Restructuring Electric Power System to Reduce Shortage of Electric Power and Increase GDP in Togo

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Dedication

I wish to dedicate this praxis to my late parents, Jeanne Adoko Buabe and Christophe Govina Aboky with whom I could not, unfortunately, celebrate this major accomplishment. I would also like to dedicate this praxis to my late aunt Charlotte Adole Buabe without whom I would not be where I am today. A special dedication to my late grand-mother, Christine Kayissan Broohm, who instilled in him at a very young age the love of study.

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Abstract of Praxis

Restructuring Electric Power System to Reduce Shortage of Electric Power and Increase GDP in Togo

Current management and technical structures of the electric power system in Togo have shown their limits. Togo continues to suffer from limited access to electric power and endemic electric power shortages resulting in the slow-down of the country's socio-economic development. For over 43 years, the electric power generation in Togo increased only twofold while consumption rose nine-fold. On average, an annual per capita consumption of electricity in Togo is significantly below the average in sub-Saharan African countries and extremely low compared to the average in the United States. To determine whether undertaking the process of restructuring the electric power system in Togo would help to remedy the power sector crisis, this praxis attempts to conduct a comparative analysis based on institutional and economic classifications of the World Bank and Transparency International between Togo and 13 selected non-OECD countries with experience in restructuring electric power systems to establish similarities. The comparison was supported by the results of econometric analyses of the impacts of the restructuring of the electric power system on technical and socio-economic indicators such as GDP per capita, shortage of electricity, electricity access level, and foreign investment in the electric power system in the examined countries. The comparative results of the countries that group with Togo suggested that restructuring could be beneficial to Togo, especially in economic and welfare development. Although technical gains such as the reduction of power shortages were not too conclusive, it is tempting to infer that restructuring could, in general, help Togo to attract foreign investors in the electric power sector.

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D_t	Dummy variable
$\hat{\delta}$	Optimal l –break estimate of δ
δ_j	Corresponding vector of coefficients
$\hat{V}(\hat{\delta})$	Estimate of the variance-covariance matrix of $\hat{\delta}$
Y_{it}	Response variable observed for country i at time t
Y_t	Observed response variable at time *t*
X_{it}	Matrix of time-variant T x k regressor
β	k x 1 matrix parameters
β_1, β_2	Slope coefficients
α_i	Unobserved time-invariant individual effect
$\alpha_1,\ \alpha_2$	Intercepts
ε_{it}	Error term
ε_i	Disturbance at time t.
X_t', Z_t'	Vectors of covariates
R	Conventional matrix
k	Number of breaks
T	Number of observations
q	Number of regressors varying from 1 to 10
p	Significance level

List of Acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
ASEP	National Authority on Public Services
CAESS	Company of Electrical Lighting of San Salvador
CEB	Communauté Électrique du Bénin
CEET	Compagnie Energie Electrique du Togo
CEL	Hydroelectric Company of the Lempa River
CIE	Compagnie Ivoirienne d'Electricite
CIPREL	Compagnie Ivoirienne de Production d'Electricite
CLESA	Electric Light Company of Santa Ana
CONEL	Compania Nationala de Electricitate
CPI	Corruption Perceptions Index
DELSUR	Electrical Distributor of the South
DINE	Direccion Nacional de Electricidad
ECG	Electricity Corporation of Ghana
EECI	Energie Electrique de Côte d'Ivoire
EEO	Electrical Company of the East
EGEE	Electricity Generation Company
EIA	Energy Information Administration
ENDE	Empresa Nacional de Electricidad
ENEL	Nicaraguan Company for Electricity

ETCEE	Electricity Transport and Control Company
GW	Gigawatt
GWh	Gigawatt hour
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEA	International Energy Agency
IMF	International Monetary Fund
INDE	Instituto Nacional de Electrificación
INE	Nicaraguan Institute for Energy
IPP	Independent Power Producer
IRHE	National Institute of Hydraulic Resources and Electrification
KETRACO	Kenya Electricity Transmission Company
KPLC	Kenya Power and Lighting Company
kVA	kilo-volt-ampere
kWh	Kilowatt hour
MW	Megawatt
NEC	National Electric Company
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Squares
OPIC	Overseas Private Investment Corporation
RENEL	Regia Autonomă de Electricitate
USITC	United States International Trade Commission
VRA	Volta River Authority

Chapter 1—Introduction

1.1 Background

In his April 11, 1949 speech, delivered before the Economic Action Conference in Washington, D.C., the then Assistant Secretary of the Interior C. Girard Davidson warned his audience about the consequences of electric power shortages on an economy. He emphasized the need for sufficient electric power to enable industries to maintain their production level; which in turn guarantees full employment for all and a higher standard of living (Davidson, 1949). According to Ebhota and Inambao (2016), the availability of energy is indispensable for human survival and the development of a country's national economy. Castellano, Kendall, Nikomarov, and Swemmer (2015) agreed by asserting that countries suffering from electricity shortages struggle to sustain GDP growth. That warning arguably still echoes all over the world today prompting many nations to begin the process of restructuring their ailing vertically integrated state-owned electric power systems to attract private foreign investors to the sector and improve efficiency (Choynowski, 2004). Unfortunately, Togo is not one.

Before providing a summary of the status of the electric power system in Togo, it is essential to define the word "restructuring." USITC (2000) defined restructuring, also known as unbundling, as a process to separate functions previously offered by a vertically-integrated public organization (USITC, 2000). Shahidehpour and Alomoush (2002) extended USITC's (2000) definition of restructuring as a process

> "in which electric energy would be traded as a commodity, electric power markets would foster open access to all suppliers of electric power, discrimination against any user of the transmission system would be reduced or eliminated, a

competitive wholesale market at the national level would be fostered to reduce prices, and a competitive retail market at the state level would be encouraged to provide customer choice and competition in service and reliability" (p. 60).

The case for restructuring the electric power system in Togo is undeniably one that does not require a particular study to determine whether Togo needs the restructuring of its electric power system or not. Access to electricity in Togo is low and estimated at 45%, compared to 58% in Nigeria and 78% in neighboring Ghana (Ntagungira, 2015). Policy and regulatory frameworks necessary for maintaining and improving the electric power system of the country are almost non-existent. Ntagungira (2015) estimated that electric consumption in Togo increased nine-fold from 1971 to 2013, while generation increased only two-fold. The country's electricity consumption grew about 5% every year since 1995. During the same period, the country's electric power generation level fell by 6%. Demand for more electric power continues to grow, but the country's outdated electric power system is unable to keep up with the supply (Allcott, Collard-Wexler, & O'Connell, 2014). The situation resulted in chronic electric power shortages forcing Togo to import electric power for sustainment of its economic growth. Ninety percent of the electricity consumed in Togo was estimated to be imported from Nigeria and Ghana while Contour Global and other minor domestic sources supplied the remaining 10% (World Bank, 2017a).

Dependence on electric power exports is proven risky and unreliable. "Inconsistent hydrological conditions, unavailability of gas, or operational constraints" (World Bank, 2017a, p. 11) experienced in the exporting countries could "constitute a bottleneck" (Gnansounou, 2008, p. 23) to the guarantying of consistent supplies of electric power to Togo. The primary challenge of the electric power sector remains the ability to maintain improved access of electricity to end-users while promoting self-dependence in supplying electric power at reasonable cost (World Bank, 2017b). This research is a case study conducted to access the effects of restructuring of electric power systems as a remedy to continued electric power shortages in 13 selected non-OECD (Organization for Economic Co-operation and Development) countries (Bolivia, Bulgaria, Colombia, El Salvador, Georgia, Ghana, Guatemala, Ivory Coast, Kenya, Nicaragua, Panama, Peru, and Romania). The choice of non-OECD countries was informed by the importance to establish close similarities between Togo and countries that have experienced restructuring of electric power systems to perform a fair comparison. As non-OECD members, the examined 13 non-OECD countries and Togo do not enjoy privileges that come with OECD membership, including easiness to attract private foreign investments. The selection of the specific 13 countries was based on their geographical locations and data availability. The results of this case study may serve the government of Togo as recommendations in formulating policies and regulations to tackle the country's dire electric power systems' needs.

1.2 Research Motivation

The reticence of the government of Togo to engage in reforms similar to those already undertaken in some countries of the region to "successfully adapt its electricity sector to the vagaries of market forces" (Ntagungira, 2015, p. 36) continues to contribute to frequent electric power shortages in the country. Sadly, issues in exporting countries' power systems at the generation and transmission levels (World Bank, 2017a) are worsening the situation. Although the government acknowledges "that strong State presence and monopolies in the electricity value chain have been partly responsible for the structural financial deficits of national electricity companies for several decades," (Ntagungira, 2015, p. 36) no substantial efforts were initiated to mitigate the issue. In consequence, "the strong increase in the demand for electricity against timid supply has reduced prospects for growth and poverty reduction" (Ntagungira, 2015, p. 37).

The motivation for this case study was rooted in the quest for solutions to the four research questions of this praxis to provide policymakers in Togo with factual recommendations that could help its electric power sector for the achievement of an economy of scale. Restructuring electric power systems to attract private foreign investments and build a competitive marketplace (Shearman & Sterling, 2012) is said to be driving the electric power market towards an environment where a competitive market starts substituting a monopolistic structure (Zhang, 2010). This research will conduct practical analyses of the success or failure of the restructuring of electric power systems in 13 selected non-OECD countries and assess its application for Togo.

1.3 Problem Statement

The shortage of electric power within Togo's electric power system, which is estimated to be 496 GWh per year on average contributes to lower than expected GDP.

As the population is continuously growing, so is the demand for more electric power. Unfortunately, the precarious nature of electric power systems in Togo restrains access to electricity for the population and hinders utility's ability to keep up with the demand. The situation resulted in chronic electric power shortages forcing Togo to import electric power mostly from Ghana and Nigeria to meet the high demand of the country (Ntagungira, 2015; World Bank, 2017a). Togo has limited electric power generation capacity and is unable to diversify its electric power sources. Poor management and maintenance of the electric power infrastructures contribute most to losses of electric power during transmission and distribution of electricity (World Bank, 2017a). Addressing all these problems successfully to prevent continued shortages will require bold legislative actions from the government.

1.4 Thesis Statement

Restructuring Togo's electric power system will reduce the shortage of electric power and increase GDP.

Current monopolized status of the vertically integrated state-owned electric power systems is ineffective and discourage foreign private investors to compete for the expansion of the systems. As the demand for electricity services continues to rise at a rate of about 8% per year (World Bank, 2017a), restructuring the electric power system in Togo will help address the governance challenges of the sector and improve "its financial sustainability, operational performance, and ability to attract new investment" (World Bank, 2017a, p. 13).

1.5 Research Objectives

The objective of this research was to undertake econometric analysis and detailed case studies of the examined countries to comprehend better how the restructuring of electric power systems impacted technical and socioeconomic indicators in these countries. Findings of this assessment are indispensable for offering restructuring policy advice, and providing alternative options to policymakers in Togo, tailored to the peculiarities of Togo, "based on the lessons learned from the taxonomy of different market structures" (World Bank, 2011b, p. 2) in this study. While the current electric power market structure in Togo, based on Besant-Jones' (2006) classification, is "a vertically integrated monopolist with independent power producer (IPP)" (p. 2) that sells electricity to the state-owned utility, the classification of market structures in the 13 examined non-OECD countries vary from partial vertical and horizontal restructuring; through exhaustive vertical and horizontal restructuring; to electric power market (Besant-Jones, 2006).

The key objectives of this research are to a) assess whether the restructuring of electric power systems helps reduce shortages of electric power and increase GDP; b) confirm that the restructuring electric power system contributes to improving overall electric power access level and attracts foreign private investors to the sector; and c) develop a classification of the market structures of the selected countries in this study to serve as guidelines in recommending alternative policy measures to Togo.

1.6 Research Questions and Hypotheses

The underlying rationale behind the following research questions and hypotheses comes from the commonly discussed macroeconomic theory in restructuring literature that restructuring electric power systems helps address governance challenges of the electric power systems financial sustainability, operational performance, and ability to attract new investments (World Bank, 2017b). The following research questions were structured to address the objectives listed earlier:

RQ1: *Do shortages of electric power within a country's electric power system contribute to lower than expected GDP?*

RQ2: *Is there a relationship between restructuring a country's electric power systems and reduced shortages of electric power?*

RQ3: *Does restructuring electric power system attract private foreign investments into the electric power sector and increase electricity access level of a country?*

RQ4: *Does the restructuring of electric power system depend on the size of a country's electric power system?*

The following hypotheses were arranged according to the research questions to test economic, technical, and welfare impacts of restructuring electric power system on the selected countries in this study:

H1: *Restructuring the electric power system in Togo will lead to an increase in the country's GDP.*

H2: *There will be a reduction in the shortage of electric power in Togo if the country's electric power system is restructured.*

H3: *If Togo's electric power system is restructured, then there will be increased private foreign investments in the electric power system.*

H4: *Restructuring Togo's electric power system will lead to an increase in electricity access level.*

1.7 Scope of Research

This research assessed the economic, technical, and welfare impacts of restructuring electric power systems in 13 selected non-OECD countries based on econometric testing and analysis of the hypotheses formulated for this case study. The study measured the outcomes of restructuring electric power systems on a set of indicators including GDP per capita, shortages of electric power, electricity access level, and foreign investments in electric power systems to determine if the restructuring of electric power systems achieves its hypothesized objectives. The results justify the necessity of restructuring electric power systems (Sen, Nepal, & Jamasb, 2016) to "enhance transparency and governance, attract private sector investment, and/or to create a competitive market and ultimately its impact on performance" (World Bank, 2011a, p. 6). Findings of the econometric analysis were also used to develop a taxonomy of the impacts of the restructuring of electric power systems on the examined countries. The taxonomy serves as basic guidelines in providing policy advice and offering alternative solutions to policymakers (World Bank, 2011a).

1.8 Research Limitations

The purpose of this praxis was not intended to conduct a comprehensive qualitative assessment of the restructuring of the electric power system in the various countries involved in this study. Instead, this research seeks to use an econometric analysis method to evaluate the impact of the restructuring of electric power systems on GDP per capita, shortages of electricity, foreign investments in electric power systems, and electricity access level of the selected countries. Conducting this type of analysis effectively requires selections of appropriate analysis method, reliable data, and a larger sample size of data. Failure to meet these requirements could constitute some limitations to the research and lead to biased results. Some of the limitations observed during this research are explained below.

1.8.1 Data Reliability

Unreliable dataset or data sources lead to limiting the scope of analysis, the sample size of the data, or preventing to find the right trends in the variables. Dataset used in this study is secondary empirical collected from various sources with different data collection processes. Although, these sources are well-respected organizations including International Monetary Fund (IMF), the World Bank, United Nations (UN), International Energy Agency (IEA), TheGlobalEconomy.com and others, the possibility of not having all the data well synchronized could influence the analysis leading to biased results.

Additionally, the data set is a time series data of 13 non-OECD countries covering a period extending from 1990 through 2015. The choice of the year 1990 as the starting date was because data for some indicators in the study, including Electricity Access Level and Foreign Investments in Electric Power Systems, were not available for some of the selected countries. For example, data sources used in this study all have data on the indicator Electricity Access Level for almost all the developing countries starting only from 1990. The final year of 2015 was also chosen for the same reason the starting year was selected as the availability of data on most indicators from developing countries are usually a few years behind. These limitations affect the sample size of the data set of this research as some statistical analyses recommend a larger sample size of data for useful results.

1.8.2 Data Sample Size

Basing econometric data analysis on small sample sizes of data could prevent findings of significant relationships between variables, and the generation of more accurate results as small sample sizes do not ensure the population is representatively distributed. Within this study was a data sample size made of 26 annual observations from each of the thirteen selected countries extending from 1990 through 2015 to conduct a Chow test. Although, this sample size may be sufficient for a Chow test, Kelly and

Sienko (2018) warned that working with annual data to establish causation poses a challenge as high-frequency data is more desirable in "sophisticated time series models, such as those accounting for structural breaks," (Kelly & Sienko, 2018, p. 3) to obtain better results. Such challenge constitutes a limitation that could inject bias in the analysis results.

1.8.3 Econometric Analysis method (Chow Test)

"While structural break analysis can provide strong support for an argument, for or against, causation" (Kelly & Sienko, 2018, p. 12), Chow (1960) requires that the single structural break date to be tested is known a priori using an F-statistic (Chow, 1960). This implies that the researcher either picks an arbitrary date or a date based on certain prior knowledge of an event (Jouini & Boutahar, 2004). Since the selection of the right breakpoint is crucial for establishing causation in a before-and-after analysis, there is a risk of "committing the post hoc ergo propter hoc fallacy" (Kelly & Sienko, 2018, p. 12) using Chow test. Furthermore, there is a possibility that more than one causal event that is unobserved occurred during the same period that could influence the results of the test. Finally, "there may be a lag between cause and effect" (Kelly & Sienko, 2018, p. 12) that Chow test does not account for. Taking into consideration all these limitations, a test for a single breakpoint to establish causation is likely insufficient to rule out issues that may affect the analysis conclusively.

1.9 Organization of Praxis

This praxis begins with Chapter 1 with an introduction of the topic of the restructuring of electric power systems and provides a brief background of the policy before setting up the rationale behind the research. Chapter 1 also covers the motivation that triggered the research, the problem statement, thesis statement, and research objectives followed by research questions and hypotheses. The rest of this chapter talks about the scope of the research, research limitations, and lastly, the organization of the praxis. The rest of the praxis is organized as follows: Chapter 2 reviews various literature in the field of the restructuring of electric power systems around the world in general, and the restructuring of electric power systems experiences of the examined 13 selected non-OECD countries in this study in particular. This chapter concludes by presenting a review of the conditions of current Togo's electric power system and argues for the need of restructuring the country's electric power system. Chapter 3 concentrates on research methodology. After the introduction of the methods employed for this research, the focus turned to data sources with descriptions of different variables. Different analysis methods undertaken are discussed in this chapter as well. In Chapter 4, the results of the various analyses are interpreted and presented in the form of tables and figures. Chapter 5 concludes the praxis with a discussion of whether this study confirms or reject the hypotheses outlined and addressed the research questions. A conclusion is drawn based on what transpires from the discussion before enumerating contributions of the research to the body of knowledge. This chapter ends with recommendations for future research.

