Applied Energy 87 (2010) 211–219

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Natural gas demand in Turkey

Erkan Erdogdu *,[1]

Energy Market Regulatory Authority, Ziyabey Cad. No.: 19 06520 Balgat, Ankara, Turkey

ARTICLE INFO

Article history:
Received 12 December 2008
Received in revised form 26 June 2009
Accepted 8 July 2009
Available online 6 August 2009

Keywords:
Turkish natural gas demand
Elasticity
ARIMA modelling

ABSTRACT

On average, energy demand of Turkey is mounting by 8% annually, one of the highest rates in the world. Among primary energy sources, natural gas is the fastest growing one in Turkey. Gas consumption started at 0.5 bcm (billion cubic meters) in 1987 and reached approximately 35 bcm in 2007. Turkish natural gas usage is projected to further increase remarkably in coming years. The present paper focuses the characteristics of this demand and estimates short and long-run price and income elasticities of sectoral natural gas demand in Turkey. The future growth in this demand is also forecasted using an ARIMA modelling and the results are compared with official projections. The paper reveals that natural gas demand elasticities are quite low, meaning that consumers do not respond possible abusive price increases by decreasing their demand or substituting natural gas with other energy sources. Since consumers are prone to monopoly abuse by incumbent, there is a need for market regulation in Turkish natural gas market. Based on forecasts obtained, it is clear that the current official projections do not over/under-estimate natural gas demand although past official projections highly overestimated it.

1. Introduction

The Republic of Turkey, located in Southeastern Europe and Southwestern Asia (that portion of Turkey west of the Bosporus is geographically part of Europe[2]), has an area of about 780,580 sq km and a population of over 70 million [2]. With its young population, growing energy demand per person, fast growing urbanization and economic development, Turkey has been one of the fast growing power markets of the world for the last two decades. Turkey is an energy importing country; more than half of the energy requirement has been supplied by imports.

Turkey's primary energy sources include hydropower, geothermal, lignite, hard coal, oil, natural gas, wood, animal and plant wastes, solar and wind energy. In 2004, primary energy production and consumption has reached 24.1 million tonnes (Mt) of oil equivalent (Mtoe) and 81.9 Mtoe, respectively. Fossil fuels provided about 86.9% of the total energy consumption of the year 2004, with oil (31.5%) in first place, followed by coal (27.3%) and natural gas (22.8%). Turkey has not utilized nuclear energy yet.[3] The Turkish coal sector, which includes hard coal as well as lignite, accounts for nearly one half of the country's total primary energy production (43.7%). The renewable collectively provided 13.2% of the primary energy, mostly in the form of combustible renewables and wastes (6.8%), hydropower (about 4.8%) and other renewable energy resources (approximately 1.6%) [3].

Turkey has initiated a major reform program of her energy market. The reform program entails privatization, liberalization as well as a radical restructuring of the whole energy sector, especially electricity and natural gas industries. Also, an autonomous regulatory body, Energy Market Regulatory Authority (EMRA), was created to set up and maintain a financially strong, stable, transparent and competitive energy market.

The most controversial reason behind, or justification for, recent reforms has been the endeavor to avoid so-called "energy crisis". Therefore, the present article focuses on the natural gas demand in Turkey by presenting a demand estimation and forecast. Besides, the econometric analysis here contributes to extremely limited literature in Turkish natural gas demand studies.

The article is organized as follows. The next section presents a literature review in energy demand studies. Section 3 concentrates on the scope of the study. Section 4 specifies the study methodology. Section 5 provides an overview of data used in the estimation

* Tel.: +90 312 2872560.
E-mail addresses: erkan@erdogdu.net, eerdogdu@epdk.org.tr.
URL: http://erkan.erdogdu.net.

[1] The author is working as an Energy Expert in Energy Market Regulatory Authority of the Republic of Turkey. In October 2005, the author is awarded an "M.Sc with distinction" by the Department of Economics, University of Surrey (UK). The present paper is a part of wider study on Turkish energy market, a part of which is published in Energy Policy. The views, findings and conclusions expressed in this article are entirely those of the author and do not represent in any way the views of any institution he is affiliated with.

[2] In October 2005, European Union (EU) opened accession negotiations with Turkey, who has been an associate member of the EU since 1963 and an official candidate since 1999. For a more detailed discussion of EU-Turkey relations, see Erdogdu [36].

[3] For a more in depth discussion of nuclear energy in Turkey, see Erdogdu [37].

0306-2619/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.apenergy.2009.07.006

and forecasting process. In Section 6, study results are presented; followed by evaluation of these results in section seven. The last section concludes.

2. Literature review

The experiences of the 1970s and 1980s led to a blast in the number of energy demand studies, a trend that has been to some extent revitalized by the emergence of worries about the emissions of greenhouse gases from the combustion of fossil fuels. Therefore, since the early 1970s, various studies of energy demand have been undertaken using various estimation methods.[4] In most of these studies the purpose has been to measure the impact of economic activity and energy prices on energy demand, i.e. estimating income[5] and price[6] elasticities, which are of the utmost importance to forecasting energy demand. The evidence shows long-run income elasticities about unity, or slightly above, and the price elasticity is typically found to be rather small [4].

