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Modelling electricity demand in Ghana revisited: The role of policy regime changes

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HIGHLIGHTS

- The study investigates time-varying nature of demand elasticities prior to 1983 and after 1983.
- Result shows differences in demand elasticities prior to and post the reform.
- Pre-reform period is characterised with energy saving technology.
- Post-reform period is characterised with energy consuming technology.
- The post-reform result reveals evidence of gradual structural shift in the economy.

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ABSTRACT

As policy regime changes, demand elasticities are unlikely to be constant since individuals change how they form their expectations, and this will change the estimated decision rules. In this paper, the time-varying nature of electricity demand elasticities prior to and post the economic reform period in Ghana is analysed using the FM-OLS. Three different sample periods -pre-reform, post-reform, and full-period- was used in the analysis. The result from the full-sample period revealed that in the long-run electricity demand is significantly affected by industry efficiency, industry value added, and real per capita GDP. Urbanization rate, however, has no significant effect. The pre-reform estimate showed lower income, output, and urbanization elasticities but higher industry energy efficiency elasticity relative to the post-reform period. This suggests that technological change in the pre-reform period has been energy saving whilst technological change in the post reform period has been energy consuming. The result further showed evidence of changing structure of the economy from the more energy intensive sector to the less energy intensive sector after the reform. Government should renew her effort in promoting energy saving technologies in the industrial sector and adjust the industrial structure to encourage the expansion of low energy intensive industries or high technology efficient industries.

1. Introduction

The Ghanaian economy since independence has undergone diverse policy regime changes all intended to improve the overall performance of the economy. For instance, in the 1960s, some control measures and state intervention programmes were implemented to enhance the industrialisation process of the economy. These interventions continued into the seventies although with very little signal as to what the major development goals were (see; Aryeetey et al., 2000).

In 1983, the inappropriate macroeconomic and institutional development policies coupled with both external and internal shocks led to severe deterioration of Ghana's economic performance. In an attempt to savage the situation, the government in February 1983 launched the Economic Resuscitation Programme dubbed "Economic Recovery Programme" under the auspices of the International Monetary Fund and the World Bank. This was later succeeded by the Structural Adjustment Programme (SAP) in 1986. The specific key policy reforms that were implemented during these periods included price decontrol, export sector rehabilitation programme, public sector investment programme, state enterprise and public sector reforms (divestiture programme), monetary and fiscal policy reforms, exchange rate

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controls and financial sector reforms (see; Toye, 1991; Ahorto, 2003).

In the first ten years after the ERP, Ghana's economy started picking up tremendously thanks to the favourable prevailing conditions at the time. That is favourable weather condition which improved agricultural production and high cocoa prices which improved the terms of trade by 37 per cent (Toye 1991; Aryeetey et al., 2000). Aryeetey and Fosu (2005) concluded that growth was turbulent during much of the period prior to the reform and only began to stabilise after the reform.

Policy regime changes are very critical to the analysis of demand behaviour. As argued by Lucas (1976), a model's parameters are unlikely to be stable since, as policy regimes change, individuals change how they form their expectations, and this will change the estimated decision rules. Ghana's economy as discussed above has undergone and continues to undergo varying structural regime changes. These policy regime changes, as argued by Lucas (1976), are expected to change the underlying individual behaviour and consequently demand elasticities.

Electrical energy is an integral complementary factor in the growth processes of economies which implies that the use of electrical energy is very much dependent on the size and structure of the economy. The poor economic performance experienced prior to the reform period translated into low domestic electrical energy consumption rate averaging at 3592.76 GWh per annum. However, consumption of electrical energy increased averaging at 4574.34 GWh following the improved overall economic performance post the reform period.[1] Certainly the predominance of demand factors prior to and after the reform period varied. This motivates the question: what factors were responsible for the pre-reform slack in electrical energy consumption and the post-reform rise in electricity consumption?

The main objective of this study is to investigate the evolving nature of long-run aggregate electricity demand elasticities prior to and post the economic recovery programme (ERP) using the Fully Modified OLS by Phillip-Hansen. Three different sample periods – 1971–1983 (pre-economic reform), 1983–2008 (post-economic reform), and 1971–2008 (full-sample) – are used. The Quandt-Andrews and Chow Breakpoint tests are used to test the instability in the data set. Also using the FM-OLS, Bounds, and Johansen cointegration, the authors investigate the long-run equilibrium relationship between electricity demand and demand factors.

