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Estimation of demand function for natural gas in Iran: Evidences based on smooth transition regression models

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ABSTRACT

This paper attempts to study the demand function of natural gas in Iran using smooth transition regression model (STR). To this end, gross domestic productions (GDP), real price of natural gas and temperature have been employed as variables explaining the natural gas demand from 1971 to 2009. The results indicate that natural gas demand follows an LSTR1 nonlinear two-regime model if the real price of natural gas is considered as the transition variable. Estimation results also indicate that the slope parameter approximately equals the high value of 10 and the threshold value is 31.82 Rials[1] per one cubic meter consumption of natural gas. The results strongly suggest that natural gas demand follows the gross domestic production during the last years, but temperature has no significant impact on natural gas demand in Iran.

1. Introduction

Oil shock of the 1970s turned energy into an important factor of production alongside capital and work force. On the other hand, intensification of environmental problems caused by fossil fuels during the recent decades brought about another challenge for fossil fuels as the most significant energy source in the world. All these issues made the nations and politicians emphasize the necessity of having various energy sources and consuming efficient and clean energies. Factors such as wide distribution of gas throughout the world, its low extraction costs, its competitive price with respect to its heating value and the fact that it produces less environmental pollution in comparison with other fossil fuels have led to a continuous and considerable increase in gas consumption.

According to statistics published by the U.S. Energy Information Administration (EIA), Iran, after Russia, holds the richest gas reservoirs in the world. In fact, 15% of the world's gas reserves are located in Iran reservoirs. Although Iran enjoys rich natural gas reservoirs, the consumption of this energy carrier in Iran has taken an incremental trend. The trend not only exceeds the expected consumption level, but also is several times higher than the average level of consumption of the world and even overpopulated countries such as China, India, and Indonesia. This is partly due to the current inefficient pricing system, which is not based on economic principles. As a result, the price of gas has remained low which has led to people's inappropriate consumption behavior. Therefore, the study of natural gas demand model in Iran can have valuable recommendations for policy-making.

Energy demand, particularly natural gas demand, has long been a subject of interest for researchers as much significance is attached to this issue. The experimental studies on natural gas demand dates back to the 1970s and USA. Balestra and Nerlove (1966), Bloch (1979), Herbert (1987), and Maddala et al. (1997) can be mentioned among studies undertaken on this subject. More recently, further studies have been conducted on modeling the demand function of natural gas using tools and economy metric techniques in recent years (Sultan (2010), Isik (2010), Bernestein and Madlener (2011), Payne et al. (2011)). One of the challenges lying in modeling and estimation of natural gas demand function is the use of an appropriate and reliable economy metric technique. Since the relationship between variables follows an asymmetrical and nonlinear model in economic phenomena, the results obtained from estimation of this range of economic relations in the form of linear models are not reliable. One of these relations is the one between demand for energy carriers (e.g., natural gas) and factors influencing the demand level. In fact, a nonlinear relationship between natural gas demand and variables influencing it can be expected. Among such variables, price of alternative energy, revenue, and temperature can be mentioned. Therefore, many of the studies of recent years (Moral and Vicens (2005), Bessec and Fouquau (2008), and Joets and Mignon (2012)) recommend the use of regime switching models for the evaluation of asymmetric and nonlinear behavior existing between energy carriers and the influencing variables.

Despite the significance of natural gas demand in Iran, few studies using the linear regression model approach have been conducted in Iran. Lotfalipour and Bagheri (2003) have estimated the demand function of natural gas in the residential sector of Tehran using the

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[1] 1 USD = 24,700 Rials (IRR) @ April 2013.

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time series linear regression method. They concluded that gas demand is a function of level and logarithm of "natural gas price," "revenue per capita," "average temperature" and "the number of families consuming gas" variables. Based on their results, the income and price elasticities of natural gas demand in Tehran equal 1.35 and −1.4, respectively. Azarbayjani et al. (2008) also estimated the demand function of gas in the industry sector of Iran per explanatory variables of value-added of industry sector, price of natural gas, price of electricity, and price of oil products using autoregressive distributed lag model (ARDL) and vector error correction model. Based on obtained results, price of gas and electricity does not have any significant impact on gas consumption in the short-term; however, the coefficient sign of gas price is negative and price of electricity has a positive influence on natural gas demand in the long-term. Further, based on the significance and cross elasticity sign of price of oil products, this variable complements natural gas in the industry sector. The value-added of the industry sector has a significant and positive impact on natural gas demand.

The objective of the current research is the estimation of demand function of natural gas in Iran using smooth transition regression model (STR).

STR is one of the most significant regime switching models. This model is able to model the nonlinear relationship between variables using transition function and in a continuous manner. Further, it can determine the number and time of regime switching as well as the speed of switching from one regime to another. To the best of the authors' knowledge of this present paper, no studies have so far evaluated the natural gas demand in Iran using the STR approach.

The second chapter of the paper deals with Literature review, and Methodology is dealt with in the third chapter. Section 4 explains about the Data and experimental results. Section 5 concludes the discussion.