In most cases, energy demand studies have adopted two different types of modelling; namely, "reduced form model" and "structural form model". The former is a double-log linear demand model under which energy demand is assumed to be a direct linear function of energy price and real income. Kouris [5], Drollas [6] and Stewart [7] have employed this model in their studies. Moreover, Dahl and Sterner [8] report that more than sixty published studies applied the reduced form model. On the other hand, the second model is a disaggregated demand model based on the idea that the demand for energy is derived demand; that is, energy is not demanded for its own sake rather for the services it provides such as lighting, heating and power. It separates energy demand into several numbers of demand equations and treats it as an indirect, rather than direct, function of energy price and real income. Pindyck [9] provides a detailed discussion of the structural form model. Although structural form model has various advantages over reduced form model from an economic point of view, its widespread utilization has been limited by the fact that it requires a large number of variables compared to the reduced form model.

Another model for energy demand estimation, namely "irreversibility and price decomposition model", was first proposed by Wolffram [10] and developed by Traill et al. [11]. Originally, it was based on the assumption that the response to price reductions would be less than that to price increases. This model was further improved by Dargay [12] and Gately [13], who introduced three-way price decomposition to isolate the effects on demand of price decrease, price increase below and above the historic maximum. Some of the work using this method includes that of Dargay and Gately [14,15], Haas and Schipper [16], Ryan and Plourde [17], just to mention a few. However, it is important to note that most of the studies that applied this method could not find evidence of irreversibility.

Despite the relative popularity of the above methods, the long time span covered by these studies raises serious concerns about the validity of the fixed coefficients assumption in the energy demand equation employed by these methods. This assumption in a double-log functional form of demand simply implies constant elasticities for the entire sample period under study. This feature of the model is indeed questionable in light of the changes that could have taken place in the economy over such a long period of time affecting the demand for energy.[7] Therefore, it is argued that if data is collected over a relatively long time period to estimate an energy demand function, the possibility that the parameters in the regression may not be constant should be considered. Furthermore; previous methods, in general, utilize time series data to estimate energy demand but they do not analyze the data to establish its properties and therefore they implicitly assume the data to be stationary, meaning that their means and variances do not systematically vary over time. However, this attractive data feature is lacking in most cases. Engle and Granger [18] have developed a technique, popularly known as "cointegration and error correction method" (ECM), for analyzing time series properties and estimating elasticities based on this analysis, which enables full analysis of the properties of the relevant data before actual estimation. In their study, Engle and Granger have devised a model estimation procedure and recommended a number of tests, among which the most notable and commonly used is the Augmented Dickey–Fuller (ADF) test. Subsequent improvements related to this approach have been in the form of inclusion of more specific energy-related variables in the model and the development of new methods to identify cointegrating relationships, amongst which the Autoregressive Distributed Lag Model (ARDL) and the Johansen Maximum Likelihood Model (JML) – as outlined in Johansen [19] – are especially popular.

As for the history of energy demand projection in Turkey; although some efforts for the application of mathematical modelling to simulate the Turkish energy system were made during the late 1970s, the official use of such methods in energy planning and national policy making by the Ministry of Energy and Natural Resources (MENR) was realized only after 1984. The forecasts made before 1984 were simply based on various best fit curves developed by the State Planning Organization (SPO) and MENR. The year 1984 has been a milestone for energy planning and estimation of future energy demands in Turkey since, in that year, the World Bank recommended MENR use the simulation model MAED[8] (Model for Analysis of Energy Demand), which was originally developed by the IAEA (International Atomic Energy Agency) for determination of the general energy demand. Besides, the energy demand model called "EFOM-12 C Mark I" developed by the Commission of the European Communities in 1984 was applied to Turkey. Furthermore, Kouris' correlation models were also applied for forecasting the primary and secondary energy demands in Turkey. Moreover, the BALANCE and IMPACT models were used in the context of ENPEP (Energy and Power Evaluation Program) for the long-term supply and demand projections. Finally, State Institute of Statistics (SIS) and SPO have developed some mathematical models [20].

Since 1984, the Ministry (MENR) prepares energy production and demand projections in accordance with the growth targets given by SPO. Projections are made taking into account various factors including development, industrialization, urbanization, technology, conservation and so on. The figures are revised each year in the light of the performance over the past year [21]. Unfortunately, the official forecasts have consistently predicted much higher values than the consumption actually occurred. There may be several reasons of these projection failures. Utgikar and Scott [22] conducted a research to identify and analyze the causes of failures in energy forecasting studies.

[4] Since economic theory and a priori knowledge indicates that the demand for energy in general depends on price and income, most of the studies in this area have been concentrated on these two variables as the major determinants of energy demand.

[5] The income elasticity of energy demand is defined as the percentage change in energy demand given a 1% change in income holding all else constant. This measure provides an indication of how demand will change as income changes.

[6] The price elasticity of energy demand is defined as the percentage change in energy demand given a 1% change in price holding all else constant. This measure calculates the influence of energy price on energy demand.

[7] See Hass and Schipper [16] for further discussion of the issue.

[8] The MAED is a detailed simulation model for evaluating the energy demand implications (in the medium and long term) of a scenario describing a hypothesized evolution of the economic activities and of the lifestyle of the population. It requires a number of data inputs from various sectors to simulate the energy demand for the desired years.