How different is the current study from other studies? First, earlier electricity demand study on Ghana by Adom et al. (2012) and Adom and Bekoe (2012) did not capture the role of policy regime changes on demand elasticities. Secondly existing literature on aggregate electricity demand (see; Adom et al., 2012; Lin, 2003; Zuresh and Peter, 2007; Amusa et al., 2009; Inglesi, 2010) is based on the assumption of weakly exogenous regressors. However, given the complex interrelationships that exist among economic, social, demographic, and industrial variables, the assumption of exogenous regressors may be problematic rendering the point estimates of such model questionable. For instance, studies (Adom et al., 2012; Zuresh and Peter, 2007; and Lin, 2003) that capture both industry efficiency (measured as the ratio of industry output to industry electricity consumption) and industry output as a per cent of GDP as separate regressors may suffer from the problem of multicollinearity thereby rendering the point estimates of such variables and the whole model questionable. In this study, the authors attempt to fill this gap by using the Wu-Hausman exogeneity test of regressors, and the Fully Modified OLS by Phillip-Hansen, which corrects for both endogeneity in regressors and serial correlation in residuals. Third, the literature gives account of works that have analysed long-run relationship using either one of the various cointegration approaches. In this paper, the ambiguity in cointegration result is cross-checked using the Phillip-Hansen Fully Modified OLS, a nonparametric statistics, Bounds cointegration, and Johansen cointegration. Lastly, evidence on the effect of policy regime changes on aggregate electricity demand elasticities (see Lin, 2003; Zuresh and Peter, 2007) is limited in the literature.

The rest of the paper is organised as follows; Section 2 reviews literature; Section 3 describes the data and method used; Section 4 presents empirical results and discussion; the last section concludes and makes policy recommendations.

2. Literature review

Various econometric techniques have been employed in the analysis of electricity demand in the energy literature (see Epsey and Epsey, 2004). Some writers have analysed electricity demand using extrapolation methods (see: Gonzales et al., 1999; Bargur and Mandel, 1981; Aras and Aras, 2004; Gonzalez-Romera et al., 2006; Himanshu and Lester, 2008). However, this approach is inappropriate for long term considerations since it fails to internalise changes in factors such as real income, output, demographic, and policy variables which have the tendency to change the pattern of electricity consumption in the long run. Econometric models, which are based on a more fundamental economic analysis, represent a major intellectual advance over extrapolation methods. They provide a medium for explaining and measuring trends in energy use in terms of cause and effect. Reduced form econometric models with or without dynamic elements (see Dahl, 1994a, 1994b; Ibrahim, 1985) have also been used, by earlier authors, to model electricity demand due to data unavailability. For instance, in analysing aggregate and industrial energy demand, Erdogan and Dahl (1996) three different specifications were employed—the static model, lag adjustment model, and the almon lag model. In the 1980s, cointegration approaches took the centre stage due to its limited data requirement, simplicity of method, and straightforward interpretation (see Adeyemi and Hunt, 2007). Since then, various cointegration approaches ranging from single cointegration models (Engle and Granger cointegration, FM-OLS, dynamic OLS, ARDL bounds approach and canonical cointegration) to multivariate cointegration model (Johansen cointegration) have been employed in the analysis of electricity demand (see; Pesaran et al. 1998; Amusa et al. 2009; Lin, 2003; Adom et al. 2012; Adom and Bekoe, 2012). The dynamic nature of these cointegration models allows to capture the short run and long run effects of variables in explaining electricity demand.

Largely economic, social, demographic, geographic, and meteorological factors have been identified to affect aggregate electricity demand. The predominance of these factors in explaining aggregate electricity consumption, however, varies across regions and countries. For instance, whilst the predominance of meteorological factors in explaining aggregate electricity demand are immense in the polar regions where there is large seasonal variation in weather, the effect is lessen in the temperate regions where there is minimal seasonal variation in weather. Also equally crucial is the fact that it is difficult to capture simultaneously the effects of all variables in one model due to either data unavailability or measurement problems. This has given rise to scenarios of single included variables (see; Adom, 2011; Wolde-Rafael, 2006; Akinlo, 2008; and Kwakwa, 2012; Dincer and Dost, 1997) and multiple included variables studies (see Ziramba, 2008; Al-Faris, 2002; Narayan and Smyth, 2005; Lin, 2003; Sa'ad, 2009; Adom and Bekoe, 2012; Adom et al. 2012).

[1] Authors' computation.