Chapter 2—Literature Review

2.1 Introduction

Until recently, empirical researches about the effects of electricity reforms on countries were rare as the restructuring of electric power system was never seen outside the U.S. (Green & Newberry, 1992) as a solution to issues affecting the efficient performance of the sector. Besides some few countries, no other country held the debate about the issue as actively as the U.S. (Green & Newberry, 1992). Thus, "the empirical literature documenting the effects of comprehensive reform is somewhat limited by the relative absence of post-reform data" (USITC, 2000, p. 2-1). Recently, solid evident-based research about past restructuring experience becomes available, but the majority of the literature is just "a compilation of economic theory, informed opinion, and anecdotal evidence" (USITC, 2000, p. 2-1) about reforms. Other literature focused more on cost-benefit analyses of the effect of restructuring (Domah & Pollitt, 2001; Pollitt, 1999) on various electric power markets. For example, Domah and Pollitt (2001) aimed at assessing the costs and benefits of the process of restructuring and privatization of the regional utilities in the U.K. Pollitt (1999) analyzed the cost-benefit effect of restructuring and privatization on the electricity supply sector in Scotland. Green and Newbery (1992), Joskow (2006), Pollitt (1997a), and Newbery and Pollitt (1997a) all used cost/ price as a primary performance indicator to assess the success of the restructuring of electric power systems.

Only some handful of literature used other economic indicators such as GDP per capita or private foreign investment to establish the success of restructuring. The research on technical indicators such as quality of supply or service reliability (shortages), or welfare indicators including electricity access level is scarce. According to Gilbert and Kahn (1996), although, "engineering methods to characterize the probability of outages as a function of supply system parameters have been developed over decades" (Gilbert & Kahn, 1996, p. 11), it is only recently that efforts for the valuation of electricity outages started. And this is because the estimation of electricity outages "requires expensive surveys and sophisticated analytical technique" (Gilbert & Kahn, 1996, p. 11). USITC (2000) added that the lack of data to conclusively estimate the effect of reforms on electric power systems is because country reform efforts are generally quite recent, except a few countries, especially the U.K., Argentina, and Australia that reformed earlier. Even recent studies based on the past two decades analyses of restructuring programs do not "represent the broad variety of institutional detail embodied in the reforms" (USITC, 2000, p. 2-16).

This praxis includes a review of the literature on the effects of the restructuring of electric power systems on some economic, technical, and welfare indicators and provides a general overview of the experience of some countries around the world that have undertaken the restructuring process. Also, the praxis offers a literature review on the experience of the restructuring of electric power systems in the examined 13 non-OECD countries (Bolivia, Bulgaria, Colombia, El Salvador, Georgia, Ghana, Guatemala, Ivory Coast, Kenya, Nicaragua, Panama, Peru, and Romania). This review begins with the history of the restructuring of electric power systems and various causes that triggered decisions of embarking upon the restructuring of electric power systems program.

2.2 Historical Background of Restructuring Electric Power Systems

Governments around the world attempted to improve human welfare and combat extreme poverty through the adoption of a series of measures to procure population (Victor, 2005) with better quality of electric power supply and reliable electric power services. According to Satpathy (2015), economic, social and environmental objectives for sustained human development could not be achieved without electric power. He alleged that the development of different sectors of an economy goes in parallel with the development of the electric power sector (Satpathy, 2015). For example, the electricity industry played an important role "in strengthening Britain's industrial base and attempting to secure technological leadership, particularly in the nuclear industry" (Gilbert & Kahn, 1996, p. 37). With the importance of electricity, policies affecting the electric power sector are always politicized (Gilbert & Khan, 1996).

For some time, governments around the world monopolized the way electricity was generated, transmitted, distributed, and sold (USITC, 2000) based on the argument that the construction of vertically integrated state-owned electric power systems and the provisions of electric services are a national duty. As electric power systems grew in size, the government monopoly positioned itself as the best way to improve service through economies of scale and scope compared to privately-owned monopoly (Victor, 2005). The concept of liberalization or restructuring with the introduction of competition was branded as wasteful and dangerous (Kopsakangas-Savolainen, 2002; Victor, 2005). There are, however, a few countries in the world including the U.S., Hong Kong, and some few states in India that allowed private organizations to operate significant parts of their electric power distribution and supply system. Countries that embraced the state-run monopoly found their model unsustainable after working from the 1920s until the 1980s (Victor, 2005) and started efforts toward restructuring their electric power systems.

2.3 Demand for Restructuring Electric Power Systems

The confluence of several trends, especially the poor performance of the electric power systems under state control, imposed severe pressure on state-owned companies and governments that led to various reform initiatives (Victor, 2005). Furthermore, as the population started to grow, the demand for electric power also increases. However, despite decades of international assistance in the sector in Sub-Saharan Africa, for instance, no significant improvements have been made (Kouassi & Pineau, 2011). The generating capacity of current electric power plants become insufficient to satisfactory address the needs of the people. Other reasons that have driven electricity reform could be characterized by the expensive technology choices rich countries made in expanding their generating capacity. In poor countries, the need to improve inefficiency, unreliability, access rate, lack of investment, and chronic shortage of electricity were the causes of the reform (Pollitt, 2007b). In addition, there is a belief that current vertically integrated state-owned electric power systems are inefficient and wasteful and efforts must be undertaken to restore efficiencies (Victor, 2005; USITC, 2000). Among these efforts is the undertaking of the restructuring of electric power systems as a panacea to remedy inefficiencies of the vertically integrated state-owned electric power system.

The restructuring of electric power systems to introduce competition and the "discipline of markets forces" (Victor, 2005, p. 8) involves turning the current vertically integrated electric power systems into a competitive wholesale power market where generators and distributors of electric power trade among themselves (Bacon & Besant-

Jones, 2002). The introduction of competition is necessary to enhance the efficiency of the electric power system. However, although, an electric power system constitutes generation plants, transmission lines, distribution lines, and retail suppliers, “a broad consensus remains that some activities, particularly transmission and distribution, require continued oversight by regulatory authorities” (USITC, 2000, p. 2-1). Gilbert and Kahn (1996) also saw the electricity transmission and distribution system as a “natural monopoly” (p. 2). Through governance arrangements, independent companies with curtailed control or ownership power supervise the transmission and the systems “to prevent the acquisition of anticompetitive amounts of vertical market power by any generators or distributors” (Bacon & Besant-Jones, 2002, p. 4).

Although the actual record of the restructuring of electric power system programs around the world is equivocal, it is indubitable that electricity plays a crucial role in economic modernization (Victor, 2005). From the numerous rationales put forward regarding efficiency gains of the restructuring of electric power systems, cost reduction comes out as the primary objective behind the restructuring program (Pollitt, 1999). Jamasb, Mota, Newbery, and Pollitt (2005), in the other hand, based their argument on the need to promote efficiency. Pollitt (1999) also supported Jamasb et al. (2005) by citing the five theoretical arguments developed in Pollitt (1997b) to support the efficiency effects of the restructuring of electric power systems.

According to Pollitt (1999), first, opening up markets to competitive tenders, new entrants or private ownership leads to exposure to the private sector capital market and hence the possibility of takeovers. Second, liberalization may involve decision-making transfer from bureaucrats to private sector managers. Third, when liberalization consists of the introduction of formal regulatory rules such as rate of return regulation, there may be incentives for firms to reduce efficiency to exploit the statutory provision to raise profit. Fourth, liberalization may increase or reduce influence activity: in a competitive market worker may reduce influence activity because of the increased threat of redundancy; while in regulated industry companies may spend money attempting to influence the regulator. Fifth, theories of policy commitment suggest that privatization may be an effective way for a government to commit to a policy of reduced interference in the running of a particular industry and hence reducing the costs of discretionary state intervention (Pollitt, 1999). Arguments based on these theories led to gradual supports for the restructuring of electric power systems globally through different forms.

In practice, the process involving the restructuring of electric power systems is not identical across countries based on their historical and institutional differences and needs. Jamasb et al. (2005) suggested that it usually involved a combination of several key elements that include (p. 7):

> "a) corporatisation of state-owned utilities; enactment of an electricity reform law; b) unbundling of vertically-integrated utilities into corporatized generation, transmission, distribution and supply activities, and where necessary horizontal separation of these; c) provision of third-party access to networks; d) regulatory reform, including adoption of incentive regulation for the natural monopoly network activities; e) establishment of independent regulators; f) establishment of a competitive wholesale generation market; g) liberalisation of the retail supply market; privatisation of electricity assets; h) definition of rules concerning consumer protection; and i) allocation of energy subsidies, and stranded costs."

2.4 The Restructuring of Electric Power Systems around the World

Many countries have sought over the last two decades to reform their electric power systems. Although the restructuring of electric power system programs around the world differs from one country to another, the common objective remains the enhancement of the electric power supply (USITC, 2000). A few studies conducted on restructuring around the world addressing its scope suggested that restructuring has been beneficial. Accordingly, studies confirmed that in-depth reforms contributed to performance improvement of electric power systems in many ways, including evidence suggesting that reforms have improved the technical efficiency of electricity suppliers (USITC, 2000). Other econometric literature documenting the consequence of privatization on firms' performance recorded reasonably strong results although not conclusive. With no clear blueprint to follow, the choice lies between the adoption of a comprehensive vertical restructuring or a horizontal restructuring (USITC, 2000; Victor, 2005).

According to USITC (2000), comprehensive vertical restructuring separates generation companies from transmission and distribution companies allowing all generators to enjoy similar access to transmission and distribution lines. Horizontal restructuring occurs when a small number of companies are in control of the majority or the entire generation resources (USITC, 2000). While the case for restructuring is "strongest in large power systems in countries well-endowed institutionally" as Besant-Jones (2006) noted, it is "weakest in small systems in countries with undeveloped institutional capacity and weak economic conditions" (p. 3). For example, lessons learned from the restructuring project in Bolivia proved that the importance of "having in place a clear regulatory system, strong and autonomous institutions to enforce it, and the will of the government to respect its commitments" (World Bank, 1999, p. 3) outweigh the size of the electric power system or the development level of the country in order to attract private investments (World Bank, 1999). Empirical research about determining evidence on the impacts of the restructuring of electric power systems on various economies concluded that expectations on the effects of restructuring should not be the same between developing and developed economies (Besant-Jones, 2006).

Several case studies focused on Sub-Saharan African countries warned that although lessons from the restructuring experience of other countries may be helpful in selecting the restructuring approach to undertake, they should not be the only determining factor in the selection of the restructuring model. Besant-Jones (2006) emphasized that decisions leading to the restructuring of electric power systems in developing countries should be structured around expected results of "better service quality for electricity consumers to support economic growth and welfare, improvement in government's fiscal position, and more affordable access to electricity for the poor" (Besant-Jones, 2006, p. 31). According to Besant-Jones (2006), countries with electric power systems too small for the introduction of competition in the electric power market should not consider undertaking a comprehensive electric power system reform. They should instead opt for restructuring only the generation and distribution legs of their systems as the possibility of losing economies of scope and scale without benefiting from the gains of competition is considerable. He recommended the establishment of electric power pool to trade with regional countries (Besant-Jones, 2006). The following sections summarize the restructuring of electric power system experiences and its outcomes in Chile, the U.K., the U.S., and Europe.

2.4.1 Chile

It is consensually agreed across literature about the restructuring of electric power systems throughout the world that Chile was first to restructure its electric power system. And this started in 1978 but it was the 1982 Electricity Act that actually marked the beginning of the restructuring process (Pollitt, 2004; Kopsakangas-Savolainen, 2002). Unlike the comprehensive restructuring of the electric power system that took place in the U.K. beginning in 1983 (Green & Newberry, 1992), the Chilean restructuring of electric power systems occurred in two phases (Victor, 2005). The first phase of the restructuring consisted of the sale of some public enterprises to private owners, while the remaining most important public companies corporatized forcing them to control costs. The second phase of the restructuring process addressed issues of concentration of ownership through the privatization of the pension funds, the strengthening of domestic capital markets, and the privatization of remaining so-called critical public companies (Victor, 2005).

Since the adoption of the 1982 Electricity Act, several attempts have been made for improving the electric power sector, but it was only in 2004 that a substantial revision to address significant shortcomings of the initial Act was established. Results of the performance of the Chilean electric power sector twenty years since restructuring in 1982 were awe-inspiring. There was a noticeable increase in investment in the industry, low price of electricity, strong financial performance, great efficiency improvements, growth in the electricity access level, and significant improvement of supply quality. However, significant issues caused by a drought in 1998 and the reduction of Argentina's exports of gas to Chile in 2004 have plunged the country back to blackouts (Pollitt, 2004).

2.4.2 United Kingdom (U.K.)

In the U.K., the restructuring of electric power systems began with the Electric Act of 1983 opening doors for competition in electricity generation; followed by the subsequent Electric Act of 1989 that encouraged full retail competition (Burtraw, Palmer, & Heintzelman, 2000). The privatization of the generators "forcing them to compete in the bulk electricity market resulted in dramatic improvements in labor productivity" (Gilbert & Kahn, 1996, p. 8). Newbery and Pollitt (1997b) confirmed Gilbert and Kahn (1996) assessment noting that labor productivity had more than double in the six years after restructuring. The performance of the English regional electricity companies does not appear to change significantly or deteriorated after restructuring. The English regional electricity companies remain natural monopolies (Gilbert & Kahn, 1996). Although the restructuring and privatization have high direct costs estimated at £2.8 billion, Newbery and Pollitt (1997b) explained the stable performance of the English regional electricity companies noted by Gilbert and Kahn (1996) by factoring in the unambiguous benefits in lower operating costs the restructuring delivered.

According to Pollitt (1999), the objectives behind restructuring and privatization were to increase efficiency, lower prices and improved quality of service. Results of the restructuring and privatization cost-benefit analysis of the U.K. electricity supply conducted by Newbery and Pollitt (1997b) concluded the restructuring and privatization were worth undertaking even though the analysis suggested for the improvement of two major areas in the process. First, the transfer of a chunk of the net gains in electricity to

France; and second, the introduction of limited competition in the generation (Newbery & Pollitt, 1997b). However, Burtraw et al. (2000) believed the restructuring process was a success in the U.K. and cited the choice of fuel used for generation as the most exciting effect of restructuring in the U.K. because it is environment-friendly.

2.4.3 United States (U.S.)

The U.S. experience is quite different from the restructuring process undertaken in the U.K., Argentina, Norway, New Zealand, Sweden, Australia, Spain, and other countries. Joskow (2006) noted that despite successful restructuring experience in some countries and long-established academic interest on the subject, U.S. policymakers began taking initiatives for a comprehensive restructuring of electric power systems and competition only in the mid-1990s. In 1998, California, Massachusetts, and Rhode Island became the first states to undertaking restructuring initiatives and introducing competitive electric power retail markets before spreading out by the end of 2000 to other states (Joskow, 2006). Between 1998 and 2002, at least 20% of the U.S. generating capacity changed ownership. By 2006, non-utility generators owned about 40% of the total U.S. power generation capacity (Lien, 2008).

There was no clear template "for vertical and horizontal restructuring, wholesale market design, transmission institutions, or retail competition; or federal legislation endorsing a comprehensive national electricity restructuring and competition policy" (Joskow, 2006, p. 4). As a consequence, restructuring efforts, either horizontal or vertical, of the electric power systems failed to be exhaustive and no longer viewed as appropriate steps to introduce retail and wholesale markets competition (Joskow, 2006). The typical wholesale market, as mentioned in Lien (2008), now includes auction arrangements between generators and transmission companies through price matching market design. The retail competition is currently allowed in 16 states and the District of Columbia after the restructuring of retail rates (Lien, 2008).

After all, the restructuring's effects on operations, trading, and investment in the U.S. have been encouraging. Econometric studies cited in Lien (2008) provide significant statistical evidence that restructuring has encouraged firms in improving their operating performance. There was also a significant improvement over the pricing mechanisms and the promotion of efficient trading among market participants (Lien, 2008).

2.4.4 Restructuring Experience in Selected Countries in Europe

Contrary to the U.S., in Europe, Kopsakangas-Savolainen (2002) remarked that Norway, Finland, and Sweden have all followed the U.K. model. In Finland, for example, the validity of a new restructuring law at the end of 1995 placed electricity sales and generation under competition while allowing the maintenance of electricity distribution and transmission under local monopoly. The good news is that the introduction of the wholesale market competition greatly succeeded along with the competition in the retail business allowing consumers to change suppliers for savings purposes (Kopsakangas-Savolainen, 2002). According to USITC (2000), the possibility of switching utilities contributed to the reduction of the sale price although only about 5% of electricity consumers in Finland changed suppliers. For instance, wholesale prices for electric power have been reduced by 1.5 cents per KWh while retail prices dropped between two and three cents per KWh, with an overall 20% decline in electric power prices since 1997 (USITC, 2000).

The reform process in Sweden started in 1996 with fully opened retail market allowing consumers to select their supplier of choice, although the transmission remained public monopoly (Erdogdu, 2010). The Norwegian restructuring of electric power system began in 1991 (Burtraw et al., 2000). Initially, Norway was following the footsteps of the model undertook in the U.K. but had finally only opened up all transmission and distribution lines, restricting the privatization of utilities. The gradual restructuring of the generation leg of the power system allows consumers to use any supplier they desire. Per the Norwegian government, transferring the price burdens of electric power from end-users to suppliers (municipal, national, and privately owned) by reducing their profit margins made the Norwegian restructuring model very successful (Burtraw et al., 2000).

2.5 Restructuring Experience in the Selected 13 Non-OECD Countries

The primary motivating reasons behind the decision to restructuring electric power system in most countries are the environment restructuring creates to attract private domestic and foreign investments to the market and the opportunity it provides to improve efficiency (Choynowski, 2004). While evidence on the effect of the restructuring of electric power systems on developed economies is discussed frequently in econometric literature and others, studies addressing the scope of the subject in non-OECD countries are not so common, especially in the sub-Saharan African countries.

