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Shocks affecting electricity prices in Kenya, a fractional integration study

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ABSTRACT

We conduct a fractional integration and cointegration study of several Kenyan electricity price series in order to determine whether signs of persistence or mean reversion can eventually be discovered. Such features can be considered as relevant when considering the possibilities of shocks affecting the energy market of Kenya, which has recently been subjected to major debate. We conclude that electricity prices in Kenya contain unit roots, implying permanent shocks lasting forever. Among the factors affecting electricity prices, we find oil prices and interest rates have significant positive effects on electricity, and based on the fact that all the series are I(1), long run relationships are examined by means of fractional cointegration. The recently introduced FCVAR model is implemented, with results showing that the series under study are fractionally cointegrated, with oil price shocks affecting electricity prices.

1. Introduction

A critical issue in energy policy in Kenya is ensuring that electricity prices are affordable but at the same time ensure fair returns to investors [39]. Consumer electricity bills have been an issue of great concern in Kenya for several years now. This preoccupation has continued into the present when it is thought that middle-class households and industrial consumers will bear the highest burden when electricity distributor Kenya Power brings the new tariffs into force, raising their monthly bills by at least 10%. This escalation in billings is linked to the planned increase in the fixed charge and the energy charge, which account for half of the monthly power costs. The new tariffs will remain in place until July 2017 when the energy charge is expected to drop marginally for the various categories of consumers. Fixed charges will either remain unchanged or rise further for industrial firms. Costly electricity means inflationary pressure which rose to 7.3% in 2015 will escalate, diminishing the consumer purchasing power as prices of goods and services produced by expensive power increase.

Electricity prices in Kenya have historically been influenced by both demand and supply side shocks. Demand side shocks arise from high demand for electricity in years of higher production associated with higher growth rates of critical sectors such as manufacturing that rely heavily on electricity as an input into the production process. They also arise from higher consumer demand associated with an increasing population. Supply side shocks arise from Kenya's heavy reliance on hydroelectric power which is in turn influenced by unpredictable annual rainfall patterns. Major attempts are currently underway to diversify Kenya's sources of electricity especially towards wind and geothermal sources which are expected to provide as much as 45% of electricity supply by 2022. The proportion of hydroelectric power is expected to fall to 20% by 2022 so as to potentially make Kenya's supply of electricity much less vulnerable to hydroelectric power during drought years. Inadequate and unreliable supply of electricity in several areas of Kenya necessitating periodic power rationing therefore compounds the problem of high electricity prices. Market structure also plays a role since there is currently also limited competition in supply of electricity to end-users. The electricity sector in Kenya also has a commercial orientation and the government currently has a policy

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of full cost recovery tariffs. Electricity prices in Kenya are however regulated by the Energy Regulatory Commission and an energy tribunal also exists to settle disputes [39].

It is within this context that we have decided to carry out a time series analysis of historical electricity cost for Kenya, with the aim of determining the size of the risks that shocks may have in this sector and in general on the Kenyan economy. We believe that the examination of the statistical properties of energy is important on several fronts. First, if energy consumption or its associated prices are stationary in levels, shocks to the series will have only transitory effects. On the other hand, if the energy series have unit roots, requiring first-differencing to render stationarity, shocks will have permanent effects. Second, the distinction between the transitory or permanent nature of shocks has implications for the transmission of shocks from energy to other sectors of the economy. Indeed, if shocks to energy are persistent such shocks may be transmitted to other sectors of the economy with inflationary consequences. We present for the first time in this kind of studies the recently introduced FCVAR model by Johansen and Nielsen [20]; which can serve as a basis for policy makers interested in energy related issues in Eastern Africa.

The paper is structured as follows; Section 2 describes the literature review on the issue of electricity prices focusing on the case of Kenya. Section 3 presents the methodology used. Section 4 presents the data. Section 5 displays the empirical results while Section 6 concludes the paper.

