Energy Strategy Reviews 20 (2018) 163–178

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.ees.elsevier.com/esr

Impact of renewable energy (hydro) on electricity prices in Ghana: A tale of the short- and long-run

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ARTICLE INFO

Article history:
Received 5 August 2017
Received in revised form
2 February 2018
Accepted 4 March 2018

JEL classification:
I3
I31
Q2
Q4
Q21
D6

Keywords:
Hydro energy
Thermal energy
Macroeconomic indices
Electricity price

ABSTRACT

This study examines the dynamic effects of a hydro-based technology on electricity prices in Ghana. As a counterfactual model, this article also examines the dynamic effects of a thermal-based technology on electricity prices. Given the significance of total electricity expenditure in national and household final consumption expenditure, the findings have important implications on economic-wide welfare. To do this, we estimate a dynamic electricity price model based on the autoregressive distributed lag model. The findings reveal that, the effect of hydro on electricity price is dynamic in nature, and the technology provides better cost advantages than the thermal technology, in terms of reducing end-user tariffs. Though there is an associated risk with relying on the former which could impose a higher cost in the short-term, in the long-term, the effect seems to vanish. Further results show that, the positive pass-through effect of interest rate, exchange rate, and crude oil price to electricity price is gradual and materialises in the long-term. In sum, the task of achieving lower electricity tariffs in the country is multifaceted. Investment in a hydro-based renewable technology is critical as well as investment in demand-side management options. Moreover, prudent macroeconomic policies and structural amendments of the automatic price adjustment formulae are also critical.

1. Introduction

The low electricity tariff that characterised most of the period prior to 1994 (Between 1970 and 1994, electricity prices averaged at Gh¢0.00334/KWh) negatively affected the production incentives of utility companies, albeit for end-users, this was good. The need to have a sustained power sector, however, motivated the institution of the Public Utilities Regulatory Commission (PURC), in 1994. The core responsibility of PURC is to set competitive prices that is meaningful from the perspectives of utility companies and end-users.[1] This restructuring raised electricity tariffs[2] but below the level required to break-even. In addition to the restructuring in the sector, generation mix after 2000 has favoured the thermal-based energy source (installed generation has increased from 614GWh in 2000 to 4.635GWh in 2013). Coupled with the sole sourcing power purchasing agreement implemented in the past and the adverse developments in macroeconomic indicators and international oil market, the situation has escalated the cost of producing electricity in the country [3]. With the gradual phase out of subsidies, the end-user electricity tariff has accordingly increased at an astronomical rate in the country. Between 2000 and 2013, electricity prices averaged at Gh¢0.12857/KWh; this represents an increase of more than six (6) times and thirty-seven (37) times, when compared to the averages for 1990 and 2000 and 1970 and 1994, respectively.

The high electricity tariff regime has several economic implications, given the significant role that electricity plays in consumption and production and the share of electrical energy

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[1] In 2000, the first Independent Power Producer- Takoradi International Company (TICO) - started.

[2] For the period 1994–2000, the end-user tariff averaged at Gh¢0.0182/KWh, which represents an increase of more than four folds.

https://doi.org/10.1016/j.esr.2018.03.002
2211-467X/

expenditure in national and household expenditures.[3] The production costs for firms have increased, and this reduces the profits of enterprises, makes enterprises less competitive, and causes retrenchment. Particularly, for small and medium enterprises, the high price regime makes businesses less profitable and causes the collapse of businesses and unemployment. Due to the negative implications of the high tariff on production incentives, enterprises find it difficult to pay their debt, and this increases the risk of loan default and raises the size of non-performing loans in the economy. As revealed in the recent Bank of Ghana (BOG) report, the high cost of energy and unstable supply of energy contribute to the rise in non-performing loans in the financial sector [40]. Consequently, the high tariff adversely affects the development of the financial sector.

On the consumer side, the high tariff has increased households' electrical energy budget. As a result, the budget shares for other basic necessities like food, water, health, and education have suffered adversely. For households that cannot afford, it reduces access to electrical energy and increases the use of unclean energy sources like wood fuel for cooking and heating. This negative substitution effect due to higher electricity tariff indicates that, Ghana risks achieving the targets of zero hunger, good health and well-being, quality education, and affordable and clean energy. For countries like Togo, Benin, Burkina Faso and Cote d'Ivoire that import electricity from Ghana, the high cost of electricity has negative implications on their economy, both from production and consumption perspectives.