Below are some statistics of national and electric power sector characteristics in the selected 13 non-OECD countries presented in Table 2-1.

Table 2-1. Statistics of Electric Power Sector Indicators in the Selected Countries

Country	Population 2015 (Million)	GDP per capita 2015 (US$)	Electricity Consumption per capita 2015 (MWh)	Electricity Access Level 2015 (% Population)	Electricity Generation 2015 (GWh)	Domestic Supply of Electricity 2015 (GWh)	Transmission & Distribution Losses 2015 (GWh)	Foreign Investment in Power System 1990-2015 (Million US$)	Year of Legislative Law Authorizing Restructuring of Electric Power
Bolivia	10.73	3077.03	0.72	91.50	8528.00	8528.00	815.00	543.30	1994
Bulgaria	7.18	6993.48	4.86	100.00	49228.00	38653.00	3785.00	6918.63	1999
Colombia	48.23	6044.53	1.23	98.20	69017.00	68602.00	9244.00	10853.42	1994
El Salvador	6.13	4127.12	1.01	95.40	5989.00	6888.00	678.00	1285.34	1996
Georgia	3.72	3764.64	2.73	99.99	10833.00	10872.00	711.00	1541.90	1997
Ghana	27.41	1361.10	0.32	75.00	11491.00	11162.00	2388.00	2690.00	1997
Guatemala	16.34	3923.57	0.60	90.51	11058.00	10556.00	719.00	3930.10	1996
Ivory Coast	22.70	1434.33	0.27	64.10	8711.00	7862.00	1744.00	1226.20	1998
Kenya	46.05	1349.97	0.17	41.60	9651.00	9673.00	1904.00	2523.20	1997
Nicaragua	6.08	2073.00	0.62	81.16	4579.00	4591.00	837.00	1227.70	1998
Panama	3.93	13684.13	2.23	92.55	10296.00	10174.00	1400.00	3252.10	1997
Peru	31.38	6030.34	1.37	93.90	48251.00	48196.00	5321.00	15718.56	1992
Romania	19.82	8978.00	2.64	100.00	66296.00	59568.00	7161.00	8526.49	1998

Data Sources: IEA, UN, AfDB, World Bank, and TheGlobalEconomy.com

This section consists of brief summaries of the restructuring of electric power systems experience in selected thirteen countries (Bolivia, Bulgaria, Colombia, El Salvador, Georgia, Ghana, Guatemala, Ivory Coast, Kenya, Nicaragua, Panama, Peru, and Romania). These summaries are derived from several literature and papers discussing the restructuring of electric power systems in these countries and are not by any means comprehensive.

2.5.1 Bolivia

The initiative to reform Bolivia's electric power system started in 1989 when the World Bank pushed the country unsuccessfully toward reform. Unlike other Latin America countries, especially, Argentina and Peru where electric power shortages and blackouts prompted privatization, the situation in Bolivia was quite the opposite. Bolivia never experienced electric power shortages, but several issues were hindering the development of the sector and needed to be addressed. First, no incentives were granted to generation and distribution companies to encourage efficiency improvement, charging competitive prices relative to marginal costs, or fostering competition in the sector and participation of the private sector. Second, there was a lack of transparency in renewing and granting licenses. Third, Empresa Nacional de Electricidad (ENDE), the state-ran utility became too powerful as a major producer, system planner, and de facto regulator. Fourth, the politicization of tariff approval process at the municipal level led to tariff distortions between consumers and regions. Fifth, electric power losses increased by 5% to 16.6 in 1990 from the 1986's level of 11.6% (World Bank, 1999). In response to these deficiencies, several regulations were adopted in 1994 into laws.

The 1994 laws including the Capitalization Law authorizing private investments in state-owned companies, the Sectorial Regulatory System Law establishing superintendency for the electric power sector and others, and the Electricity Law detailing the operation of the power sector (World Bank, 1999) entirely restructured the electric power system (Williams & Ghanadan, 2006). A new regulatory body in replacement of the previous energy ministry-run the Direccion Nacional de Electricidad (DINE) was created. Before electricity reform, ENDE, which was in charge of 80% of the generation and transmission system, was the leading player in the sector with the remaining 20% distributed between private, municipal, and cooperative ownership (Williams & Ghanadan, 2006). The 1994 Electricity Law broke ENDE's assets into three private generation companies. The transmission company of ENDE along with its distribution subsidiaries were also sold to private bidders (Williams & Ghanadan, 2006; Word Bank, 1999). Observers have qualified the restructuring of the electric power system in Bolivia as a success.

The restructuring of the electric power system created a robust institutional environment where control of the sector has been decentralized. According to the World Bank (1999), the restructuring of the electric power sector brought approximately US$ 1,600 million to the Bolivian economy from private foreign investors. Fiscal revenues from the power sector increased by 247% from US$17 million in 1994 to about US$42 million in 1997 with the cumulated ENDE's debt around US$61 million transferred to private entities. There was a significant increase in the price of shares while the annual rates of return for private investors went up to 14%. Electricity consumers enjoyed stable electricity rate as the quality of service was expected to improve considerably (World Bank, 1999).

2.5.2 Bulgaria

Imports of cheap energy from the Soviet Union in the 80's helped support at a meager price the ever-growing electric power supply needs of the developing Bulgarian economy. But Bulgarians began experiencing a hike in energy prices following the suspension of the Yambourg Agreement for supplying low-priced natural gas from Russia (Dukov, 2001). Also, the inability of the power industry to cope with the continued demand increase from industrial and other organizations' customers led to frequent breakdowns of the country's system. Construction of new generation capacities started as the solution to the electric power shortages with the expansion of the Kodloduy nuclear power plant and the investment of more than US$1.3 billion in the unfinished-construction of a new Belene nuclear power plant. Before the reform of the power sector, the share of the total national installed capacity of National Electric Company (NEC) was at almost 88% or 11,062 MW. The remaining generating capacity of 1,606 MW was shared among other entities including large industrial enterprises. Although, the power sector has witnessed a drop in power consumption in 1998 due to some series of issues including socio-economic instability, the rapid revival of the economy leading to forecasting high demand in electricity shortly prompted the talk for reform (Doukov, 2001).

In 1999, the World Bank and the IMF pressured the country to start taking steps towards separating the accounting of the electric power generation, transmission and distribution activities in preparation for the restructuring of the electric power system.

The implementation of these procedures allowed policymakers to establish future sales and purchase price of electricity based on precise operations costs of generation, transmission, and distribution determined during the separation. However, the disparity in pricing between household and industrial consumers called for efforts to establish impartiality before undertaking any measures for the restructuring of the electric power system and the institution of independent power distribution companies (Doukov, 2001). The law on energy efficiency and energy enacted in 1999 opened doors for the regulation of the energy sector with the real restructuring of the NEC beginning in 2000 (Bekiarov & Shahidehpour, 2003; Doukov, 2001; Ganev, 2007). NEC was separated, and various legal entities were established from the separation. Electricity distribution and sales activities were assigned to different divisions. NEC is solely responsible for electric power transmissions as a single buyer and exporter of electric power (Doukov, 2001; Ganev, 2007). NEC could now sell electricity directly to enterprises without any intermediary distribution company's assistance (Bekiarov & Shahidehpour, 2003; Doukov, 2001).

Some of the principal objectives of the restructuring project were "to improve the operating efficiency and reliability of the power system, thus reducing supply disruptions; realign the level and structure of electricity tariffs to rationalize consumption of electricity, reduce imports, reduce the population associated with electricity generation, and mobilize resources for NEK" (Doukov, 2001, p. 17). The restructuring project also sought to improve and depoliticize the tariff setting system through the establishment of an independent tariffs setting regulatory body. Finally, the project aimed at turning NEC into more commercial operations organization and strengthening the safety of Belmeken, Chaira, and saddle dams (Doukov, 2001). Despite the legal restructuring of the electric power system, there is no noticeable competition in the distribution leg of the system to allow consumers to select their suppliers freely. Another observed issue considered as a significant challenge to the restructuring of electric power system project is the continued high dependence of Bulgaria's energy market on the importation of Russian gas and technology (Duoukov, 2001; Export.gov, 2017). The restructuring of the electric power system success in Bulgaria could be summarized as the application of a tourniquet on the Bulgarian "bleeding" electric power sector to prevent further damages. The restructuring process halted further deterioration of the power sector, and the entry of strategic investors on the market contributed to the country's plans to rehabilitate the electric power generation plants and improve electric power efficiency (Dukov, 2001).

2.5.3 Colombia

One of the incentives leading to the decision of restructuring the electric power system in Colombia may be the amount of the power sector debt in the early 1990s that led the sector close to bankruptcy. The electric power sector debt was 30% of the total foreign debt of the country and 33% of the nonfinancial public deficit (Choynowski, 2004). Efforts to avert the crisis in the power sector including severe insufficiency of energy and chronic power outages resulted in the adoption of 1994 Public Utilities Law 142 and Electricity Law 143 (Choynowski, 2004; Lugo & Villada, 2017). Until 1995, the state-owned Interconexión Eléctrica SA and other enterprises belonging to the government still maintain controls of most electricity services in the country (Lugo & Villada, 2017). Inspired by the restructuring model in the U.K., the aim of the 1994's legislation was to introduce competition in the market, access to the independent grid, and the regulation of price and quality control (Choynowski, 2004; Lugo & Villada, 2017; Pombo & Taborda, 2006).

Colombia was one of the first countries in Latin America to implement a bidding system for its electricity pool market and introduce wholesale electricity transactions through a market system (Kessides, 2012; Pombo & Taborda, 2006). The reform led to a full separation of the electric power generation, transmission, distribution, and the establishment of new commercial activities (Pombo & Taborda, 2006). By 2000, the control of about 56% of generation and 48% of distribution were managed by the private sector. The public sector still operated the transmission grid, but the Energy and Gas Regulation Commission was responsible for quality control and price for the end user. Electricity is traded on the wholesale market with the participation of more than 40 traders (Choynowski, 2004; Pombo & Taborda, 2006).

The success of the reform in Colombia resulted in electricity price savings and real term generation costs. Since 1995, the introduction of the wholesale market contributed in lowering tariffs significantly to about 25% for end users (Choynowski, 2004). The competition introduced in the wholesale market had positively impacted the efficiency of electric power distribution. Additionally, as the market became liberalized, US$6 billion in foreign investment were injected in the power sector, and an additional gas-fired capacity of about 2.5 GW was built (Kessides, 2012).

2.5.4 El Salvador

The restructuring of the electric power system in El Salvador was part of a series of institutional reforms undertaken by the government under the Economic Stabilization and Structural Adjustment Programs. The main objectives of the restructuring program were the promotion of competition into the electricity market and the establishment of an open competitive strategy (Saprin, n.d.). Before the restructuring process began in the late 1990s, the horizontally and vertically integrated state-owned company, the Hydroelectric Company of the Lempa River (CEL), was the autonomous institution with the responsibility to run generation, transmission and distribution services in the country (World Bank, 2011b; Saprin, n.d.). The Company of Electrical Lighting of San Salvador (CAESS) was also in charge of the distribution segment of the power system.

In 1996, the General Law of Electricity passed in the Legislative Assembly after the law creating the regulatory body, General Superintendency for Electricity and Telecommunications, with the responsibility of guaranteeing compliance with the regulations guiding the electricity sector (Saprin, n.d.; World Bank, 2011b). The General Law of Electricity led to the horizontal division of the vertically integrated generation and distribution into several entities (World Bank, 2011b). The four electricity distribution companies that came out of the restructuring process covered the electrification of rural zones that were once in charge of CEL. These companies are CAESS, the Electric Light Company of Santa Ana (CLESA), Electrical Distributor of the South (DELSUR) and the Electrical Company of the East (EEO) (Saprin, n.d.). The four companies were sold at public bidding in 1997 generating US$586 million.

Although the primary objective of the Electricity Law of 1996 was to address inefficiency in the public administration of the electric power distribution services, the restructuring results do not quite meet the expectations put upon the private administration of the sector. For example, the results of a survey conducted by one of the leading national newspapers found in 1999 that 81% of the population did not experience any improvement in the quality of service. Other evaluation of the impact of the restructuring of the electric power system found no considerable change in coverage of and access to the service, and prices for the end-users (Saprin, n.d.).

2.5.5 Georgia

In 1991, before its independence from the Soviet Union, the Georgia electric power system was a part of the South Caucasian United Energy System regrouping Armenia, Azerbaijan, and Georgia (ADB, 2015). After the disassociation from the Soviet Union, the electric power system in Georgia was run by Sakenergo, a state-ran vertically integrated monopoly (ADB, 2015; World Bank, 2004). The dependence of Sakenergo on imported fossil fuel from Russia and Central Asia for operations was undermined by price volatility in international energy markets and the hard currency requirement from Russia for energy imports. Facing severe financial burden accentuated by mismanagement, corruption, widespread electric power theft and meager collection rates estimated at 5%, Sakenergo accumulated up to US$600 million in debt to Turkmenistan for unpaid natural gas deliveries (ADB, 2015; Kurdgelashvili, 2008).

With no revenues to pay for arrears, re-invest in the system for repairs and maintenance of infrastructure, exporting countries cut off gas imports. The situation led to the closure of thermal plants and nationwide blackouts as the availability of electricity expanded to only 2-3 hours a day (ADB, 2015). The electric power system was financially bankrupt, and the infrastructure was deteriorating rapidly. The dire condition of the electric power system forced the government to seek international assistance for power sector reforms. The banks conditioned their support with the adoption of a plan for privatization and restructuring of the power sector (ADB, 2015; Kurdgelashvili, 2008).

It was the Presidential Decree No. 437 of July 1996 that started the restructuring of the electric power system in Georgia. All the power once vested upon Sakenergo as the vertically integrated monopoly with policy-making and regulation role was stripped down. Sakenergo is reorganized into three financially independent subsectors with the management of the distribution sector transferred to local administrations, and the generation sector attributed to the newly established Sakenergogeneratsia (ADB, 2015). The new law also created in 1998, the Georgian National Electricity Regulatory Commission as an independent entity to regulate retail tariffs in the power sector. In 1999, the Georgian Wholesale Electricity Market was established to monitor commercial transactions (ADB, 2015; Kurdgelashvili, 2008; World Bank, 2004).

The Presidential Decree No. 828 introduced the privatization of the electric power system. Several new companies emerged from the decree with management responsibilities for the generation, transmission, and distribution to improve poor financial and technical performance of the system. Compared to pre-reform condition, significant improvements were noticed regarding performance, technical efficiency, quality of service, and financial resources. The power sector became profitable and recorded electric power surplus for exportation. Dependence on foreign fuel dropped as hydropower plants increased electrical power generation after substantial rehabilitation (ADB, 2015).

2.5.6 Ghana

Like most developing countries, the electric power system in Ghana was a state-owned vertically integrated monopoly ran by the Volta River Authority (VRA) and the Electricity Corporation of Ghana (ECG) (Kumi, 2017; Williams & Ghanadan, 2006).

While VRA was in charge of all generation and transmission, the distribution segment of the country's electric power system belonged to ECG. But the poor performance of ECG resulting in high electric power losses throughout the distribution channels, poor quality of service, and low electricity access rate of only 24% in 1993 precipitated efforts to reform the power sector (Victor, 2005; Williams & Ghanadan, 2006). Furthermore, the reliance on Mother Nature for rainfalls to fill the hydro dams as more than 90% of Ghana's electric power supply is hydropower generated contributed to the quest of reform (Eshun & Amoako-Tuffour, 2016). Other significant issues that encouraged efforts for change were electric power shortages due to severe drought coupled with supply crunch due to high demand that was estimated to cost Ghana an annual lost between 2 and 6 % of GDP (Eshun et al., 2016; Williams & Ghanadan, 2006). When in 1993, the government of Ghana approached the World Bank for assistance to finance the expansion of the sector, the bank requested for the removal of barriers to private participation among others as a precondition for additional loans (Victor, 2005; Williams & Ghanadan, 2006).

In 1997, the government approved a restructuring plan opening generation to competition and transmission access (Williams & Ghanadan, 2006). VRA was restructured into a separate generation and transmission system operations allowing entrance to market for other Independent Power Producers (IPP) (Kumi, 2017). The assets of ECG were transferred in 1997 to the newly corporatized Electricity Company of Ghana. In same year, the government created legal guidance for an independent regulatory commission, the Public Utilities Regulatory Commission to address issues about tariff setting and pricing (Victor, 2005), but the plan for reform failed to be implemented. VRA opposed the proposal arguing that the restructuring of its assets would weaken the company's position as a competitor in the West Africa Power Pool. The country's largest electric power consumer, Kaiser Aluminium, did not also welcome the plan for reform seen as a pretext for the government to end the company's sweet deal with VRA. In the end, in 2000, the government set aside the restructuring legislation (Williams & Ghanadan, 2006).

The outcomes of the reform did not meet the expectations. For instance, the private management contract signed with a European company did not help to reduce electric power losses from ECG's system. There was no proof in the improvement of electric power services, yet tariffs skyrocketed. Access to electricity was not significantly improved. The loss of Kaiser Aluminium, the country's largest electric power consumer, after filing for bankruptcy had strained the national budget leaving the sector with excess capacity with expensive obligations (Williams & Ghanadan, 2006). In 2006, the government embarked yet again in another round of reforms that saw the restructuring of generation, transmission, and retail distribution, the establishment of Ghana Grid Company Limited and the introduction of Independent Power Producers (IPPs), but the results do not appear to be on the trend towards the country's goal of universal access to electricity by 2020.