2. Literature review

Research by Chen and Lee [5]; Narayan and Smyth [31]; Hsu et al. [15]; and Mishra et al. [29] has focused on the stationarity of aggregate energy consumption across panels of countries using standard unit root procedures. This short communication parallels the recent work by Lean and Song [23] which dealt with the long memory processes for U.S. petroleum consumption by sector. Specifically, this study emphasizes the long memory properties in the consumption of various energy sources by the U.S. electric power sector: coal, natural gas, petroleum, hydroelectric, nuclear, total fossil fuel, total renewable energy, and total primary energy. In this work we use fractional integration methodologies that permit us to study the standard cases of stationarity ($d = 0$) and unit roots ($d = 1$) as particular cases of interest. Moreover, allowing the order of integration to be a real value we allow for a richer degree of flexibility in the dynamic specification of the series, and, depending on the value of d we can determine if the series is I(0) stationary ($d = 0$); stationary with long memory ($0 < d < 0.5$); nonstationary but mean reverting ($0.5 < d < 1$); or nonstationary and non-mean reverting ($d > 1$). In this work we introduce for the first time in the energy field the implementation of the FCVAR model, which was recently introduced by Johansen and Nielsen [20]; which extends the more traditional CVAR model to the fractional long memory case.

Several studies exist on various aspects of electricity prices in the Kenyan context. Wasseja and Mwenda [38] analyze the monthly costs of electricity using Autoregressive Integrated Moving Average Models (ARIMA) so as to determine the most efficient and adequate model for analyzing the volatility of the electricity cost in Kenya. The fitted ARIMA model is used to do an out-of-sample forecasting for electricity cost for September 2013 to August 2016. The forecasting values obtained indicated that the costs will rise initially but later adapt a decreasing trend. The authors argue that a better understanding of the electricity cost trend in the small commercial sector will enhance the ability of producers to make better decisions about their products since electricity is a major input in the sector. Mabea [27] investigates the relationship between Kenya electricity consumption, real disposable income and residential electricity prices. The research employs the Engle and Granger [11] two-step procedure and error correction model to a time series from the period 1980 to 2009 to analyze electricity demand. The model suggests a cointegration with long run price and income elasticity of −0.095 and 0.1 respectively with a 4% increase in consumption of other non-economic factors. The results of the analysis are indicative of rising electricity requirements as Kenya achieves higher GDP growth rates. This has a potential implication for electricity prices.

Mumo et al. [30] seek to determine the best tariff model that can be used in Kenya to improve on the electricity consumption and their study explores all the factors which affect the costing of electrical energy. The tariff model is developed considering fuel prices, the economic factors such as inflation and the purchasing power of the consumers, and the other factors associated with system costs such as capital costs and running costs. In addition, the study also considers some recent developments and significant trends in distribution and pricing of the electrical energy such as pre-paid metering. It is expected that this will help Kenya to develop better tariff structures and more reasonable charging rates. The research uses the data provided by the KPLC to analyze the consumer purchasing trends and uses the current tariff system as a reference to see how best the power company can supply the energy to the country at a balanced cost which encourages industrial development. The study develops a tariff model which is gradual in nature and one which excludes the fixed changes but where the consumers are charged on a gradual basis such that the price increases with the increases of the Kilow at hours consumed.

The Kenyan Institute for Public Policy Research and Analysis [22] has also conducted an analysis of energy consumption patterns in Kenya which in turn affect electricity prices. With regard to the electricity sub-sector the study finds that costs should be reduced and electricity tariff setting harmonized to minimize costs transfer to low income households with regard to fuel and exchange rate adjustment costs which have remained high due to over reliance of thermal electricity generation. It is argued that increasing funding and resources to the electricity sector to increase clean electricity generation from wind energy and solar energy will not only put more electricity on the national grid, but also ensure improved access and reduction in the cost of power as well as protect the environment from carbon dioxide emissions. It is also argued that there is a need to ensure that universal access to electricity in the rural areas for the majority of citizens is adhered to so as to increase access. Thus, from this literature review, it can be seen that most studies in Kenyan electricity prices have focused on standard methods of unit roots and cointegration, and no existing study in the Kenyan context however examines the long memory properties of electricity prices and whether the effects of shocks on electricity prices are transitory or permanent using this approach.

3. Methodology

It is quite common in macroeconomics to find nonstationarity in the time series to be analyzed and many attempts have been proposed in the literature to remove it.[1] The two standard approaches are i) the Trend Stationarity (TS) that basically assumes that the series is stationary I(0) once the trend (or other deterministic

[1] Nonstationarity means that the series fails to achieve any of the following three properties that must be satisfied for a time series to be considered (covariance) stationary: a) the mean should be constant across time; b) the variance should also be constant across time; and c) the covariance between any two observations does not depend on the specific location on time but simply on the distance between the observations. Stationarity is in fact a minimal requirement in time series to make statistical inference.