2. Literature review

Balestra and Nerlove (1966) were the first to study the subject under question for America. Their study determines demand function of natural gas in America as a function of real revenue, real price of gas and population. In his experimental study, Bloch (1979) specified gas demand as a function of real price of gas, temperature, and timeline. Herbert (1987) specified gas demand in USA as a function of price of gas, temperature, revenue per capita, real price of electricity and virtual variable for 1973–1974. In an experimental study, Maddala et al. (1997) estimated demand function of natural gas in USA in terms of revenue per capita, real price of natural gas, price of electricity and temperature.

A considerable number of studies have been focused on natural gas demand as new economy metric approaches have spread and as natural gas demand has assumed much significance in different countries in recent years. For instance, Yoo et al. (2009) analyzed and estimated the natural gas demand of the residential sector in Seoul using sampling bias correction method. The results of their case study indicated that the area of the house, income of family, and the virtual variable for living in apartments had a positive and significant impact on natural gas consumption in Seoul. On the other hand, the number of family members and the price of natural gas have a significant and negative relationship with natural gas consumption in Seoul. Shukla et al. (2009) studied the natural gas demand of the electricity sector in India using the ANSWER MARKAL model. According to the results obtained, natural gas demand maintains a reverse relationship with the price of coal in such a way that increase in gas demand decreases coal supply; thus, natural gas can be considered as an alternative for coal. In a study conducted in Mauritius, Sultan (2010) estimated the petrol demand function in the transportation sector using bounds test to cointegration method and ARDL dynamic model. The results indicated that the long-term elasticities of price and income were −0.44 and 0.77 and the short-term elasticities were −0.21 and 0.37, respectively. Isik (2010) studied the relationship between natural gas consumption and economic growth in Turkey using the bounds test to cointegration method and the ARDL dynamic model. The results showed that gas consumption has a positive impact on economic growth in the short-term, but in the long-term there is a negative relationship between the two variables. Bernestein and Madlener (2011) also estimated natural gas demand as a function of real income, real price of gas and temperature for the residential sector in OECD countries using the bounds test to cointegration method and the ARDL dynamic model. According to the results, the elasticity of real income and price of gas demand is less than 1 and the elasticity of temperature is larger than 1. Payne et al. (2011) estimated the natural gas demand function for the residential sector in USA in terms of real income, real price and temperature and real price of oil products using time series model of ARDL and the bounds test to cointegration method. According to the findings, coefficients are significant in the long- and short-term and long-term elasticities were larger than short-term elasticities.

All the above-mentioned studies examined natural gas demand within the framework of linear regression models. However, it is most likely that natural gas demand follows a nonlinear model. Thus, the studies adopting regime-switching economy metric approaches are reviewed below. Among such studies, Moral and Vicens' (2005) study on threshold impacts of temperature on electricity demand in Spain using nonlinear smooth transition regression model can be mentioned. The results indicated that temperature as a threshold variable plays a role in the nonlinear behavior of electricity demand in Spain. Bessec and Fouquau (2008) also studied the relationship between electricity demand and temperature in 15 European countries using panel smooth transition regression model (PSTR); the existence of such a relationship was proved for most of those countries. On the other hand, nonlinear models were of better results in tropical regions rather than in cold areas. Aslan (2011) carried out a study on the presence of any nonlinear and durable behavior on the timeline of gas consumption in 50 states of America. Based on the results of the nonlinear test on the ESTAR model, nonlinear behavior was observed in 60% of the data related to American states. Based on nonlinear unit root tests, a nondurable trend of gas consumption was observed in 27 states, and a durable trend of gas consumption was observed in 23 states. Joets and Mignon (2012) studied the nonlinear relationship between the price of different energy carriers such as oil, gas and electricity in terms of a panel smooth transition regression model. According to the cointegration test, there was a significant and positive relation between the price of oil and price of gas and coal. However, the results indicated a negative relation between the price of oil and electricity. The estimation results of the PSTR model showed that the long-term transition process of oil price is nonlinear and follows an asymmetric process.

Tolga et al. (2012) studied the relation between energy consumption and economic development for G7 countries as per ESTAR nonlinear models and panel vector error correction nonlinear model. Their results indicated a causative nonlinear relationship between energy consumption and economic development for G7 countries.

Chien-Chiang and Yi-Bin (2013) studied the energy demand function in OCED countries as per the panel smooth transition regression model. Their results showed a significant long-term nonlinear relation between energy consumption, real income and real price of energy in OCED countries. The ratio of gross capital to gross domestic production was considered as the transition variable according to the obtained results.

Joëts and Mignon (2011) studied the nonlinear co-set relation for the price of energy resources such as gas, coal, electricity and petroleum as per panel smooth transition regression model. Their results showed an asymmetric long-term relation between the prices of various energy carriers. The results on the other hand indicated that petroleum price maintained a positive relation with the price of gas resources and coal, and maintained a negative relation with the price of electricity. This emphasizes the fact that these two energy resources can be substituted.