2.5.7 Guatemala

The Instituto Nacional de Electrificación (INDE), the vertically and horizontally integrated state-owned utility has been responsible since 1959 for Guatemala's electric power generation, transmission and distribution. Incapable of financing the expenses necessary for the growth and development of the electric power sector, INDE turned to policymakers. An attempt by the government to generate private investments through the Renewable Energy Law of 1986 failed to reach its objective leaving 92% of electric power still in the hands of state-owned entities by 1990. As demand for electric power started skyrocketing in the early 1990s, INDE was unable to keep up. Daily blackouts became the new norms. To remedy the situation, INDE began to offering irresistible electric power purchase agreement to encourage investments from the private sector. Between 1993 and 1996, the electric power market was opened to private investors with the signing of thirteen private Power Purchase Agreements, but it was the Ley General de Electricidad Law of 1996 that officially opened the market (Koberle, 2012).

The Ley General de Electricidad Law of 1996 established the Wholesale Electricity Market Administrator for the management of system operations and the financial administration of the wholesale market. The Ministry of Energy and Mines and the National Electricity Commission were policy and regulatory bodies responsible for the planning of the electric power system. Despite the horizontal unbundling of INDE's generation, transmission and distribution activities, the operation of about 85% of the transmission network along with about 60% of the hydro generation plants was still under INDE's control (Koberle, 2012; World Bank, 2010). In 1998, the Electricity Transport and Control Company (ETCEE), the Electricity Generation Company (EGEE) and two energy distribution companies were created.

2.5.8 Ivory Coast

Until 1990, the electric power in Ivory Coast was managed by the state-owned vertically integrated company, Energie Electrique de Côte d'Ivoire (EECI), with monopolistic control over electric power generation, transmission, and distribution in the country. However, the consistently poor performance of EECI including overexpansion and mismanagement of the electrical power system, excessive debt, and severe droughts (Malgas & Gratwick, 2008) were enough to convince the Ivorian government to consider reform initiatives. Ivory Coast turned to the World Bank and the IMF for loans, but not without the international institutions' requests for the country to reform and restructure the electric power system to encourage private sector participation. As a good student, the government quickly engaged Societe d'Amenagement Urbain et Rural and Electricite de France for help (Malgas & Gratwick, 2008).

After six months of negotiations, in 1990, a tripartite agreement was signed between the parties attributing the management control of the sector to the private companies for 15 years. As a result of the deal, Societe d'Amenagement Urbain et Rural and Electricie de France formed the Compagnie Ivoirienne d'Electricite (CIE) assuming 51% stakes of the company with the remaining 49% controlled by the public sector. Despite the financial contributions the establishment of CIE brought, the government found it necessary to turn to IPPs in response to the inadequate supply of electric power and threat from future droughts. The negotiations led to the creation in 1994 of Compagnie Ivoirienne de Production d'Electricite (CIPREL). Ivory Coast became one of the first African countries to introduce IPP in its electric power system for power generation (Eberhard & Gratwick, 2001). Azito was contracted two years later as the second IPP (Kempen, 2014) followed by the third IPP, Aggreko. In 1998, the government dissolved EECI in lieu of three new public institutions including the Societe de Gestion du Patrimoine du Secteur de l'Electricite, the Societe d'Operation Ivoirienne d"Electricite, and the Autorite Nationale de Regulation (Kempen, 2014; Malgas & Gratwick, 2008).

Compared to Nigeria and Ghana, the restructuring of the electric power system in Ivory Coast contributed to performance improvement of the system (Gnansounou, 2008). With a total generation capacity of 1,886 MW in 2016 and a total production of 8,618 GWh in 2015, Ivory Coast benefited from electricity needs of its neighboring countries to compensate for stagnant growth in the demand of electric power at home. According to Ministry of Mines and Energy, electric power exports in 2005 totaled 1397 GWh (Malgas & Gratwick, 2008) with the main clients being Énergie du Mali, VRA of Ghana, Communauté Électrique du Bénin (CEB) of Bénin-Togo, the Société Nationale d'Électricité in Burkina Faso, and Liberia Electricity Corporation.

2.5.9 Kenya

Until recently, Kenya's electric power system relied heavily on hydropower for electricity generation with almost 87% of the country's 1992 electrical power supply generated from hydro (Victor, 2005). Severe droughts in the 1990s diminished the generation capacity of hydropower considerably by 79% resulting in widespread electric power cuts and substantial financial losses from businesses. But the impacts of the electric power crisis were not felt by household's consumers since the electricity access level was only at 18% at the time. The expansion of the country's electric power system was impossible because Kenya was unattractive for foreign private investors due to aid embargo against the country and corruption allegations surrounding the one-party ruling government (Victor, 2015). All these reasons were enough for the government to launch a comprehensive restructuring of its electric power system. The objectives of the reform were the separation of the regulatory functions of the sector from the commercial ones, the facilitation of restructuring, creation of an environment that encouraged private sector investments and ensured reliable, sustainable, and affordable electric power for consumers (Chimbaka, 2016).

Before restructuring, the electric power system in Kenya was operated by the state-owned vertically integrated monopoly Kenya Power and Lighting Company (KPLC). KPLC was in charge of all aspects of the electric power system. But the enactment of the Electric Power Act of 1997 conferred only the transmission and distribution segments to KPLC. The primary role of the government was reduced to policy formulation while the regulatory authority was attributed to a newly established Electricity Regulatory Board. The generation activities became the responsibility of Kenya Electricity Generation Company in 1997 (Vagliasindi & Besant-Jones, 2013; Victor, 2005). Dissatisfied with the performance of the electric power sector after restructuring, the government adopted new strategies based on the National Energy Policy of 2004 to improve the reforms (Chimbaka, 2016). In 2008, the government created the Kenya Electricity Transmission Company (KETRACO) to handle the transmission segment of the system leaving KPLC with only distribution services. The Rural Electrification Agency was also established to increase the access level of electricity in rural areas (Chimbaka, 2016).

Despite further efforts undertaken by the government after the Electric Power Act of 1997 to improve the electric power system, the outcomes were not after all impressive across the board. For instance, the impact of the reform on the electric power structure was characterized by the inability of the government to significantly restructure the vertical integration of the transmission, distribution and generation segments of the system. The failure resulted in the allocation of 46% of the generating capacity to Independent Power Producers (IPPs) by 2007. But with average tariffs lower than operating costs, the electric power sector was unable to finance expansions of the system sufficiently. On the contrary, evidence on the impact of the reform on the power sector's performance suggested an improvement in the electricity access rate of the population. The quality of service improved as well as a noticeable decline in electric power losses from 20% in 2002 to 12% in 2008 (Vagliasindi & Besant-Jones (2013).

2.5.10 Nicaragua

Reform processes in Nicaragua began in 1979 when the government established the Nicaraguan Institute for Energy (INE) to control the electricity sector with the responsibility to regulate and direct national energy policymaking. INE was also responsible to administrate, explore, and manage domestic energy assets (Worldwatch, 2014; World Bank, 2011a). The creation in 1994 of the vertically and horizontally integrated government-owned company, the Nicaraguan Company for Electricity (ENEL), marked the beginning of the decentralization of the electric power sector. Not only ENEL was in charge of generation, transmission, distribution and commercialization of electricity in the country, but was also granted rights to develop the electric power sector, including the exploration, exploitation, and use of domestic energy resources (Worldwatch, 2014; World Bank, 2011b).

Significant reforms were introduced in 1998 with the objectives to develop Nicaragua's economic renewable energy potential for generations, to minimize high losses in the distribution system, and to expand the national electrification rate (Mostert, 2009). The enactment of Laws Nos. 271 and 272 led foundations for modern electricity market in Nicaragua. Law No. 271 contributed to the creation of the National Energy Commission to assume the role of the electric power sector policy settings and planning. INE kept oversight of regulatory and supervisory functions, monitoring, concession licensing, and the electricity sector control. Law No. 272 outlined fundamental principles for competition and the promotion of private sector participation in the electric power market (Worldwatch, 2014; World Bank, 2011b). Generation and distribution assets of ENEL were separated and assigned to two new entities (Disnorte & Dissur). The transmission segment of ENEL was attributed to the National Transmission Company, and the National Dispatch Center was assigned the commercial administration of the Wholesale Electricity Market of Nicaragua and the operation of the system (World Bank, 2011b).

By the early 2000s, the restructuring efforts of the electric power system in Nicaragua were characterized by the transfer of the distribution system and 80% of the country's electricity generation to the private sector, while transmission remained in the hands of the state-owned National Transmission Company (Worldwatch, 2014). The restructuring process in Nicaragua showed that halfway implementation of reforms carries a high economic cost. Although the country's competitive market structure offered cost savings, it was not priced rise-proof as the fluctuation of fuel prices at the world stage could increase the cost of electricity for consumers (Mostert, 2009).

2.5.11 Panama

Like many Latin America countries, the electricity reform in Panama was market-oriented towards the improvement of essential electric power services such as quality, reliability, and efficiency; as well as the fiscal growth of the sector and the increase of affordable access to energy services (World Bank, 2010). Before the Regulatory and Institutional Framework for the Provision of Public Electricity Services Law 6 of 1997, electricity services in Panama was served by the vertically integrated state-owned National Institute of Hydraulic Resources and Electrification (IRHE). IRHE was the generator, transmitter, and distributor of electric power services (World Bank, 2010).

The passing of Law 6 of 1997 amended later by the introduction of Law 10 of 1998 regulated by the Executive Decree 22 of 1998 established the Wholesale Electricity Market (Mercado Mayorista de Electricidad) in Panama (World Bank, 2010; World Bank, 2011b). The new law promoted the introduction of competition and economic regulation of activities considered natural monopolies, as critical means for improving efficiency in the economy. The bill also separated the roles of policymakers, regulators and service providers, attributing policy-making and regulation obligations to the state and relying on the private sector to provide electricity services and investments (World Bank, 2010). The regulatory body, the National Authority on Public Services (ASEP) responsible for the supervision of electric power, water and telecommunications sectors was created in 1998. The unbundling of the former vertically-integrated monopoly IRHE into several generation, transmission and distribution activities saw the privatization of eight generation and three distribution companies (World Bank, 2010; World Bank, 2011a). The state-owned company Empresa de Transmisión Eléctrica held the responsibility to define plans related to power and transmission expansion according to the energy policy approved by the Comisión de Política Energética (World Bank, 2010).

Under the new system, electric power distributors are required to use a bidding process for competition to acquire a sufficient supply of electric power to cover for the projected demand of two years. Unfortunately, after 2004, the market mechanisms failed to attract new generation companies leading to a decrease in generation capacity. Concerned about future electric power shortages in the short terms, proposals to purchase emergency electric power supply were submitted to generation companies at the request of the regulator. In 2007, new competition bidding procedures were adopted for electric power purchases. The success of the new processes led to resulting in awarding 350 MW of long-term supply to five hydroelectric generators (World Bank, 2010).

2.5.12 Peru

The pre-reform electric power system in Peru was state-owned vertically integrated. The leading two utility companies providing about two-thirds of the country's electric power services were Electroperú and Electrolima with the rest of the services covered by nine regional companies. The Peruvian government's attempt to privatize the electric power sector in the 1980s failed due to some political issues. Lack of funding to rehabilitate the system and low electricity tariffs were enough to deteriorate the condition of the electric power sector in the early 1990s. The inadequate maintenance in operating capacity associated with the sabotage of the electric power system's physical assets in the 1980s contributed to the severity of the country's electricity problems. The electricity access level of the country in 1990 was only 45%. The electric power system was characterized by the insufficient power supply to cover demand, and high-power losses in transit estimated at more than 20% (Vagliasindi & Besant-Jones, 2013). In the face of this disastrous condition of the Peruvian electric power system, the necessity to reform was apparent.

In 1992, the reform began with the enactment of the Electric Concessions Law (LEC) with the objective to establish foundations for a reliable electric power sector that assured favorable, reliable, adequate, and cost-effective electric power services to end-users (Hammons, Corredor, Fonseca, Melo, Rudnick, Calmet, & Guerra, 1999). The legal framework of the law allowed for the establishment of a regulatory body, Organismo Supervisor de la Inversion en Energía y Minería, and the restructuring of Electroperú and Electrolima into separate generation, transmission, and distribution companies. Thirteen companies were created out of the generation segment, while the control of the transmission system was granted to six private organizations. At the same time, the restructuring of the distribution segment created sixteen companies. The period of 1994 through 1997 witnessed the "transfer of 70% of generation capacity, 100% of transmission capacity, and 45% of the distribution market from the public to private ownership, management, and operation" (Vagliasindi, & Besant-Jones, 2013, p. 207).

The Peruvian reform was one of the most influential and far-reaching models. The model was very effective and successful and was credited for the operating efficiency improvements of the Peruvian's electric power system (Kessides, 2012). For instance, the access level of electricity increased from about 60% in 1995 to almost 80% in 2008. Electric power losses that were close to 20% nationally in 1995 went down to 8.2% in 2007. The financial performance of the sector was enviable (Vagliasindi & Besant-Jones, 2013, p. 207).

2.5.13 Romania

The electric power system reform in Romania has been fueled by a series of socio-economic and political issues that were preventing Romania to develop a more efficient and competitive electric power market. The country's state-owned vertically integrated monopoly, the Regia Autonomă de Electricitate (RENEL), established in 1990 was suffering from a lack of economic growth throughout the 1990s resulting in limited electric power demand. Past years neglect for adequate maintenance and rehabilitation of deteriorating electric power subsystems was rapidly catching up with the sector. As Romania's demand for electric power started picking up with a now accelerating economic growth, pressure on generation plants and distribution channels began mounting. Investment needs for the rehabilitation of the country's aging electric power system became evident. Romania launched reforms in the late 1990s to address the country's electric power issues (World Bank, 2003).

In 1998, the government enacted an electricity law establishing the Autoritatea Nationala de Reglementare in domeniul Energiei as national energy regulation authority (Badileanu, 2014; World Bank, 2003). The restructuring of RENEL established the Compania Nationala de Electricitate (CONEL) as the national power company. Electric power generation, transmission, distribution, and system operations activities were no longer carried out by RENEL. CONEL comprised three entities with Termoelectrica responsible for thermal power generation, Hidroelectrica for hydropower generation, and Electrica for electric power distribution and supply. But with the restructuring process still ongoing, in 2000, CONEL was unbundled into various independent entities totally owned by the government and dissolved. Termoelectrica, Hidroelectrica, and Electrica reported to the Ministry of Industry and Resources; Transelectrica covered electric power transmission and the operations activities of the system; and the Romanian Electricity and Gas Market Operator, a subsidiary legal entity of Transelectrica, managed the commercial functions of the sector (Badileanu, 2014; World Bank, 2003; Diaconu, Oprescu, & Pittman, 2007).

Romania made significant progress in the implementation of its electric power system reforms, but some of the objectives that led to undertaking reform initiatives were not met. For example, the competition in the generation subsystem remains weak. The sector still struggles to ensure the security of energy supply and lower tariffs for end-users. High prices of electric power hinder domestic companies' competitiveness (Diaconu et al., 2007).

2.6 Background of Electric Power System in Togo

Togo is a small country in West Africa with a population of just over seven million people covering an area of 57,000 square kilometers. After independence in 1960, Togo achieved great economic success and became a sub-regional center for logistics, trade, and banking. The country built an effective administration and pursued open-market economic policies. Despite the country's economic progress with a GDP per capita rising from US$349 in 1960 to US$683 in 1980, prolonged years of political tension and suspension of programs initiated by international development partners over concerns about human right abuses, lack of good governance, and democracy diminished significantly Togo's abilities in delivering adequate public services (World Bank, 2017b).

The history of electric power began in 1926 in Togo when the very first 350 kVA plant was constructed. Before the establishment of the electric power generation and transmission company CEB in 1968 based on a partnership between Togo and Benin, the vertically integrated state-owned monopoly, the Compagnie Energie Electrique du Togo (CEET) assured coverage of electricity of the country using generators exclusively since its creation in 1936. Twenty years after the establishment of CEB, the country's first and only hydropower dam was constructed in Nangbeto with a generation capacity of 65 MW (Ntagungira, 2015). Since then, national electric power consumption had grown exceeding the country's production capacity, but policy and regulatory frameworks necessary to maintaining and improving the country's electric power systems are almost non-existent (World Bank, 2017b).

For over 43 years, the national electric power generation in Togo increased only "twofold while consumption rose nine-fold. From 1995, electricity consumption grew by 5% yearly" (Ntagungira, 2015, p. 12). During the same period, the country's electric power generation level fell by 6%. Figure 2-1 below illustrates the discrepancies between national electric power production and consumption in Togo covering a period from 1990 through 2015.

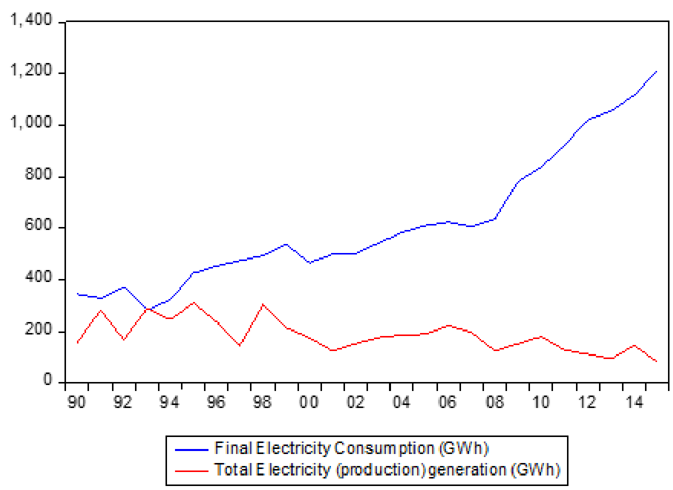


Figure 2-1. National electricity production and consumption in Togo (1990 – 2015)

To remedy the issues, the government signed bilateral cross-border electric power exchange agreements with its regional neighbours to supplement the electric power deficits. Thus, since 1972, VRA has been supplying Togo with electric power through CEB, followed by CIE since 1995 (UN, 2003). Supplementary electric power also comes from Nigeria with a very insignificant percentage from Niger (Ntagungira, 2015).

