Error correction model associated with ARDL dynamic model of natural gas supply is showed in table 5:

$$\mathrm{dCO} = \mathrm{dINPT} + \beta_1 \mathrm{dRE} + \beta_2 \mathrm{dPR} + \beta_3 \mathrm{dTE} + \mathrm{du}_t$$

Table (5) presents the coefficientspertaining to the estimation of error correction model which indicate the relationship between first order difference of natural gas demand functions and first order difference of explanatory variables in the short run.

Table 5: Quantitative results for estimation of error correction model of natural gas demand function in Ramhormoz City

Prob.	Value of $t_{statics}$	Explanatory variables	Estimated coefficients
0.000	8.9466	0.50751	Dco
0.000	4.8263	0.006036	Dre
0.000	-8.9633	-35947.2	dTR
0.041	2.0678	1772.7	Dpr
0.000	-14.5595	-0.62137	$ECM(-1)$
R^2=0.72732	$\overline{R^2} = 0.71391$	F(6.122)=65.0826(0.000)	D.W=2.1105

Source: study calculations

RESULTS AND DISCUSSION

Results of the above table indicate that estimated coefficients of variables in demand function of natural gas are significant at 5 percent level. Given the adjusted coefficient of determination (0.71), explanatory variables of the model have explained about 71 percent of variance in demand function of natural gas. Estimated coefficients of variables natural gas price and income are significant at 5 percent level. Given the adjusted coefficient of determination (0.72), explanatory variables of model explain about 72 percent of variance in demand function of natural gas.

Error correction coefficient of natural gas supply function ECM(-1) has been estimated to be -0.62137. This coefficient is negative and less than unity and it is statistically significant at 5 percent error level. Estimated coefficient of error correction indicates the adjustment speed from short term imbalance to the long term balance; so that, in each period about 62 percent of imbalances in previous period are adjusted in demand function of natural gas in current period.

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