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Estimating industrial and residential electricity demand in Turkey: A time varying parameter approach

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ABSTRACT

This paper estimates the price and income elasticity of industrial and residential electricity demand in Turkey for 1960–2008 period. Time varying parameters model based on Kalman filter is employed. The results show that the income and price elasticities of industrial and residential electricity demand are lower than unity. The income elasticity of demand has a positive sign and it is statistically significant which is 0.979 and 0.955 for industrial and residential electricity demand, respectively. Thus, an increase in per capita electricity consumption is less than increase in per capita income. Moreover, the estimates of price elasticity are very inelastic for both residential and industrial electricity demand. The price elasticity of industrial electricity demand is −0.014 and price elasticity of residential electricity demand is −0.0223. Therefore, the price increase will not discourage residential and industrial electricity demand and consumers will show little response to electricity price variations because electricity is a necessary good.

1. Introduction

Over the past decades, electricity as one of the most significant components in energy sources has witnessed substantial increases in consumption figures mainly due to the growing population, increasing living standards and industrialization process. The observed upward trend in electricity consumption has therefore led to a great deal of empirical studies because electricity is a crucial input for technical, social and economic development of any country.

In Turkey, electricity demand has been growing in parallel with the urbanization and industrialization level and economic development as the other countries. An increasing trend in electricity consumption of Turkish economy has been recently becoming an issue of concern for the policy makers in Turkey. In the last decade, Turkey has been the second country, after China, in terms of natural gas and electricity demand increase (TMFA (Turkey Ministry of Foreign Affairs) [1]). Furthermore, the rise in electricity demand exceeded economic growth in the last two decades. The rapid increase in electricity consumption could be explained by a number of factors that include economic growth and increased urbanization. Moreover, with the support of growing population, electricity demand in Turkey has a great potential for further growth given the fact that Turkish economy has enjoyed relatively rapid economic growth over the last decade. At present, Turkey ranks among the fastest growing energy markets in the world. The country is the 17th largest economy in the world, and total electricity demand in 2010 was 211 TWh (Ozer et al. [2]).

Aggregate electricity consumption, one of the key indicators of economic activity, grew by an average of about 9% per annum between 1970 and 2010. It reached a level of 156 TWh in 2009 and 193 TWh in 2010. Currently, industrial sector after the residential electricity consumption makes up the biggest share of total electricity demand in Turkey. Transportation and agriculture sectors are relatively small electricity consumers. Net electricity consumption in Turkey was 13.50 TWh in 1975 and it increased to 46.82 TWh in 1990 and 156.90 TWh in 2009.

As of 2009, residential electricity consumption (80.68 TWh) accounted for %51 of total electricity consumption while industrial electricity consumption (70.47 TWh) was the second with a share of %45 in total electricity consumption. The remainder of total electricity consumption, that is, agricultural sector and transportation constituted relatively small share, thus they could be ignored (Hamzacebi [3]; Bilgili et al. [4]; Dilaver and Hunt [5]; Dilaver and Hunt [6]; Seckin et al. [7]).

The main aim of this paper is to estimate the time-varying price and income elasticity of disaggregate electricity demand (industrial

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Table 1
Summary of selected studies on price and income elasticity.