For many years, the state-run monopoly, CEET, in charge of domestic electric power generation and distribution undertook no significant investment actions to rehabilitate the sector and boost production (Ntagungira, 2015). Unfortunately, with increasing domestic demand for electric power in exporting countries, coupled with hydropower dams' vulnerability to droughts, foreign producers were facing generation capacity problems and were unable to meet their contractual export obligations in 1998 (UN, 2003). Togo faced its worst electric power crisis and forced to supply power to its end-users with frequent daily blackouts. According to OPIC (2013), frequent electric power outages in 2006 cost the country about $150 million to $190 million in private sector losses, representing around half of the government of Togo annual revenues (OPIC, 2013). Allcott et al. (2014) credited endemic electric power shortages to the deliberate low-quality electricity distribution companies provide with the complicity of the consumers and government subsidies to cover distribution companies' losses for offering low prices (Alcott et al., 2014).

The rehabilitation, the reinforcement, and the expansion of the country's electric power system required finance to help minimize technical and commercial losses, promote efficient management at CEET, and increase cash flow and financial performance through efficient bill collection (World Bank, 2017a); but CEET was in a dire need for investments (Ayenagbo, Johnson, Tchalim, Kimatu, & Nguhi, 2013). Efforts to attenuate the impacts of the power crisis were made through importation of thermal power plants, but the surge in fuel prices in the international market made the situation worse (IMF, 2008). In 2000, the Ministry of Mines and Energy in charge of activities related to energy sector including strategy and planning of the industry established a regulatory agency, Autorité de Reglementation du Secteur d'Electricité to monitor and regulate activities of the sector (World Bank, 2017b).

Table 2-2 below lists the country's electric power generation facilities with their installed capacity along with imports sources with their importation volume.

Table 2-2. Generation Facilities and Import Electric Power (MW)

	Installed	Available	Firm
CEET POWER PLANTS IN TOGO		**128**	**100**
Lome A Thermal Power Plant (Sulzer) - Diesel	2 x 8	7	10
Lome B Thermal Power Plant (CTL Site) - Diesel	1 x 14	14	
Kara Thermal Power Plant - Diesel	16	4	
Sokode Thermal Power Plant – Diesel	4	1.5	
Kpime Plant – Turbine	6 x 0.78	1.5	
Contour Global Thermal Power Plant – Engine	6 x 16.6	100	90
CEB SOURCES (TOGO AND BENIN)		**407**	**372**
Imported TCN (Nigeria)	..	200	200
Imported VRA (Ghana) & CIE (Cote d'Ivoire)	..	102	102
Lome Thermal Power Plant TAGS	2 x 25	40	40
Nangbeto Power Plant - Hydro	2 x 32.8	65	30
S/Total CEB Dedicated to Togo (47%)	..	191	175
TOTAL POWER PLANTS AND CEB TOGO		**329**	**275**

Source: African Development Bank (Ntagungira, 2015)

In 2008, Overseas Private Investment Corporation (OPIC) approved a loan estimated at $147 million and an insurance grant of $62 million to ContourGlobal, an American company, to construct and operate a 100 MW thermal power plant in Lome. In 2009, the International Finance Corp (IFC), a World Bank division, also invested in the project (OPIC, 2013). In 2010, ContourGlobal, the only IPP in Togo, terminated the construction of its thermal power plant, but increased fuel prices in the world stage have surged the production cost, which in turn increased service cost for consumers (Ntagungira, 2015). Although the transmission and the distribution of electricity within the country were the responsibility of CEET, it is a distribution company purchasing power from CEB and ContourGlobal (World Bank, 2017a).

On average, a per capita consumption of electricity in Togo is 118 kWh a year compared to Sub-Saharan African countries average of 535 kWh and 13,246 kWh in the U.S. (Ntagungira, 2015). The overall electricity access rate in 2015 was only 29.2%, lower than the Sub-Saharan Africa average of 37% (World Bank, 2017b). Table 2-2 below outlines some crucial parameters of the electric power sector in Togo.

Table 2-3. Some Important Parameters of Electric Power Sector in Togo

Electricity Access Rate (2015)	29.2% (56.4% Urban, 5.5% Rural
Number of Electricity Customers	290,000
Installed Capacity (2016)	205 MW
Energy Mix (2016)	50% Hydro, 50% Thermal
Share of Private Sector in Generation	50%
Average Cost of Service (2001 – 2015)	USc$29 per kWh
Cost of Service (2015)	USc$29 per kWh
Average Tariff (2016)	USc$19 per kWh
Total System Losses (2016)	24%
Electricity Bill Collection Rate (2016)	90% Domestic and Industrial Consumers 36% Government Bills
Level of Debt of Utility (2016)	US$29 Million (or 25% of Annual Revenues)

Source: World Bank (2017)

Later signs indicated minor performance improvements in electricity access level in the country, but the electric power system still faced significant issues in reliability and efficiency. Chronic electric power shortages continue to force Togo to rely on import electricity for the sustainment of its economic growth. Maintaining improved access while promoting national electric power autonomy in supplying energy at reasonable cost remained the primary challenge for the government (World Bank, 2017a).

2.7 Summary and Conclusion

In general, although the restructuring of electric power system around the world has been triggered mainly by the quest of financial resources to address some pressing needs of the sector, including poor performance, high costs, low quality services, poor investment decisions, and deteriorating infrastructure; literature reviews showed that drivers for reform differ from one country to another (Besant-Jones, 2006). Unlike the developing countries, the restructuring of electric power systems in developed countries was initiated to achieve further gains in efficiency, although the electricity sector in most of these countries performed well technically under vertically integrated organizations. In contrast, in much of the developing countries, dissatisfaction surrounding the poor performance of state-run monopolies, and the need for new financial means to modernize and meet the increasing electric power demand obligations constitute the driving force (Besant-Jones, 2006).

The experience in the examined countries demonstrated the institutional and technical difficulties that affect the transition of the power sector from a state-owned monopoly to a one that is competitive (Victor, 2005). Although the electric power systems have been somewhat restructured in these countries, public sector provisions continue to influence the outcome of the reform (Sen et al., 2016). The main barrier to successful restructuring and competition programs is the lack of commitment from policymakers (Joskow, 2006) to take the necessary steps to create an investment-friendly environment that encourages continued investments in the sector.

Chapter 3—Methodology

3.1 Introduction

This research is a case study that aims at investigating whether restructuring of the electric power system contributed to economic growth, efficiency improvement, electricity access expansion, and attraction of foreign private investors in Bolivia, Bulgaria, Colombia, El Salvador, Georgia, Ghana, Guatemala, Ivory Coast, Kenya, Nicaragua, Panama, Peru, and Romania. Findings of the investigation will be used based on a comparative analysis approach to infer that restructuring the electric power system in Togo should produce results similar to countries that share same international classification groups with Togo.

According to the World Bank (2011b), citing Jamasb et al. (2004), there are three approaches to analyse electric power reforms. First, econometric methods, which are best suited for testing hypotheses through statistical analysis of the variables; second, efficiency and productivity analysis methods suited for measuring the effectiveness of the process; and third, comparative case studies for in-depth investigation or qualitative analysis. From the three approaches, this study will, first, use econometric methods to determine economic, technical, and welfare impacts of the restructuring of electric power systems in the selected thirteen countries and provide support of causation claims in restructuring recommendation case for Togo. Then, comparative case studies methods to establish similarities between the selected countries and Togo based on the results of the statistical analyses.

3.2 Data Sources

This study was based on secondary empirical data collected from various world-renowned international organizations databases including the World Bank's World Development Indicators database, the U.N. databank, the African Development Bank (AfDB) Group's data portal, the International Energy Agency (IEA) statistics, and the U.S. Energy Information Administration (EIA) independent statistics and analysis. The study also used data from TheGlobalEconomy.com to supplement missing data from primary sources.

The study used 26 years observations of annual time series data of 13 selected non-OECD countries for a period covering 1990 through 2015. The study also converted the time series data into a panel dataset for the same 13 countries covering the same period of 26 years for a maximum of 338 observations (13 x 26). Due to data unavailability for certain variables such as Electricity Access Level and Electricity Imports/Exports for years preceding 1990 and for other variables for years after 2015, the study limits the data sample size to cover only 26 years.

The data collection of the study included the following response variables (Y) including GDP per capita estimated in current U.S. dollar; Balance of Required Domestic Electricity Provisions, also known as Shortage/Surplus of Electricity in GWh; Electricity Access Level in percentage of population; and Foreign Investment in Electric Power System in million U.S. dollar. The only predictor variable (X) used for this study was Restructuring of Electric Power System, which is a dummy variable that takes 0s for pre-restructuring years and 1s for post-restructuring years.

In the absence of available data for the response variable, Shortage/Surplus of Electricity, for the selected 13 countries in this study, the paper estimated data for

Shortage/Surplus of Electricity by subtracting the annual domestic supply of electricity estimated in GWh out of the total annual electricity generation also in GWh. The estimated yearly domestic supply of electricity is the sum of the total annual electricity generation plus the annual imports and exports of electricity in GWh. Based on the estimation results of Shortage/Surplus of Electricity, a positive balance of annual domestic electricity provisions translates to supply surplus that constitutes the amount of electricity to export. A negative balance, on the other hand, means supply shortages resulting in electricity imports to meet the domestic demand. Thus, the Shortage/Surplus of Electricity can be estimated as the difference between total electricity exports and imports. It is important to note that the annual domestic supply of electricity accounts for power plants' own use, transmission, distribution, and transformation losses, and electricity imports and exports. The equation used for the estimation of Shortage/Surplus of Electricity is given below.

$$ST/SP = TEG - DSE \quad (3.1)$$

where, $$DSE = TEG + TEI - TEX \quad (3.2)$$

thus, $$ST/SP = TEX - TEI \quad (3.3)$$

ST is Shortage, SP is Surplus, TEG is Total Electricity Generation, TEI is Total Electricity Import, TEX is Total Electricity Export, and DSE is Domestic Supply of Electricity.

Data on GDP per capita are obtained from the World Bank's World Development Indicators database. We calculated data for balance of domestic electricity provisions based on electricity import/export, domestic supply, and production data from IEA and TheGlobalEconomy.com. Data for electricity access level were also derived from the same sources. Foreign investment in electric power system data came from the World Bank Private Participation in Infrastructure Database.

Tools used for data analysis were the econometric software Stata 13 and EViews 10. While Stata was used for Ordinary Least Squares (OLS) model and Breusch-Pagan / Cook-Weisberg test for heteroskedasticity and Breusch-Godfrey LM test for autocorrelation, EViews was used for Chow test, and Bai-Perron Tests of 1 to M Globally Determined Breaks. Minitab 18 and R Studio 3.5.1 were also used for time series plots and other estimations. Table 3-1 presents the hypotheses, analysis methods, and details of variables used in this study to estimate restructuring of electric power system impacts in the 13 selected non-OECD countries.

Table 3-1. Overview of Research Hypotheses and Data Analysis Methods

Hypotheses	Response Variable (Y)	Predictor Variable (X)	Analysis Method
H1: Restructuring the electric power system in Togo will lead to an increase in the country's GDP per capita.	Per capita GDP (Current US$)	Restructuring of Electric Power System (Yes=1; No=0)	Bai-Perron Test, Chow Test, OLS Regression Model, Fixed Effect (FE)
H2: There will be a reduction in the shortage of electric power in Togo if the country's electric power system is restructured.	Shortage of Electric Power (GWh)	Restructuring of Electric Power System (Yes=1; No=0)	Bai-Perron Test, Chow Test, OLS Regression Model, Fixed Effect (FE)
H3: If Togo's electric power system is restructured, then there will be increased foreign investments in the electric power system.	Foreign Investments (Million US$)	Restructuring of Electric Power System (Yes=1; No=0)	Bai-Perron Test, Chow Test, OLS Regression Model, Fixed Effect (FE)
H4: Restructuring Togo's electric power system will lead to an increase in electricity access level.	Electricity Access Level (% of Population)	Restructuring of Electric Power System (Yes=1; No=0)	Bai-Perron Test, Chow Test, OLS Regression Model, Fixed Effect (FE)

3.3 Analysis Methods

3.3.1 Econometric Methods

We started this study by conducting a before-and-after analysis based on Chow (1960) to establish a causal relationship between the predictor variable and the response variables. Researchers use Chow test to examine whether the actual coefficients in two linear regressions on different datasets are equal. The whole or pooled period of the study is divided into two sub-periods (Pre- and post-restructuring). Chow test runs the two regression assuming there is structural instability due to changes in slope parameters or intercept parameters. The regression for the pooled period assumes there is no structural breakpoint and that the intercept and the slope coefficient remain the same throughout the pooled period. We estimated the model using basic Chow test model defined as

$$Y_t = \alpha_1 + \alpha_2 D_t + \beta_1 X_t + \beta_2 X_t D_t + \varepsilon_t \quad (3\text{-}1)$$

Where Y_t is the observed dependent variable at time *t*; D_t is the dummy variable, restructuring of electric power system, taking 0s for pre-restructuring observations and 1s for post-restructuring observations. The dummy variable *D* allows to differentiate between the intercepts and slope coefficients of the two periods. β_1 and β_2 are the slope coefficients; α_1 and α_2 are the intercepts; and ε_i is the disturbance at time t. The test examines the null hypothesis, there is no structural break, against the alternative, there is a structural break in the time series. The residual sum squares obtained from the three regressions are used to calculate the Chow F-statistic given as

$$F = \frac{\left(RSS_p - (RSS_1 + RSS_2)\right)/k}{(RSS_1 + RSS_2)/(N_1 + N_2 - 2k)} \quad (3\text{-}2)$$

Where RSS_p is the residual sum squares for the pooled period regression, RSS_1 is for pre-restructuring period regression, and RSS_2 is for post-restructuring period regression. N is pre- and post-restructuring total number of observations, and k, the number of regressors.

In this study, we tested for the presence of a structural breakpoint at the date the examined 13 countries restructured their electric power systems. We performed statistical analyses on fundamental economic and electric power system variables about the examined 13 countries to determine whether the restructuring of electric power systems resulted in virtually a different economic development path regarding GDP per capita, shortage of electricity, electricity access level, and foreign investment in electric power system. We used the time series data based on the known a priori date of the enactment of the restructuring of electric power system law in each selected country. Although the results of the Chow test confirmed, for the most part, the presence of very significant structural breaks at breakpoints corresponding to the known a priori dates (see Appendix for Table A-2 through Table A-5 and Figure A-6 through Figure A-9), we cannot conclusively rule out the existence and influence of other unobserved or unknown factors that could affect the results. Cooper, Piehl, Braga, and Kennedy (2001) reminded us that testing for a single structural break known a priori in a time series as recommended by Chow (1960) could lead to an inaccurate conclusion relating to timing and statistical significance of a breakpoint in the time series (Cooper, Piehl, Braga, and Kennedy, 2001); and is probably not sufficient to establish causation (Kelly & Sienko, 2018).

Several tests for identification of multiple structural breakpoints in a time series data have been discussed extensively in the econometric literature, but we found Bai (1997) and Bai and Perron's (1998, 2003a) approach to structural break testing suitable for this study. Following this approach, we considered a standard multiple linear regression model with T periods and m potential breaks (producing m + 1 regimes). For the observations T_j, $T_j + 1$, …, $T_{j+1} - 1$ in regime j, we have the regression model

$$y_t = X_t'\beta + Z_t'\delta_j + \varepsilon_i \qquad (3.3)$$

for regimes j = 0, …, m. y_t is the observed dependent variable at time *t*; both X_t' and Z_t' are vectors of covariates and β and δ_j are the corresponding vectors of coefficients; ε_i is the disturbance at time t. We divided the regressors into two groups. The parameters for the X variable do not vary across regimes, but the Z variables have coefficients that are specific to the regime.

For the test of the null hypothesis of no breaks against the alternative of breaks, we employed Global L Breaks Vs. None method with Bai-Perron tests of 1 to M globally determined breaks to determine the exact structural breakpoints in the examined variables. To evaluate the null hypothesis that $\delta_0 = \delta_1 = \ldots = \delta_{i+1}$, we needed to determine the F-statistic based on the following Bai and Perron (2003a) general form of the statistic:

$$F(\hat{\delta}) = \frac{1}{T}\left(\frac{T-(l+1)q-p}{kq}\right)(R\hat{\delta})' \left(R\hat{V}(\hat{\delta})\, R'\right)^{-1} R\hat{\delta} \qquad (3.4)$$

where $\hat{\delta}$ is the optimal l -break estimate of δ, $(R\hat{\delta})' = (\delta_0' - \delta_1', \ldots, \delta_i' - \delta_{i+1}')$, and $\hat{V}(\hat{\delta})$ is an estimate of the variance covariance matrix of $\hat{\delta}$ which may be robust to serial correlation and heteroscedasticity. *R* is the conventional matrix; *k* is the number of breaks; *T* is the number of observations; *q* is the number of regressors that varies from 1 to 10; and *p* is the significance level.

We estimated the equation in EViews by regressing each variable with the constant coefficient C. We selected Least Squares with Breakpoints method. For robustness, we chose HAC (Newey-West) for the covariance matrix and allow error distributions to differ across breaks. The most relevant breakpoints are determined using unweighted max-F (UDmax), Trimming percentage of 0.15, Maximum breaks of 5, and Significance level sets at 0.05. UDmax chooses the alternative that maximizes the statistic throughout the number of breakpoints.

After identifying the breakpoints, we chose the most "relevant" breakpoint, which is the breakpoint corresponding to UDmax. We re-ran the test with only one break to see if the result corresponds to the initial most relevant breakpoint identified. Whenever the test with five (5) breaks found one (1) or no break during the test for five breaks, we did not implement the test for one break. Whenever the test for five breaks was not possible, we decreased the number of tested breaks. The results are summarized in table 4-2. The summary of the results of five structural breakpoints test are presented in the appendix.

With all the breakpoints identified for all the dependent variables per country, we conduct the Chow test again to determine the F-statistic and its corresponding p-value for each dependent variable. We reject the null hypothesis whenever the p-value was significant (<0.05). The results are summarized in table 4-3 through table 4-6.

