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The demand for residential electricity in South Africa

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ABSTRACT

This paper examines the residential demand for electricity in South Africa as a function of real gross domestic product per capita, and the price of electricity during the period 1978–2005. We make use of the bounds testing approach to cointegration within an autoregressive distributed framework, suggested by Pesaran et al. [2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16(3) 289–326]. Following the literature, we use a linear double-logarithmic form using income and price as independent variables in the empirical analysis. In the long run, we find that income is the main determinant of electricity demand, while electricity price is insignificant.

1. Introduction

South Africa is a middle income country and one of the most industrialized countries in Africa. Her economy is heavily dependent on energy. Electricity is used for a number of purposes that include industrial, commercial and household purposes. It is supplied to consumers by a monopolized public utility known as Eskom. Eskom embarked on rapid electrification program in the mid 1990s. Between 1994 and 1999 about 2.8 million households were connected to the national grid. It is estimated that by 2025 about 11.4 million households will be connected (Davidson et al., 2002). This accelerated electrification of households is expected to increase residential electricity demand.

The main objective of this paper is to develop and test an econometric model to identify the main economic fundamentals that influence the behavior of electricity consumption (EC) in South Africa. The empirical analysis is for the period 1978–2005, employing annual data. Income and price sensitivity of both the long- and the short-run demand for electricity are examined.

Our study makes a methodological contribution to the literature on electricity demand. We use the bounds testing approach to cointegration, developed by Pesaran et al. (2001), within an autoregressive distributed lag (ARDL) framework, to test for a long-run level relationship in the demand for residential electricity. We use small sample critical values tabulated in Narayan (2005). This ensures that our conclusions regarding cointegration are accurate. Following Narayan and Smyth (2006) we also formally test for the time trend in the cointegrating relationship.

The remainder of the paper is organized as follows: the next section reviews the major developments in EC and energy indicators in South Africa. Section 3 provides an overview of some of the empirical studies on the residential demand for electricity. Section 4 outlines the empirical model specification that is employed in this study. Section 5 explains the bounds testing approach to cointegration. The empirical results are presented in Section 6. Section 7 summarizes the main findings of the paper and gives their policy implications.

2. Background

South Africa has a highly sophisticated electricity production and distribution capabilities developed under circumstances of economic isolation to meet the needs of the industrial sector and a privileged white minority. Successive governments encouraged 'separate development' for the black population and drove millions to live in homelands where services such as power were rarely provided. For years, the national power utility, Eskom, showed no interest in electrifying the townships (De Selincourt, 1991). In 1987 Eskom announced a policy of "electricity for all" but only where it was going to pay for itself. This excluded most of the rural sector. By 1991 only one-third of the population had electricity. The majority of the millions black population lived in poverty without electricity (De Selincourt, 1991).

The political restructuring, which began in 1990, brought changes in the field of electricity provision and consumption. The National Electrification Forum of 1991–1993 focused on addressing the inequities in access to electricity services, specifically in the household sector. It was only during this period that Eskom embarked on an accelerated electrification program. The current government's electrification policy is encompassed in the White Paper on Energy Policy of 1998 (Government of South Africa, 1998). This policy document provides the basic direction for energy service delivery strategies and their implementation

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Table 1
Electricity indicators in South Africa

Year	Electricity consumption (Gwh)	Electricity consumption/GDP (kWh/2000 US$)	Electricity consumption/pop (kWh/capita)	World electricity consumption/pop (KWh per capita)
1971	54,647	0.71	2246.17	1286.736
1975	74,894	0.845	2801.12	1471.02
1980	98,951	1.052	3644.44	1718.182
1985	143,491	1.317	4298.1	1869.365
1990	167,226	1.406	4431.48	2066.552
1995	187,825	1.498	4433.59	2145.521
2000	210,670	1.462	4416.57	2322.26
2005	244,920	1.423	4847.64	2595.742

Sources: International Energy Agency: Energy Statistics and Balances of non-OECD countries (various issues).