Study	Period	Country/sector	Methodology	Income elasticity		Price elasticity	
				Short-run	Long-run	Short-run	Long-run
Dilaver and Hunt [5]	1960–2008	Turkey -Residential	Structural time series model	0.38	1.57	−0.38	−0.09
Dilaver and Hunt [6]	1960–2008	Turkey -Industrial	Structural time series model	0.149		−0.160	
Inglesi-Lotz [15]	1980–2005	S. Africa -Residential	Kalman filter	0.794		−0.075	
Lee and Chiu [16]	1978–2004	24 OECD Countries -Aggregate	Panel smooth transition regression	0.365 (All countries) 0.882 (Turkey)		−0.229 (All countries) −0.228 (Turkey)	
Dergiades and Tsoulfidis [17]	1964–2006	Greece -Residential	ARDL	0.642	0.795	−0.092	−0.606
Nakajima and Hamori [18]	1993–2008	Japan -Residential	Panel cointegration	0.602		−1.127	
Athukorala and Wilson [19]	1960–2007	Sri Lanka -Aggregate	Johansen cointegration	0.43	0.78	−0.58	−0.61
Amusa et al. [20]	1960–2007	S. Africa -Aggregate	ARDL	0.217	1.673	0.038	0.298
Sa'ad [21]	1973–2007	South Korea -Residential	Structural time series model	0.56	1.33	−0.14	−0.27
Dergiades and Tsoulfidis [22]	1965–2006	USA -Aggregate	ARDL	0.101	0.278	−0.386	−1.065
Ziramba [23]	1978–2005	S. Africa -Residential	ARDL	0.30	0.31	−0.02	−0.04
Halicioglu [24]	1968–2005	Turkey -Residential	ARDL	0.44	0.70	−0.33	−0.52
Atakhanova and Howie [25]	1994–2003	Kazakhstan					
		-Aggregate	Panel GMM	0.72		0.00	
		-Industrial		0.78		0.00	
		-Services		0.75		−0.12	
		-Residential		0.12–0.59		−0.22 to −1.10	
De Vita et al. [26]	1980q1–2002q4	Namibia -Aggregate	ARDL	–	0.589	–	−0.298
Narayan and Smyth [27]	1969–2000	Australia -Residential	ARDL	0.012–0.041	0.32–0.41	−0.26	−0.54 to −0.47
Hondroyiannis [28]	1986–1999	Greece -Residential	Johansen cointegration	–	1.56	–	−0.41
Al Faris [29]	1970–1997	Saudi Arabia	Johansen cointegration	0.05	1.65	−0.04	−1.24
		UAE		0.02	2.52	−0.09	−2.43
		Kuwait		0.70	0.33	−0.08	−1.1
		Oman		0.02	0.79	−0.07	−0.82
		Bahrain		0.02	5.39	−0.06	−3.39
		Qatar		0.08	2.65	−0.18	−1.09
Erdogdu [30]	1984Q1–2004Q4	Turkey -Aggregate	Time series analysis	1.094		−0.012	
Dilaver and Hunt [31]	1960–2008	Turkey -Aggregate	Structural time series model	0.17		−0.11	
Amarawickrama and Hunt [32]	1970–2003	Sri Lanka -Aggregate	Time series analysis	1.80–2.00		0 to −0.06	
Ang et al. [33]	1972–1990	Singapore -Residential	Time series analysis	1.00		−0.35	

and residential) in Turkey over the 1960–2008 period by using TVP approach (time varying parameters). This study makes two main contributions in the existing literature. First, we formulate the electricity demand function for disaggregated level by introducing real income and real price of electricity. Second, we implement time varying parameters approach. The TVP approach, contrary to alternative estimation procedures, offers a more convenient way to estimate the electricity demand function and yield more reliable results regarding the price and income elasticities of electricity demand because it considers the effects of structural breaks and regime shifts on the determinants of electricity demand. The number and the timing of parameter changes are determined by the data. Furthermore, the parameter changes are independent of each other, i.e. they are allowed to break at different points in time. This is important because the changes in the parameters might have different causes. In addition, for each variable in the model it is possible to detect how the respective coefficients have changed over time.

The study is outlined as follows: Section 2 summarizes the literature survey. Section 3 introduces the data and empirical methodology. Section 4 presents the empirical results and discussions. Finally, Section 5 gives conclusion and policy implications.

2. Literature review

Energy studies have received a great deal of attention during the last two decades. Thus, there is an extensive literature in which electricity demand functions have been estimated or forecasted by using several econometric and statistical methods such as univariate and multivariate techniques (see e.g. Zhou et al. [8]; Akay and Atak [9]; Zhang et al. [10]; Adom and Bekoe [11]; An et al. [12]; Lin and Liu [13]) or cointegration analysis (see Table 1).

However, in a most recent study, Zahedi et al. [14] employ the ANFIS (adaptive neuro fuzzy inference system) based on employment, GDP (Gross Domestic Product), dwelling count and population data to model the electricity demand in Ontario province of