To confirm that the Chow test results were not misleading, we decided to use an Ordinary Least Squares (OLS) approach where we regressed each variable on the break dummy variable to estimate the unknown parameters. We conducted the analyses for each country separately. But before running the model, we first check whether the OLS approach applies to the study by testing two main assumptions of the OLS model. First, the error term has a constant variance and second, there is no first-order serial correlation. We performed these tests because the error term variation is said to be common in time series measurements. So, to test for both assumptions, we employed the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity and Breusch-Godfrey LM test for autocorrelation per variable per country. The null hypothesis for the heteroskedasticity test was that the error term has a constant variance. The null hypothesis for the autocorrelation test was that there is no first-order serial correlation. After the test, if the p-value is found to be less than 0.1 for both tests, we rejected the null hypothesis. Results for both tests are shown in table 4-7 through table 4-10.

To resolve the issue in case of rejection, we re-estimated the OLS models with autocorrelation and heteroskedasticity robust standard errors, which estimated the variances correctly using the following simple equation:

$$Y_i = \hat{\beta}_0 + \hat{\beta}_1 X_i + \hat{u}_i \qquad (i = 1, \ldots, N) \qquad (3.5)$$

where $\hat{\beta}_0$ is the OLS estimator of the intercept coefficient β_0; $\hat{\beta}_1$ is the OLS estimator of the slope coefficient β_1; $\hat{u}_i$ is the OLS residual for sample observation i. The results of the models are summarized per variable in table 4-11 through table 4-14. For all the tables, * denotes p<0.10, ** denotes p<0.05, and *** denotes p<0.01, standard errors are in the parenthesis, and dependent variables are estimated on a log scale.

Finally, since we cannot with certainty affirm that the predictor variable in the OLS model accounts for all relevant characteristics of the selected countries, we used the whole sample of all the countries by converting the time series data of the 13 countries with 26 observations from 1990 to 2015 into a panel data with 338 observations. The choice of panel data was guided by the possibility it provides the analyst to control for unknown factors or the heterogeneity of the examined variables (Torres-Reyna, 2007). Since we are concerned about accounting for unknown or unobserved factors within a country that may influence or bias our response variables, we decided to estimate the model using Fixed Effects (FE) regression approach with robust standard errors to control for country-specific effects. FE model allowed us to account and control for country-specific characteristics such political institutions' independence, or utilities' business practices that may influence or bias the outcomes of the predictor or response variables. In general, FE is used whenever there is a doubt about the existence of unknown factors that could impact the outcome of the variables (Torres-Reyna, 2007). The basic specification of the FE model was estimated as follows:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \qquad (t = 1, ..., T \text{ and } i = 1, \ldots, N) \qquad (3.6)$$

where Y_{it} is the dependent variable observed for individual i at time t; X_{it} is the time-variant T x k regressor matrix; β is the k x 1 matrix parameters; α_i is the unobserved time-invariant individual effect; and ε_{it} is the error term. The results are presented in table 4-15. The outputs for the separate models are also given in the appendix.

3.3.2 Comparative Case Study Method

Restructuring of the electric power system is the process of separating functions once provided by a vertically-integrated organization to make it competitive, more profitable, and well-structured to meet the pressing needs of the end-users. Hence, to achieve great success in restructuring electric power systems in Togo, the initiative must be built around some essential elements that should serve as guidelines to encourage participation of those that may otherwise look elsewhere. These elements must include the introduction of competition; the encouragement of foreign private investors for financial, technical, and managerial expertise; the development of transparent economic regulation, the prevention of anticompetitive abuses, and the political commitment of the government to formulate and enact legislation to sustain the restructuring program (Bacon & Besant-Jones, 2001).

Using the World Bank's classifications of countries based on the following five indicators: Income Level Groups, Operational Lending Categories, Government Effectiveness Index, Regulatory Quality Index, Energy Use per Capita; and Transparency International's Corruption Perceptions Index (CPI); we conducted a comparative analysis between the selected 13 countries and Togo to establish economic and political similarities. From the six classification indicators, countries that group with Togo at a minimum four out of six are considered similar to Togo economically and politically.

Income Level Groups used Gross National Income (GNI) per capita to divide the 13 non-OECD examined countries into four different income groups (Low, Lower-Middle, Upper-Middle, and High). Following the established 2017 World Bank classifications threshold of GNI per capita in dollar terms, we grouped the countries with GNI per capita lower than $995 as low-income countries. Additionally, countries with GNI per capita between $996 and $3,895 were classified as lower-middle-income countries. Furthermore, countries with GNI per capita between $3,896 and $12,055 were titled upper-middle-income countries. Lastly, countries with GNI per capita more than $12,056 were classified as high-income countries (World Bank, 2018).

We divided the countries' Operational Lending Categories into three lending groups (IDA, IBRD, and Blend) according to the World Bank operational policy procedures. Thus, countries with small income per capita lacking financial creditworthiness to borrow from the International Bank for Reconstruction and Development (IBRD) are grouped under the International Development Association

(IDA). Countries grouped under Blend are financial creditworthy. Not only they are eligible for IDA loans but can also apply for IBRD loans (World Bank, 2018).

The Government Effectiveness Index (GEI) illustrates perceptions governments have regarding the quality of services in public and civil sectors. It underscores the degree to which governments are independent of political pressures, their ability to formulate quality policies and implement them, and their credibility towards the commitment to such policies (World Bank, 2018). The 2016 average of GEI was -0.02 points with Singapore being attributed the highest value of 2.21 points and Somalia, the lowest value of -2.18 points (World Bank, 2018). Based on this distribution, we divided the index into two groups (Good and Bad) with Good being countries with an index above zero and Bad, countries with an index below zero.

The World Bank's Regulatory Quality Index is the perceptions of governments' ability to formulate and put into action sound regulations and policies geared toward the promotion of private sector development (World Bank, 2018). This study divided the Regulatory Quality Index into two groups (Good and Bad) based on the distribution of the index's scores. Since the average value of the index was -0.02 points in 2016 with the highest value being 2.18 points and the lowest -2.33 points, we rounded the average index value to zero. Thus, countries that score above zero are assigned to the Good group while those with a score lower than zero are assigned to the Bad group.

Energy Use per Capita is an economic development indicator that measures the yearly amount of energy used by a person in a country. The average for the year 2014 was 2623.31 kilograms of oil equivalent. Qatar recorded the highest value at 18562.67 kilograms of oil equivalent use per capita, and the lowest value in Niger with 150.73

kilograms of oil equivalent use per capita (World Bank, 2018). Using structures similar to those used for the classification of Income Level Groups, we also divided Energy Use per Capita into four different groups. Hence, countries with less than 1,000 Kilograms of oil equivalent are classified as low energy consumption countries, those with between 1,001 and 3,000 Kilograms of oil equivalent as lower-middle energy consumption countries, those with between 3,001 and 6,500 Kilograms of oil equivalent as upper-middle energy consumption countries, and those with energy use per capita of more than 6,501 as high energy consumption countries.

Corruption Perceptions Index (CPI) ranks countries on the assessed level of corruption in the public sector (administrative and political corruption) based on expert evaluations and surveys of opinions collected from a variety of reputable institutions (Transparency International, 2018). The 2016 average CPI was 43 points, with the highest value of 90 points being assigned to Denmark and the lowest value of 10 points to Somalia. For this study, countries with index scores higher than the average score of 43 points for the year 2016 are considered transparent, and any country with a score of 43 points or lower is deemed to be non-transparent. The comparison is summarized in table 4-16.

Chapter 4—Results

4.1 Introduction

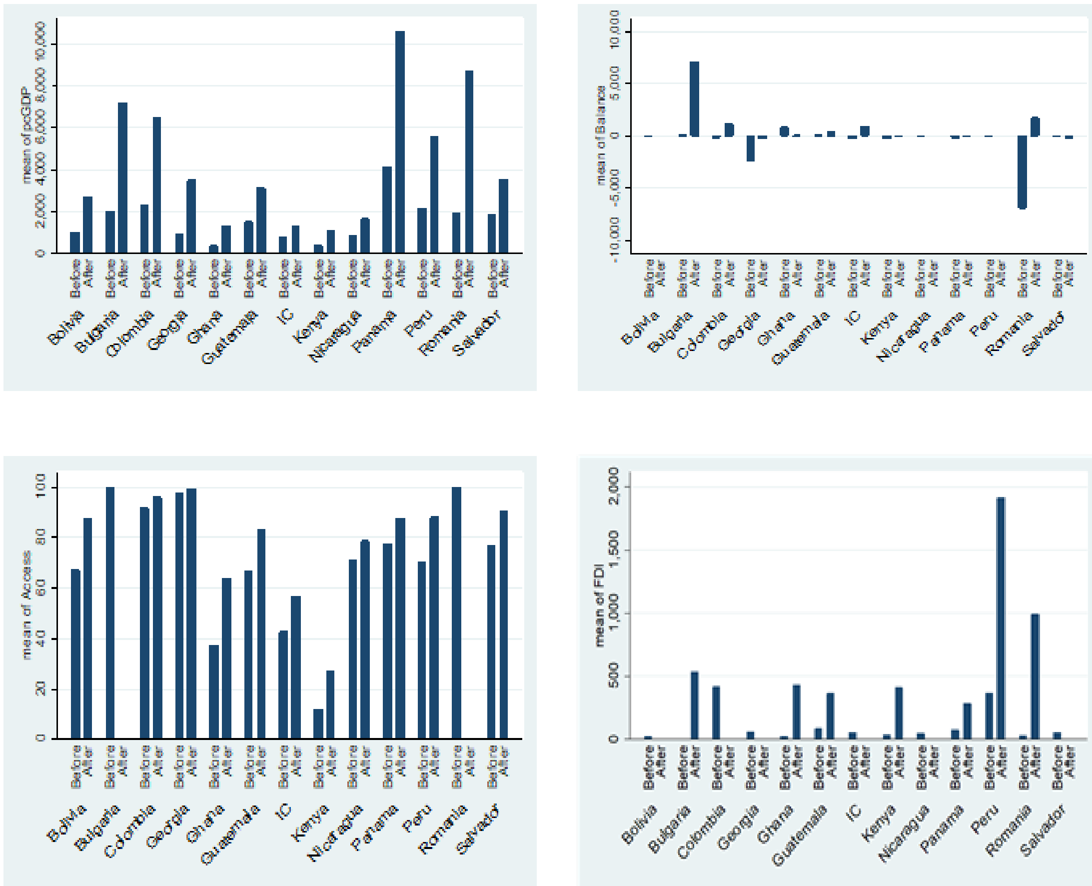
Throughout this study, we used various econometric analysis methods to establish causation between the restructuring of the electric power system and the dependent variables to support the claims made in the hypotheses. The analysis of the results could help determine whether the restructuring of the electric power system in the selected 13 countries helped to improve efficiency, reliability, and access rate; contribute to economic growth; increase foreign private investment, and reduce chronic shortages of electricity. Thus, using comparative case studies methods, we established similarities between the selected 13 countries and Togo to infer that restructuring electric power system in Togo should produce results similar to those of the selected 13 countries that share same international classification groups with Togo.

4.2 Discussion of the Results

4.2.1 Results of the Descriptive Analysis

Before empirical interpretation of the impacts of the restructuring of the electric power system (predictor variable Y) on the developments of the examined response variables (X), we implemented some descriptive analyses to understand the data and get a better sense of the developments of the examined variables in each country. Figure 4-1 illustrates the before-and-after comparison of the average values of the examined variables per country based on their respective breakpoints.

Figure 4-1. Before-and-After Comparison of the Average Value of the Examined Variables per Country Based on their Respective Breakpoints



IC stands for Ivory Coast

Figure 4-1. Before-and-After Comparison of the Examined Variables per Country

Attentive observation of Figure 4-1 shows that average values of the examined variables increased after the breakpoint for almost all the examined countries. The illustration of per capita GDP is unequivocal. We can, therefore, insinuate that all the 13 examined countries experienced economic growth after the breakpoints. The same observation can be made with the variable electricity access level where all the examined countries experienced a bump in their electricity access level, except Bulgaria and Romania that have been enjoying 100% electricity access level since 1990. There are some noticeable improvements observed with variable balance of domestic electricity provisions, especially with Romania that turned shortage into surplus; and Georgia that is almost eyeing the equilibrium level. As far as the variable, foreign investment, is concerned, seven out of the 13 examined countries saw substantial increases in foreign investment with a remarkable bump for Peru and Romania. Although the after observations for the rest of the examined countries are not significant, we can also say that the before observations were almost non-existent, except Colombia. The time series boxplot representations of all the examined variables per country are presented in Appendix.

Table 4-1 below provides descriptive statistics of the examined variables for the whole panel of countries. The variables used in the table include GDP per capita (pcGDP), balance of domestic electricity provisions (BalanceEl), electricity access level (AccessEl), and foreign investment in electric power system (FIEl). The table is a comparison of the main distributions.

Table 4-1. Descriptive Statistics of the Examined Variables per Country

country	variable	N	mean	sd	min	max
Bolivia	pcGDP	26	1419.0	781.7	710.0	3124.0
	BalanceEl	26	-14.4	42.4	-220.0	0.0
	AccessEl	26	74.0	11.2	56.4	91.5
	FIEl	23	23.6	59.4	0.0	252.4
Bulgaria	pcGDP	26	3820.7	2646.5	1148.5	7853.3
	BalanceEl	26	4390.6	4068.2	-3790.0	10661.0
	AccessEl	26	100.0	0.0	100.0	100.0
	FIEl	26	266.1	494.4	0.0	2342.1
Colombia	pcGDP	26	3764.4	2235.8	1175.2	8030.6
	BalanceEl	26	531.0	739.8	-370.0	1792.0
	AccessEl	26	94.5	2.4	89.9	98.2
	FIEl	26	417.4	689.1	0.0	3142.2
Georgia	pcGDP	26	1831.5	1356.1	517.1	4429.7
	BalanceEl	26	-474.2	919.4	-3203.0	1260.0
	AccessEl	26	98.8	0.8	97.3	100.0
	FIEl	26	59.3	139.1	0.0	457.7
Ghana	pcGDP	26	752.7	507.8	263.1	1814.5
	BalanceEl	26	174.3	467.0	-610.0	930.0
	AccessEl	26	49.6	15.9	23.5	78.3
	FIEl	25	107.6	219.8	0.0	900.0

Guatemala	pcGDP	26	2091.0	883.8	825.8	3923.6
	BalanceEl	26	157.3	236.3	-318.0	704.0
	AccessEl	26	75.4	9.3	60.2	90.5
	FIEl	26	151.2	209.1	0.0	758.0
Ivory Coast	pcGDP	26	967.8	270.3	590.3	1569.9
	BalanceEl	26	656.0	590.4	-484.0	1565.0
	AccessEl	26	50.2	8.3	36.5	64.1
	FIEl	23	53.3	97.9	0.0	350.0
Kenya	pcGDP	26	640.2	352.8	223.3	1350.0
	BalanceEl	26	-104.4	98.0	-273.0	59.0
	AccessEl	26	18.8	9.7	3.3	41.6
	FIEl	26	97.0	187.6	0.0	764.0
Nicaragua	pcGDP	26	1144.0	494.2	243.6	2073.5
	BalanceEl	26	-24.4	47.5	-162	48.0
	AccessEl	26	74.0	4.3	66.8	81.9
	FIEl	26	47.2	92.6	0.0	425
Panama	pcGDP	26	5882.2	3270.1	2603.8	13684.1
	BalanceEl	26	-24.0	105.7	-251	177.0
	AccessEl	26	82.6	6.1	70.2	92.6
	FIEl	26	125.1	192.8	0.0	680.5
Peru	pcGDP	26	3216.3	1759.8	1210.0	6583.1
	BalanceEl	26	9.0	26.6	-6.0	112.0
	AccessEl	26	76.9	10.3	60.2	93.9
	FIEl	26	604.6	655.2	0.0	2444.7
Romania	pcGDP	26	4560.3	3500.3	1102	10136
	BalanceEl	26	750.8	3619.7	-9476	7126
	AccessEl	26	100.0	0.0	100.0	100.0
	FIEl	26	327.9	645.7	0.0	2121.2
Salvador	pcGDP	26	2564.5	999.5	913.6	4127.1
	BalanceEl	26	-183.9	227.9	-899.0	35.0
	AccessEl	26	85.1	7.7	69.6	95.4
	FIEl	23	55.9	131.3	0.0	594.0
Total	pcGDP	338	2511.9	2378.8	223.3	13684.1
	BalanceEl	338	449.5	1939.9	-9476	10661.0
	AccessEl	328	75.4	24.2	3.3	100.0
	FIEl	338	183.6	406.4	0.0	3142.2

4.2.2 Results of the Bai-Perron Multiple Breakpoint Test

As stated before, this study used the Bai-Perron tests of l to M globally determined breaks test method against the null of no structural breaks with the corresponding UDmax to identify the breakpoints (dates) in the time series. Table A-1 in Appendix showed the summarized results of the first test when the maximum breakpoint to detect was set at 5. Table 4-2 is the summarized results of the second test confirming the corresponding breakpoint to UDmax.

