THE DEMOGRAPHIC FACTOR OF ENERGY CONSUMPTION IN SAUDI ARABIA

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Overview

Over the past three decades, Saudi Arabia, one of the world's largest producers and exporters of crude oil, has witnessed rapid growth in both its population and domestic energy consumption. Thanks to the combination of an improving life expectancy, a continued influx of immigrants, and a relatively high fertility rate, the demographics of the kingdom is characterized by a rapid expansion in overall size and an age structure that is increasingly concentrated on the prime working ages. It is widely believed that such dramatic changes in the size and structure of the population has been one of the main contributors to the fast growing energy use in the kingdom, which now consumes slightly more than 30% of total domestic oil production. Since Saudi Arabia is still reliant on revenues from oil exports, and rising domestic use compromises the kingdom's ability to export to the international market, it is imperative for policymakers and other stakeholders to understand the effects of the changing demographic characteristics on energy consumption in order to make relevant decisions. The main purpose of this research is to investigate how demographic factors, such as population size, age structure and urbanization, jointly determines energy consumption with other factors including income, price and climate in Saudi Arabia. Residential electricity consumption is the main object of analysis, since it directly reflects the changing energy demand as a consequence of the population dynamics, and because it constitutes the largest part of total electricity use while growing more than twice as fast as total energy consumption in the past thirty years.

Methods & Data

We investigate the following variables as potential determinants of aggregate residential electricity consumption: total population, real GDP per capita, residential electricity tariffs, percentages of population at 15-64, 0-14 and 65+, percentage of urban population, and cooling degree days (CDD). Time series data of electricity, GDP and population indicators for 1983-2012 are obtained from IEA and World Bank. Electricity tariff and cooling degree days for the same periods are from Atalla and Hunt (2016) and Atalla et al. (2015) respectively.

Given the short span of the time series, we measure the effects of age structure and urbanization variables seperately. Unit root tests are performed first to check the order of integration of individual series. Autoregressive distributed lag bounds testing (ARDLBT, Pesaran et al. 2001; Pesaran and Shin, 1999) is then applied to account for the cointegration property of the data and derive long run parameters, since this approach has some advantages such as allowing for a mixture of I(0) and I(1) regressors, being robust to endogeneity and being particularly relevant for small samples. Finally, an error correction representation is obtained based on the ARDL specification for short run analysis.

Results

The results of the long run analysis from the ARDL model is provided in the following table. The effects of total population is significant throughout the specifications, suggesting that the size of the population at least performs as a scaling factor. GDP per capita is insignificant in most cases and have negative signes for two specifications. This is consistent with the socioeconomic context in Saudi Arabia, where energy is considered as part of implicit social welfare, and therefore is not significantly influenced by the level of income. For the same reason, price of electricity is significant in only half the specifications.

Weather is an important determinant of energy consumption in Saudi Arabia, as 70% of residential electricity use is attributed to air-conditioning, primarily for cooling (ECRA, 2015). Accordingly, CDD is found significant in half the cases. The growing share of working age population (15-64), which reached 67% in 2012, is expected to positively influence electricity use since this age group is more active in energy consumption compared to other age groups. The result is consistent with this expectation. In comparison, the coefficient for the share of youth population (0-14) dispays a negative sign, albeit being insignificant. Urbanization exhibits the largest impact on electricity use compared to all other variables. This suggests that the process of urbanization, which usually means having access to the grid and achieving better standards of living, may have dramatically changed individual behavior with respect to energy consumption, and thus substantially raised electricity use.

ARDL specifications	population	GDP per capita	electricity tariff	CDD	percentage 0-14	percentage 15-64	percentage urban
ARDL(3,1,3,0,0)	2.343*** (0.000)	-0.109** (0.034)	-0.125** (0.047)	0.085 (0.165)	-	-	-
ARDL(3,2,3,3,2,2)	1.964*** (0.002)	0.023 (0.854)	-0.023 (0.668)	0.416 (0.141)	-0.365 (0.546)	-	-
ARDL(3,0,0,3,3,2)	2.220*** (0.000)	-0.032 (0.344)	-0.022 (0.174)	0.540*** (0.000)	-	0.213* (0.082)	-
ARDL(1,3,2,1,1,2)	1.034*** (0.001)	0.055 (0.456)	-0.210*** (0.000)	0.184** (0.069)	-	-	11.720*** (0.000)

Note: Dependent variable is aggregate residential electricity consumption. Percentage of the population age group 65+ is excluded from the long run analysis since it does not pass the serial correlation test requirement for ARDL model with bounds testing. The optimal ARDL specifications are selected based on the Schwarz information criterion. All variables are in logaritham. Probabilities are in parentheses. For simplicity, intercept and dummy variables are not reported here. Estimation period: 1986-2012. ***, ** and * denote 1%, 5% and 10% statistical significance respectively.

Conclusions

This research investigates the relationships betweens residential electricity consumption, population size and age structure, urbanization, income, price and climate for Saudi Arabia. The results suggest that the demographic factors play a significant role in shaping total residential electricity use, while the impacts of income and electricity tariff may not have been equally important. These findings provide several useful implication for policymakers. First, as Saudi Arabia retains the second largest stock of immigrants in the world with almost one third of its population being non-Saudi (World Bank, 2016), total residential electricity consumption may continue to depend on the trend of migration in the near future, both because immigrant workers are primarily concentrated in the age group of 18-60, and that energy consumption behavior of immigrants may not be significantly different from the Saudi nationals, especially considering the low electricity price. Second, urbanization has assumed a significant role in the past. Massive urbanization in Saudi Arabia occurred between 1983 and 2003, where the share of urban population increased from 70% to 80%. During the past decade of oil boom, the rate of urbanization dramatically slowed down, only growing by two percentage points from 2004 to 2013. However, given the magnitude of its impact, urbanization will continue to be an important determinant of residential energy consumption in the future.

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