Table 2
Selected empirical results of the residential electricity demand function estimation

Sources	Price elasticity	Income elasticity	Study period	Country
Yoo et al. (2007)	−0.2463	0.0593		Seoul
De Vita et al. (2006)	Short run: −0.26; Long run: −0.54	Short run: 0.012 Long run: 0.41		Namibia
Filippini and Pachauri (2004)	−0.42 to −0.29	0.60–0.64	1993–1994	India
Pesaran et al. (1998)	Long run: −0.043	Long run: 1.252	1973–1990	Bangladesh
Holtedahl and Joutz (2004)	−0.15	1.57	1955–1995	Taiwan
Bose and Shukla (1999)	Short run: −0.65	0.88	1985/6–1993/4	India
Ang et al. (1992)	−0.35	1.0	1972–1990	Singapore
Balabanoff (1994)	Long run: −0.18	Long run: 1.88		Colombia
Donatos and Mergos (1991)	Short run: −0.21 Long run: −0.58	Short run: 0.53 Long run: 1.50	1961–1986	Greece

towards achieving the national goals. At present, the thrust of South Africa's electrification program is on service delivery rather than the provision of energy to productive purposes.

The political transition to democracy in 1994 opened doors to many households, especially in the rural areas, to access electricity. The rapid electrification program meant that the number of electricity consumers connected to the national grid increased tremendously over the years.

Table 1 contains the main electricity indicators for South Africa. EC in South Africa has increased tremendously over the last three decades. From the table it can be seen that EC increased by more than 200 per cent between 1975 and 2005. Over the same period per capita EC almost doubled. EC per capita has always been above world average. Table 1 also shows another important indicator, electricity intensity or EC/GDP ratios. This indicator measures the electricity required to generate one unit of output. These ratios have shown an upward trend since the 1970s until the mid 1990s. Such a steady increase in electricity intensity reflects faster EC growth rates compared to economic growth rates.

The rapid increase in EC could be explained by a number of factors that include economic growth, population growth due to regional migration and increased urbanization.

3. Literature review

Empirical studies of the residential electricity demand have received considerable attention in both developed and developing countries. There are several empirical studies that have examined the determinants of residential demand for electricity in a number of countries (see Table 2). To our knowledge, this study is the first attempt to examine the determinants of residential demand for electricity in South Africa. Here we review some of the studies on the subject.

From the empirical findings in Table 2 a number of conclusions can be made. First, the price elasticity of demand is negative. This means that an increase in the price of residential electricity causes the residential electricity demand to decrease. Second, the residential electricity demand is price-inelastic. This implies that EC is fairly unresponsive to price changes. Third, according to Donatos and Mergos (1991) and De Vita et al. (2006) long-run price and income elasticities are more elastic than the short-run ones. Fourth, the income elasticity of demand for residential electricity is positive.

Different approaches have been used to analyze the determinants of residential demand for electricity in the literature. A number of studies have analyzed the demand for residential electricity in the context of household production theory in which the household combines capital stock and electricity to purchase a composite energy commodity. This is true for such studies as Narayan and Smyth (2005) for Australia, Filippini and Pachauri (2004) for India, Holtedahl and Joutz (2004) for Taiwan, Donatos and Mergos (1991) for Greece, Al-Faris (2002) for the Gulf countries, Filippini (1999) for Switzerland and Beenstock et al. (1999) for Israel. Most studies have used annual time series data. There are also studies that have used micro-level household data in the analysis of residential demand for electricity. These include Yoo et al. (2007) for Seoul households, Filippini and Pachauri (2004) for Indian households, and Filippini (1999) for Swiss households among others.

A number of determinants for electricity or energy demand have been considered in the empirical literature. In the simplest form, the demand for electricity or energy in general has been modeled as a function of a single variable, such as real income (Dincer and Dost, 1997). Some studies have expressed the demand for electricity as a function of own price, price of a substitute and real income (Al-Faris, 2002; Narayan and Smyth, 2005). Nasr et al. (2000) model electricity demand in Lebanon as a function of