Table 4-2. Results of Bai-Perron tests of 1 to M globally determined breaks

Country	GDP per capita	Shortage/Surplus of Electric Power	Electricity Access Level	Foreign Investment in Electric Power System	Actual Year of Restructuring
Ghana	2006	1994	2004	2011	1997
Ivory Coast	2007	1996	2002	no break	1998
Kenya	2007	2004	2004	2012	1997
Peru	2008	no break	2006	2012	1992
Bolivia	2010	no break	2007	no break	1994
Salvador	2005	1999	2000	no break	1996
Colombia	2007	2002	2000	no break	1994
Romania	2006	1993	no break	2008	1998
Georgia	2007	1993	1999	no break	1997
Bulgaria	2007	2000	no break	2003	1999
Guatemala	2007	2013	2002	2010	1996
Panama	2009	1999	2003	2010	1997
Nicaragua	2007	no break	2006	no break	1998

As expected, the breakpoints shown in Table 4-2 do not correspond to the known a priori breakpoints. The known a priori breakpoints were based on the dates the examined countries enacted laws introducing restructuring of their electric power systems. Results of the Chow test performed using the known a priori breakpoints are presented in Table A-2 through Table A-5 and Figure A-6 through Figure A-9 in the Appendix. However, relying on these dates to perform the Chow test could lead to "an erroneous conclusion regarding both timing and statistical significance of a break in the time series" (Cooper et al., 2001, p. 8). Jouini & Boutahar (2004) admitted that conducting a Chow test using a known a priori break date as imposed in Chow (1960) is prone to flawed results. Cooper et al. (2001) advised against the prescribed practice in the literature for post-intervention period evaluation that recommends "testing for a change in mean or other parameters" (p. 8). They argued that "even when the start date of a program is known, implementation lags and even leads (through 'announcement effects' where the program has an effect before it even begins) make it virtually impossible to identify the timing of effect a priori" (Cooper et al., 2001, p. 9). Supporting the arguments made in the other literature regarding Chow test, Kelly and Sienko (2018) acknowledged that "testing a single breakpoint can provide only weak evidence in an argument for causation if the Chow test is dependent on knowing, a priori, the date of the structural change" (p. 8). Cooper et al. (2001), Jouini and Boutahar (2004), and Kelly and Sienko (2018) proposed the test for structural breakpoint using Bai (1997) and Bai and Perron (1998), which are extensions of the Quandt-Andrews test that tests for multiple unknown breakpoints and selects "the date that maximizes the Chow test" (Jouini & Boutahar, 2004, p. 395) as the breakpoint.

The determined dates per country per variable used as breakpoints to conduct the Chow test are displayed in Table 4-2 and are within the restructuring process windows. It is important to state that the restructuring of the electric power system is still ongoing in most of the examined countries and could be the reasons behind the noticeable difference between the actual start dates of restructuring as breakpoints and the determined breakpoints. For instance, in Ivory Coast, a program called Electricity for All was adopted in 2014 to expand grid connections throughout the country although reform activities started in 1998. Another reform in 2010 led to the merger of two state-owned electricity companies to form Société des Énergies de Côte d'Ivoire (RECP, 2018). All these two events could affect the breakpoint in the time series for Ivory Coast. Also, in Kenya, 2006 saw the restructuring of the state-owned Kenya Electricity Generating Company where 30% of the company was sold to the public. 2006 was also the year the Energy Act No. 12 was enacted to consolidate all electricity laws to better monitor the sector (Vagliasindi & Besant-Jones, 2013), which could influence the time series data leading to the breakpoint of 2007 identified for GDP per capita.

Depending on subsequent policies following the introduction of restructuring and the commitment of the lawmakers in the examined countries towards the process, causal lags could be long reflecting the determined breakpoints listed in Table 4-2. In Bolivia, for instance, the breakpoints of 2010 determined for GDP per capita and 2007 for electricity access level could be associated with the new law in 2006 aiming for universal access to electricity and numerous decrees enacted in 2008 and 2009 to promote the economic development of the electric power sector (Caballero, 2013). Although the law allowing the restructuring of electric power system was enacted in 1999 in Bulgaria, we can associate the breakpoint of 2003 used for the Chow test of foreign investment in electricity with the 2003 Energy Law and Directive 2003/54. The breakpoint 2007 used for the GDP per capita is in line with the year the Bulgarian electric power market became fully liberalized with the merging of distribution companies (Sirleshtov & Maneva, 2018). There were numerous post-restructuring legislative efforts made in all the selected countries to enhance the restructuring of electric power system programs that could affect the post-restructuring trends of the examined dependent variables. All the breakpoints used for the Chow test could be justified based on restructuring-related activities that occurred after the reported restructuring dates in all the selected countries.

Variables for some countries show no breakpoints because of the trend-stationary nature in the behavior of those variables. For instance, electricity access levels for Romania and Bulgaria show no break because they have been trend-stationary at 100% throughout the time series.

4.2.3 Results of the Chow Test

Tables 4-3 through 4-6 show the results of the Chow tests. The results presented in all the tables indicate very significant structural breaks for all the variables based on their respective breakpoints; with high F-statistics statistically significant at their corresponding p-values much lower than the level of significance 0.05. Based on these results, we can reject the null hypothesis of no break in all cases and confirm that the identified dates from Bai-Perron tests of 1 to M globally determined breaks are the actual breakpoints. The results of the log likelihood ratio test decisively reject the null hypothesis of no structural break at their corresponding probability chi-square values. Just like the log likelihood ratio statistic, the Wald statistic test also decisively reject the null hypothesis. These results indicate that restructuring can influence the dependent variables.

Table 4-3. Summary of Chow Breakpoint Test for GDP per capita

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	2006	183.9703	0	56.14288	0	183.9703	0
Ivory Coast	2007	98.89428	0	42.46504	0	98.89428	0
Kenya	2007	132.8596	0	48.80974	0	132.8596	0
Peru	2008	122.1467	0	46.97048	0	122.1467	0
Bolivia	2010	115.1743	0	45.6995	0	115.1743	0
Salvador	2005	72.79376	0	36.25775	0	72.79376	0
Colombia	2007	118.4396	0	46.30247	0	118.4396	0
Romania	2006	245.0699	0	62.83985	0	245.0699	0
Georgia	2006	109.3308	0	44.58427	0	109.3308	0
Bulgaria	2007	194.7008	0	57.45092	0	194.7008	0
Guatemala	2007	86.01199	0	39.58592	0	86.01199	0
Panama	2009	91.19431	0	40.78273	0	91.19431	0
Nicaragua	2007	50.17061	0	29.33617	0	50.17061	0

Table 4-4. Summary of Chow Breakpoint Test for Shortage of Electricity

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	1994	12.68985	0.0016	11.0356	0.0009	12.68985	0.0004
Ivory Coast	1996	51.61988	0	29.8393	0	51.61988	0
Kenya	2004	109.1874	0	44.55629	0	109.1874	0
Salvador	1999	8.543493	0.0074	7.917614	0.0049	8.543493	0.0035
Colombia	2002	88.81668	0	40.24047	0	88.81668	0
Romania	1993	37.1333	0	24.31008	0	37.1333	0
Georgia	1993	28.93523	0	20.5664	0	28.93523	0
Bulgaria	2000	61.54066	0	33.04439	0	61.54066	0
Guatemala	2013	6.605756	0.0168	6.321491	0.0119	6.605756	0.0102
Panama	1999	22.13668	0.0001	16.99242	0	22.13668	0

Table 4-5. Summary of Chow Breakpoint Test for Electricity Access Level

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	1994	12.68985	0.0016	11.0356	0.0009	12.68985	0.0004
Ivory Coast	2002	71.50807	0	35.91008	0	71.50807	0
Kenya	2004	46.37937	0	27.97201	0	46.37937	0
Peru	2006	83.79406	0	39.05639	0	83.79406	0
Bolivia	2007	84.6345	0	39.25831	0	84.6345	0
Salvador	2000	101.2031	0	42.94897	0	101.2031	0
Colombia	2000	72.98207	0	36.30828	0	72.98207	0
Georgia	1999	33.20636	0	22.58389	0	33.20636	0
Guatemala	2002	88.10314	0	40.0755	0	88.10314	0
Panama	2003	69.08039	0	35.24065	0	69.08039	0
Nicaragua	2006	62.21521	0	33.24861	0	62.21521	0

Table 4-6. Summary of Chow Breakpoint Test for Foreign Investment in Electricity

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	2011	30.19889	0	21.17977	0	30.19889	0
Kenya	2012	27.67294	0	19.93889	0	27.67294	0
Peru	2012	73.19093	0	36.36421	0	73.19093	0
Romania	2008	22.63493	0.0001	17.2717	0	22.63493	0
Bulgaria	2003	10.34687	0.0037	9.31988	0.0023	10.34687	0.0013
Panama	2010	6.509524	0.0175	6.239612	0.0125	6.509524	0.0107
Guatemala	2010	11.48410	0.0024	10.16680	0.0014	11.48410	0.0007

Figure 4-1 below is the illustration of the Chow test plot per country of GDP per capita showing pre- and post-restructuring slopes. The plots confirmed the Chow test results of the existence of structural breaks in the time series. The plots also show that post-restructuring slopes are higher that the pre-restructuring ones.

Per Country Chow Test Plot of GDP per capita Showing Pre- and Post-Restructuring Slopes

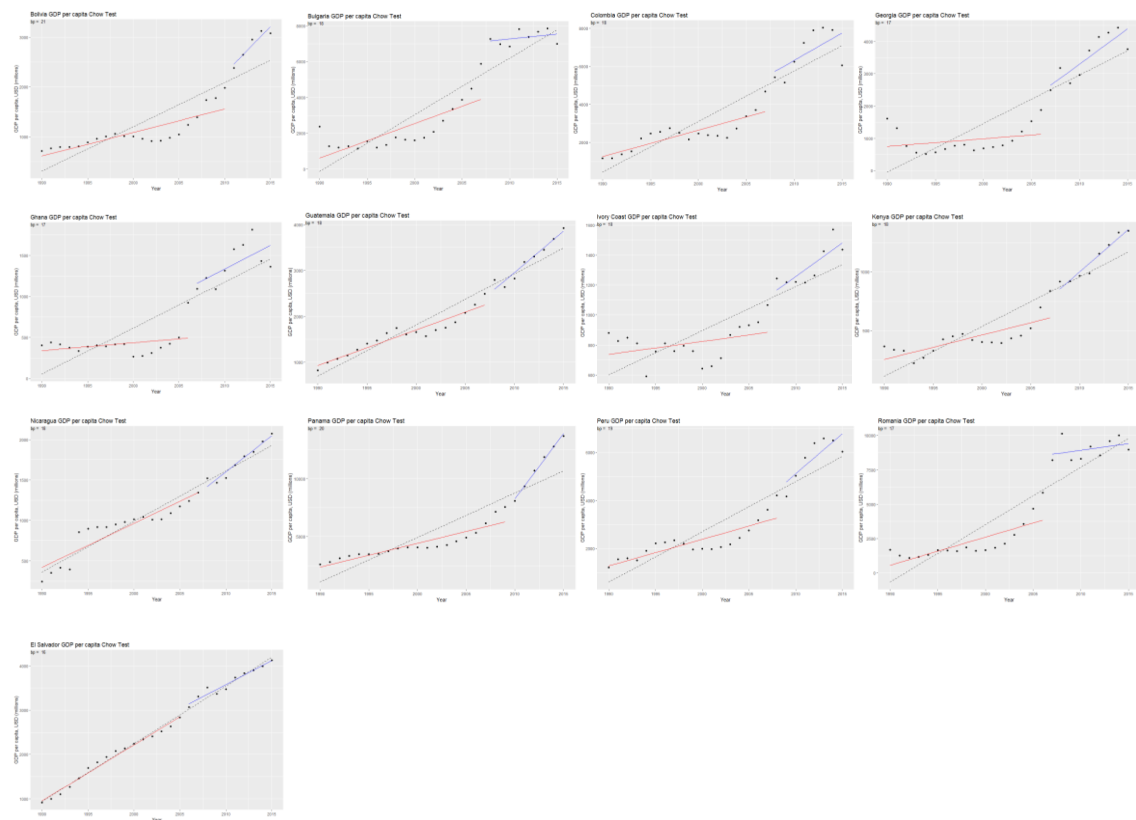


Figure 4-1. Chow Test Plot of GDP per capita per Country

4.2.4 Results of Heteroskedasticity and Autocorrelation Tests

Results for Breusch-Pagan / Cook-Weisberg test for heteroskedasticity and Breusch-Godfrey LM test for autocorrelation shown in Tables 4-7 through 4-10 indicate, except Table 4-10, the existence of heteroscedasticity and autocorrelation. We rejected the null hypothesis for heteroskedasticity test that the error term has a constant variance and the null hypothesis for the autocorrelation test that there is no first-order serial correlation for p-values less than 0.1. These results indicate the presence of issues in the application of the OLS model, which can nullify statistical analyses of significance with the assumption that modeling errors are uncorrelated and uniform. In many cases, these issues occur when errors in the model are proportional to outcome variable Y. We assumed, in this case, a situation where the absolute value estimates of residuals of some countries were larger than expected. The estimated variances of the parameters are not correct under heteroskedasticity and correlation. Since the tests of significance are misleading, we can conclude that the OLS approach is inconsistent and biased; thus, not efficient. This model needs to be re-estimated using log-based approach. Below are summarized representations of the results of heteroskedasticity and autocorrelation tests shown in table 4-7 through table 4-10.

Table 4-7. Heteroskedasticity and Autocorrelation Tests for GDP per capita

	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		**Breusch-Godfrey LM test for autocorrelation**		**Heteroskedasticity**	**Autocorrelation**
	chi2	**Prob > chi2**	**chi2**	**Prob > chi2**		
Ghana	0.42	0.5192	4.539	0.0331	No	Yes
Ivory Coast	0.33	0.5649	4.199	0.0404	No	Yes
Kenya	1.39	0.2386	8.348	0.0039	No	Yes
Peru	1.08	0.2978	8.371	0.0038	No	Yes
Bolivia	0.93	0.3345	9.637	0.0019	No	Yes
Salvador	6.56	0.0105	14.487	0.0001	Yes	Yes
Colombia	2.02	0.1554	10.234	0.0014	No	Yes
Romania	4.79	0.0286	7.002	0.0081	Yes	Yes
Georgia	2.91	0.0882	8.283	0.0040	Yes	Yes
Bulgaria	6.06	0.0138	11.197	0.0008	Yes	Yes
Guatemala	2.31	0.1285	11.072	0.0009	No	Yes
Panama	0.19	0.6593	9.507	0.0020	No	Yes
Nicaragua	5.28	0.0216	11.625	0.0007	Yes	Yes

Table 4-8. Heteroskedasticity and Autocorrelation Tests for Shortage of Electricity

	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		Breusch-Godfrey LM test for autocorrelation		Heteroskedasticity	Autocorrelation
	chi2	Prob > chi2	chi2	Prob > chi2		
Ghana	2.28	0.1310	12.74	0.0004	No	Yes
Ivory Coast	1.61	0.2044	9.57	0.0020	No	Yes
Kenya	1.02	0.3123	2.67	0.1025	No	No
Salvador	6.37	0.0116	6.01	0.0142	Yes	Yes
Colombia	6.00	0.0143	0.15	0.6974	Yes	No
Romania	95.53	0.0000	0.51	0.4759	Yes	No
Georgia	4.82	0.0281	4.55	0.0329	Yes	Yes
Bulgaria	7.84	0.0051	6.72	0.0095	Yes	Yes
Guatemala	1.34	0.2473	10.95	0.0009	No	Yes
Panama	0.77	0.3796	0.56	0.4536	No	No

Table 4-9. Heteroskedasticity and Autocorrelation Tests for Electricity Access Level

	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		Breusch-Godfrey LM test for autocorrelation		Heteroskedasticity	Autocorrelation
	chi2	Prob > chi2	chi2	Prob > chi2		
Ghana	3.79	0.0515	14.07	0.0002	Yes	Yes
Ivory Coast	1.80	0.1795	8.78	0.0030	No	Yes
Kenya	5.13	0.0236	11.31	0.0008	Yes	Yes
Peru	1.14	0.2858	8.25	0.0041	No	Yes
Bolivia	3.55	0.0595	6.07	0.0138	Yes	Yes
Salvador	0.58	0.4445	12.43	0.0004	No	Yes
Colombia	0.00	0.9533	10.62	0.0011	No	Yes
Georgia	0.75	0.3854	6.43	0.0113	No	Yes
Guatemala	2.09	0.1487	9.62	0.0019	No	Yes
Panama	2.10	0.1477	13.31	0.0003	No	Yes
Nicaragua	1.26	0.2620	9.43	0.0021	No	Yes

Table 4-10. Heteroskedasticity and Autocorrelation Tests for Foreign Investment

	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity		Breusch-Godfrey LM test for autocorrelation		Heteroskedasticity	Autocorrelation
	chi2	Prob > chi2	chi2	Prob > chi2		
Ghana	0.15	0.7009	0.03	0.8549	No	No
Kenya	0.40	0.5271	0.64	0.4231	No	No
Peru	2.02	0.1549	0.34	0.5601	No	No
Romania	0.03	0.8677	1.43	0.2318	No	No
Guatemala	0.62	0.4318	0.68	0.4114	No	No
Panama	0.03	0.8598	0.08	0.7829	No	No

4.2.5 OLS Model Estimates with heteroskedasticity and autocorrelation

Tables 4-11 through 4-14 show outputs of the re-estimated OLS model using a simple data transformation with autocorrelation and heteroscedasticity-consistent robust standard errors estimator. It is important to note that all the dependent variables are estimated on a log scale. Each coefficient under the variables represents the post-restructuring variation of the variables per country compared to the pre-restructuring coefficient that is not provided in the tables. For instance, the estimated GDP per capita coefficient for Ghana in Table 4-11 means that on average, the GDP per capita for Ghana was about 1.25 times more after restructuring or 125% increase in GDP per capita that pre-restructuring estimates. GDP per capita illustration for Ghana under Figure 4-1 also correspond with this assessment. Constant terms, which are the intercept of the regression line, are not usually interpreted but can be described as the values of the dependent variables when the independent variable is 0. They are the value of the variables in the absence of a break, but we are more interested in the estimated coefficient of the break.

In general, for all the examined countries the break impact on GDP per capita, electricity access level, and foreign investment in the electric power system are positive and highly significant. These results mean that after the break, GDP per capita, electricity access level, and foreign investment in the electric power system improved significantly for all the examined countries. The same results were also noticed with Balance of Domestic Electricity Provisions models, except Ghana and El Salvador where we observed post-break increases in electric power shortages by about 7.6% and 2.6% respectively. Outputs for each separate OLS model re-estimation with heteroskedasticity and autocorrelation are provided in Tables 4-11 through 4-14.