The above suggests that, in the case of Ghana, it is critical to achieve lower electricity tariff for different reasons. First, the positive effects of lower tariffs on production incentives will improve business profits, competitiveness, and employment, all things being equal. Second, lower tariffs will minimise the risk of loan default and non-performing loans, and hence cause the development of the financial sector. Third, lower tariffs will increase the likelihood of achieving the sustainable development goal targets in the areas of hunger, good health and well-being, quality education, and affordable and clean energy, all else equal. Fourth, on the environment, the use of clean energy source (electricity) induced by lower tariffs will promote environmental quality, all things being equal. Finally, achieving lower tariffs will promote cross-border production and consumption incentives.

Despite the national and regional significance of the above problem, empirical studies that examine the drivers of electricity price remain very scanty, particularly from a developing country context. The aim of this study is to examine econometrically the drivers of electricity price, using the case of Ghana, a developing economy in Africa. Specifically, this article investigates the role of a hydro-based energy in reducing electricity tariff. Hydro is known to be the most matured, flexible, reliable, and cost-effective renewable energy technology in the world. In the short-term, the high initial capital outlay associated with the deployment of a hydro-based energy technology might have positive implications on production cost and hence end-user tariff. However, with the lowest levelized cost, production cost with hydro is likely to be lower, in the long-term. Moreover, since hydro depends on the power of moving water, its price is not dependent on the fluctuations in fuel prices. Together, this ensures lower cost of production and lower tariffs for consumers. The above suggests that, the nexus between electricity price and hydro is a dynamic one. Therefore, delineating the short-term and long-term effects of a hydro-based energy technology is critical, to account for the dynamism that characterises the hydro-electricity price nexus.

While there are several empirical studies that investigate the effect of other renewable energies (RES) on electricity price [2,7,10,15,18,27,28,37] *inter alia*), few studies investigate econometrically, the effect of a hydro-based energy technology on electricity price. Notable amongst them are Huisman et al. [20]; Pereira et al. [31]; and Unger et al. [36]. Huisman et al. [20] examine the hydro-electricity price nexus in the Nord Pool, using the non-linear OLS estimator Pereira et al. [31] examine the effect of hydro and wind on the mean and volatility of electricity prices in Spain, using the ARX-EGARCHX model. Unger et al. [36] examine the marginal effect of different electricity generation sources including hydro on wholesale electricity prices in Nord Pool, Denmark and Finland. The study uses a standard robust OLS and differences the series to achieve stationarity, which means loss of some long-run information. In all three studies, the dynamism identified above that characterises the hydro-electricity price nexus was not examined. This represents an important lacuna, given the long period nature of hydro technologies. The contribution of this study is two-folds. First, this study delineates the short- and long-run effects of a hydro power energy source on electricity price. The study estimates an autoregressive distributed lag price model. As a counterfactual model, the study also examines the effect of a thermal technology-based energy on electricity price. Finally, this article contributes to the scanty literature and provides evidence to fill the gap in Africa, where evidence is lacking.

Ghana has one of the biggest hydro capacity in Africa [39,3] and hosts about 76 feasible small and medium hydro sites with a potential of 800 MW [39]. The Akosombo and Kpong dams are the two major hydro sites in the country. Prior to the implementation of the Renewable Energy Law (REL) Act 832 in 2011, the development of mini hydro projects was problematic due to the lack of a well-defined regulation and legal framework for renewable energy. However, with the institution of REL, these barriers seem to have been removed, and this has created the environment for private participation. The REL Act aims to achieve a 10% share of renewable energy-based generation in total generation mix by 2020. The Act has introduced the Feed-in tariff (FIT) and Renewable Energy Purchase Obligation (RPO) and established the Renewable Energy Fund (REF) as an incentive mechanism to promote the deployment and development of REs in the country. The current FIT for hydro <10 MW and hydro$>10<100$W are Gh¢26.557/KWh and Gh¢ 22.557/KWh, respectively.

Section 2 reviews the empirical literature. Section 3 presents the method and model. Section 4 discusses the main findings of the study, and section 5 concludes the paper with some policy recommendations.

2. Literature review

REs have become increasingly important due to energy insecurity and climate change problems. REs have the potential to reduce prices in the electricity sector. Several empirical studies have tested this claim but with a mixed result. This section reviews the empirical studies on the subject.

Adaduldah et al. [2] examine the influence of renewable energy on the day-ahead electricity prices in Germany. They observed that, the share of renewables in the country has increased to such an astronomical level that, electricity prices on the day-ahead spot market depends acutely on the expected supply of wind and solar energy. They found that, on windy and sunny days, this has caused an exceptional cases of negative electricity prices. Mulder and

[3] According to the Ghana Living Standard Survey (GLS 6), electricity and water constitute 11.3% of total household expenditure. In 2014, the share of total electricity expenditure as a percent of gross national expenditure, household final consumption expenditure, and gross national income was 1.7%, 2.8%, and 2%, respectively.