Table 4-11. OLS Model Estimates for GDP per capita

	break_pcGDP		_cons			
	Coefficient	Stand. Error	Coefficient	Stand. Error	# of Obs.	R^2
Ghana	1.2514***	(0.08)	5.9334***	(0.04)	26	0.9205
Ivory Coast	0.4901***	(0.05)	6.6697***	(0.03)	26	0.7798
Kenya	0.9869***	(0.09)	5.9818***	(0.06)	26	0.8138
Peru	0.9654***	(0.09)	7.6470***	(0.06)	26	0.7827
Bolivia	0.9731***	(0.09)	6.9124***	(0.06)	26	0.7665
Salvador	0.7078***	(0.10)	7.4629***	(0.09)	26	0.6318
Colombia	1.0663***	(0.10)	7.6970***	(0.08)	26	0.7620
Romania	1.5566***	(0.11)	7.5045***	(0.10)	26	0.8552
Georgia	1.3830***	(0.12)	6.7641***	(0.10)	26	0.7959
Bulgaria	1.3508***	(0.11)	7.5256***	(0.10)	26	0.7814
Guatemala	0.7391***	(0.08)	7.3033***	(0.07)	26	0.7053
Panama	0.9454***	(0.10)	8.2998***	(0.06)	26	0.7592
Nicaragua	0.7646***	(0.13)	6.6593***	(0.12)	26	0.4636

* p<0.10 **, p<0.05 and *** p<0.01

Table 4-12. OLS Model Estimates for Shortage of Electricity

	break_Balance		_cons			
	Coefficient	Stand. Error	Coefficient	Stand. Error	# of Obs.	R^2
Ghana	-0.0762***	(0.01)	9.2382***	(0.00)	26	0.3359
Ivory Coast	0.1152***	(0.01)	9.1332***	(0.01)	26	0.7025
Kenya	0.0186***	(0.00)	9.1369***	(0.00)	26	0.8185
Peru			9.1576***	(0.00)	26	0.0000
Bolivia			9.1551***	(0.00)	26	0.0000
Salvador	-0.0261***	(0.01)	9.1538***	(0.00)	26	0.2564
Colombia	0.1291***	(0.01)	9.1390***	(0.00)	26	0.8021
Romania	3.8519	(2.33)	5.4554**	(2.33)	26	0.4623
Georgia	0.2605***	(0.07)	8.8693***	(0.07)	26	0.5867
Bulgaria	0.5714***	(0.09)	9.1356***	(0.09)	26	0.6930
Guatemala	0.0347***	(0.01)	9.1688***	(0.00)	26	0.2144
Panama	0.0160***	(0.00)	9.1436***	(0.00)	26	0.4811
Nicaragua			9.1540***	(0.00)	26	0.0000

* p<0.10 **, p<0.05 and *** p<0.01

Table 4-13. OLS Model Estimates for Electricity Access Level

	break_Access		_cons			
	Coefficient	Stand. Error	Coefficient	Stand. Error	# of Obs.	R^2
Ghana	0.5576***	(0.07)	3.5935***	(0.06)	26	0.6820
Ivory Coast	0.2911***	(0.04)	3.7444***	(0.03)	26	0.7415
Kenya	0.9258***	(0.16)	2.3468***	(0.14)	26	0.5713
Peru	0.2331***	(0.03)	4.2442***	(0.02)	26	0.7545
Bolivia	0.2679***	(0.03)	4.2006***	(0.02)	26	0.7401

Salvador	0.1682***	(0.02)	4.3356***	(0.01)	26	0.8096
Colombia	0.0453***	(0.01)	4.5207***	(0.00)	26	0.7546
Georgia	0.0129***	(0.00)	4.5851***	(0.00)	26	0.5813
Guatemala	0.2199***	(0.02)	4.1966***	(0.02)	26	0.7798
Panama	0.1260***	(0.02)	4.3478***	(0.01)	26	0.7331
Nicaragua	0.0994***	(0.01)	4.2645***	(0.01)	26	0.7115

* p<0.10 **, p<0.05 and *** p<0.01

Table 4-14. OLS Model Estimates for Foreign Investment in Electric Power System

	break_Foreign		_cons			
	Coefficient	Stand. Error	Coefficient	Stand. Error	# of Obs.	R^2
Ghana	1.1002**	(0.36)	5.1153***	(0.29)	7	0.6673
Ivory Coast			4.1450***	(0.46)	10	0.0000
Kenya	1.3111***	(0.23)	4.9529***	(0.11)	9	0.8519
Peru	1.6685***	(0.22)	5.8658***	(0.19)	22	0.4588
Bolivia			2.9316***	(0.59)	9	0.0000
Salvador			4.4555***	(0.47)	8	0.0000
Colombia			5.3567***	(0.28)	22	0.0000
Romania	2.0129**	(0.80)	4.8511***	(0.63)	9	0.4602
Georgia			3.7417***	(0.54)	11	0.0000
Bulgaria			6.1648***	(0.23)	11	0.0000
Guatemala	0.7959	(0.58)	4.6604***	(0.29)	17	0.1279
Panama	0.9503	(0.75)	4.3738***	(0.41)	15	0.1153
Nicaragua			4.4356***	(0.31)	10	0.0000

* p<0.10 **, p<0.05 and *** p<0.01

4.2.6 Results of Fixed Effects Regression with Robust Standard Errors

Results in Table 4-15 below represent the estimation of the model with panel data approach using Fixed Effects with robust standard errors to account for country-specific effects. Based on the results indicated in the table, we can assert that on average, restructuring has a significant positive impact on the change in GDP per capita, electricity access level, and foreign investment in electric power system in all the examined countries collectively. We can say that collectively, on average, the post-restructuring GDP per capita increased very significantly, while electricity access level and foreign investment in electric power system both experienced an increase as well by about 27.23% and 125% respectively. Balance of domestic electricity provisions does not show any significant impact on the countries collectively as it failed to reject the null hypothesis that there is no post-restructuring change in the shortage of electric power.

Table 4-15. OLS Model Estimates for the Entire Panel Data

	pcGDP	Balance Electric.	Electricity Access	Foreign Investm.
break_pcGDP	1.0164***			
	(0.09)			
Break_Balance		0.3352		
		(0.23)		
break_Access			0.2723***	
			(0.08)	
break_Foreign				1.2499***
				(0.19)
_cons	7.1052***	8.9982***	4.1135***	4.7528***
	(0.03)	(0.11)	(0.03)	(0.05)
# of Obs. (N)	338	338	338	160
R^2	0.7136	0.0593	0.3343	0.1097

* p<0.10 **, p<0.05 and *** p<0.01

4.2.7 Results of the Comparison of the Examined Countries

The results of the comparison of the 13 examined non-OECD countries with Togo based on the set-up criteria using the World Bank, and Transparency International indicators are presented in Table 4-16 below. The results indicate that Togo groups with Bolivia, Guatemala, and Kenya four times out of the possible maximum six groups about Index of Government Effectiveness, Index of Regulatory Quality, Index of Corruption Perceptions, and per capita Energy Use. Ghana, Ivory Coast, and Nicaragua group five times with Togo based on the same indicators the last three countries were associated with Togo; in addition to Lending Group.

Each of these economic and political indicators is critical as they translate perceptions of these countries on the world stage in the view of foreign and domestic private investors to contemplate investment deals within these countries. For instance, beside the World Bank's IDA, which is somewhat given, grouping Togo in the other categories with these countries that have succeeded in restructuring their electric power systems means that pursuing such policies in Togo could produce the same result. IDA provides funding for economic development projects in the world's poorest countries to alleviate poverty and improve the lives of the forgotten poor in the beneficiary countries (World Bank, 2017b).

Table 4-16. Summarized Results of the Comparison of the Examined Countries

Country	Income Level	Lending Group	Government Effectiveness Index	Regulatory Quality Index	Corruption Perceptions Index	Energy Use per capita
Bolivia******	Lower-Middle	IBRD	-0.57	-0.92	33	788.80
Bulgaria	Upper-Middle	IBRD	0.29	0.66	41	2,477.66
Colombia	Upper-Middle	IBRD	0.02	0.40	37	711.58
El Salvador	Lower-Middle	IBRD	-0.28	0.09	36	647.31
Georgia	Lower-Middle	IBRD	0.51	0.01	57	1,177.87
Ghana*********	Lower-Middle	IDA	-0.20	-0.23	42	335.05
Guatemala******	Upper-Middle	IBRD	-0.60	-0.20	28	830.09
Ivory Coast*********	Lower-Middle	IDA	-0.67	-0.36	34	615.80
Kenya******	Lower-Middle	BLEND	-0.31	-0.30	26	513.43
Nicaragua*********	Lower-Middle	IDA	-0.70	-0.51	26	609.01
Panama	High	IBRD	0.19	0.36	38	1,079.13
Peru	Upper-Middle	IBRD	-0.17	0.51	35	757.69
Romania	Upper-Middle	IBRD	-0.17	0.59	48	1,591.67
Togo	Low	IDA	-1.08	-0.79	32	456.67

Sources: The World Bank, Transparency International, and the GlobalEconomy.com

****** denotes countries that share four groups with Togo (Bolivia, Guatemala, and Kenya).**

******* denotes countries that share five groups with Togo (Ghana, Ivory Coast, and Nicaragua).**

Chapter 5—Discussion and Conclusions

5.1 Discussion

Despite the divergence of opinions in the literature about restructuring, the textbook's underlying reasoning towards the implementation of the restructuring of electric power system remains that restructuring would improve efficiency by reducing power shortages and expand electricity access level (Sen et al., 2016). To prove the expectations prescribed in the textbook required usage of robust econometric analysis methods. However, determining such methods to conclusively rule out effects of unknown or unobserved factors that could influence the trend of the response variables remains a challenge. Contrary to testing for the efficacy of a drug, Lagarde (2012) agreed that investigating whether the adoption of a specific policy was successful is more complicated as it requires accounting for a variety of possible causes of any unknown or unobserved trend.

This study chose to use the Chow test technique supported by robust OLS models after evaluating other alternatives including Paired T-test, Interrupted Time Series Analysis, Change Point Analysis, and Auto-Regressive Integrated Moving Average modeling. Although the Chow test is not bias-proof, it can provide convincing results when supplemented with appropriate regression models. Confirming the difficulty presented by this test; Sridharan, Vujic, and Koopman (2003) argued that disassociating alternative factors prohibiting to conclusively prove any behavior of a dependent variable at a breakpoint was the result of a known intervention poses a severe methodological challenge. Jouini and Boutahar (2004) and Kelly and Sienko (2018) supported Perron's (2006) proposition of testing for multiple unknown structural breaks to rule out all other possible reasons a change may have occurred in the time series. However, Kelly and Sienko (2018) warned that while econometric techniques may not be able to establish causation with absolute certainty, it is possible that structural break analysis can provide support for, or help to refute, the change observed during the period after an intervention (Kelly & Sienko, 2018).

The Chow test results show that in all the cases except those with no identified breakpoints, we reject the null hypothesis of no breakpoint for the specified date; which confirmed that the breakpoints determined from multiple structural breakpoints test are the actual breakpoints. In general, for all the 13 examined countries, the estimated coefficients are positive and highly significant after the identified breakpoints. These results generally support the claims made in all four hypotheses. For instance, the post-restructuring GDP per capita coefficient for all 13 examined countries rose on average by about 100% supporting the first hypothesis that the restructuring of the electric power system will lead to an increase in GDP. Despite the pre-restructuring upward trend of GDP per capita in most of the examined countries as illustrated in the time series plots in Figure A-1, these results correspond to those of other studies, such as Sen et al. (2016), who found that the restructuring of the electric power sector in non-OECD Asian countries led to improved economic growth. The coefficients for the shortage of electricity also seem to be positive and significant except Ghana and El Salvador that experienced a slight hike in their power shortages. For Peru, Bolivia, and Nicaragua, no breakpoints were detected to use for the analysis. This means that the results of eight countries out of the thirteen examined support the claim of hypothesis 2 that there will be a reduction in shortages of electric power if restructuring is implemented. These results mirrored Pollitt's (2004) findings of the performance of the Chilean electric power sector since restructuring.

Since foreign investments on projects related to the electric power sector are not mostly yearly transactions, data for this variable were not available for every year in the sample data. Also, due to lack of data, the test for detecting multiple unknown structural breakpoints came up with no break. Thus, only the coefficients of Ghana, Kenya, Peru, and Romania are found to be positive and significant; which supports hypothesis 3 that restructuring the electric power system will increase foreign investments in the sector. Although the coefficients of Guatemala and Panama failed to reject the null hypothesis of no increase in foreign investment after restructuring, the results of Ghana, Kenya, Peru, and Romania married findings in the most literature. For example, Pollitt (2004) found a noticeable increase in investment in the electric power sector and a growth in the electricity access level after restructuring in Chile since 1982. Like GDP per capita, the performance of Electricity Access Level jumped significantly after the breakpoints except for Bulgaria and Romania where electricity access level has been stationary throughout the series. Again, this result meets the expectation of hypothesis 4 that restructuring the electric power system will lead to an increase in electricity access level.

The comparison results of the 13 examined countries show that besides Income Level Group and Lending Group, Togo grouped with Bolivia, Guatemala, and Kenya regarding Government Effectiveness Index, Regulatory Quality Index, Corruption Perceptions Index, and Energy Use per capita. The three countries have post-restructuring coefficients that are positive and highly significant for GDP per capita and Electricity Access Level. Although no breakpoint was identified for Bolivia for Shortage of

Electricity and Foreign Investment, Kenya and Guatemala respectively saw a reduction of about 2% and 3% in power shortages and 131% increase in foreign investment for Kenya. The post-restructuring coefficient for Guatemala in foreign investment was not significant, meaning that we failed to reject the null hypothesis of no increase in foreign investment post-restructuring.

Ghana, Ivory Coast, and Nicaragua grouped with Togo in every indicator except Income Level. Results of the coefficients for GDP per capita for these three countries are similar to those of Bolivia, Guatemala, and Kenya. For Shortage of Electricity, although the coefficient for Ghana is significant, it is negative meaning an increase of about 8% in power shortages. While Ivory Coast experienced a reduction of power shortages of about 12%, the result for Nicaragua was unavailable because no breakpoint was identified in the data for Shortage of Electricity. The results were different for Electricity Access Level for the three countries as their post-restructuring coefficients for this variable are positive and significant. Ghana enjoyed about 56% growth in electricity access level after restructuring, about 29% in Ivory Coast, and almost 10% in Nicaragua. In foreign Investment, only Ghana had a positive and highly significant post-restructuring coefficient. Ivory Coast and Nicaragua did not have any breakpoint identified.

5.2 Conclusions

Throughout this study, the quantitative analyses of possible economic, technical, and welfare gains of the restructuring of the electric power system around the world, particularly in 13 selected non-OECD countries were performed to determine whether undertaking restructuring process for Togo's electric power system will be beneficial for the country. Discussions in the literature about the benefits associated with the restructuring of electric power systems and the most appropriate statistical or econometric analysis methods to use to determine whether these gains were due to the effects of the restructuring program are diverse and often contradictory. This praxis tried to reconcile empirical qualitative assessments of other analysts of the restructuring program experience in different countries with econometric analysis results obtained from the examination of the 13 selected non-OECD countries to support the research hypotheses.

Arguably, the findings of the analysis were pretty impressive. Econometric studies of the impacts of the restructuring of the electric power system on GDP per capita, shortage of electricity, foreign investments in the electric power system, and electricity access level in the examined 13 selected non-OECD countries generally support the study's hypotheses. However, inferring that Togo will experience the same results after restructuring its electric power system without situating Togo in the same economic and political contexts as those of the examined countries could be misleading. Performing the comparison with countries from the same categories, not only levels the playing field but makes the study meaningful. Thus, the decision of selecting only non-OECD developing countries for this study and the choice of using the grouping criteria of the World Bank and Transparency International indicators to perform the comparison. With everything almost equal, there is no reason why Togo should not engage in introducing restructuring of its electric power system to modernize the power sector's infrastructure, improve efficiency and quality of services. The recommended structure of the post-restructuring of the electric power system in Togo is illustrated in Figure A-1 shown in the Appendix.

The econometric analysis results of the countries that group with Togo suggested that restructuring could be beneficial to Togo, especially in economic and welfare development. Technical gains such as reduction of power shortages were not too conclusive, probably due to the absence of actual empirical data. Finally, it is tempting to infer that, in general, restructuring could help Togo attract foreign investors in the electricity sector although econometric analysis results were insufficient to support the claim.

5.3 Contributions to Body of Knowledge

Decisions to restructuring electric power systems are usually based on the belief that current vertically integrated state-owned electric power systems are inefficient and efforts must be undertaken to restore efficiencies. The Chilean or the U.K. restructuring models are often cited as the blueprint that other countries follow (Eberhard & Gratwick, 2001) without any scientific analysis to determine whether it is an appropriate policy to undertake or to weigh its possible success rate. Even studies that attempted to establish a causal relationship between restructuring and technical and socioeconomic indicators were constrained by lack of sufficient reliable data; forcing them to rely on qualitative case studies for their analyses. This study tried to fill the gap by:

1. contributing to the literature on the restructuring of the electric power system in the 13 selected non-OECD countries based on econometric analyses of yearly time series dataset of technical and socioeconomic indicators covering the period from 1990 through 2015;
2. establishing a causal relationship between restructuring and GDP per capita, shortage of electricity, foreign investments in the electric power

system, and electricity access level in the 13 selected non-OECD countries using econometric analysis methods;

3. predicting future outcomes of restructuring on technical and socioeconomic indicators in Togo based on the restructuring experiences in the 13 non-OECD countries and the similarity comparisons of their international economic and political standings with Togo.

5.4 Recommendations for Future Research

There were a few limitations for this research including a limited size of the data sample, and limited econometric analyses in the literature to establishing a causal relationship between restructuring of the electric power system and critical technical and socioeconomic indicators to support this research. Future econometric researches about non-OECD countries need to address these limitations by extending the pool of countries beyond 13 and enlarge the sample size of the dataset to cover more than 26 observations to avoid limiting the data analysis to just a few econometric modeling techniques. Also, future researchers should consider undertaking more quantitative research approach instead of the most common qualitative approach to provide scientific evidence of technical and socioeconomic benefits of the restructuring of the electric power system in a country.

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Appendix A

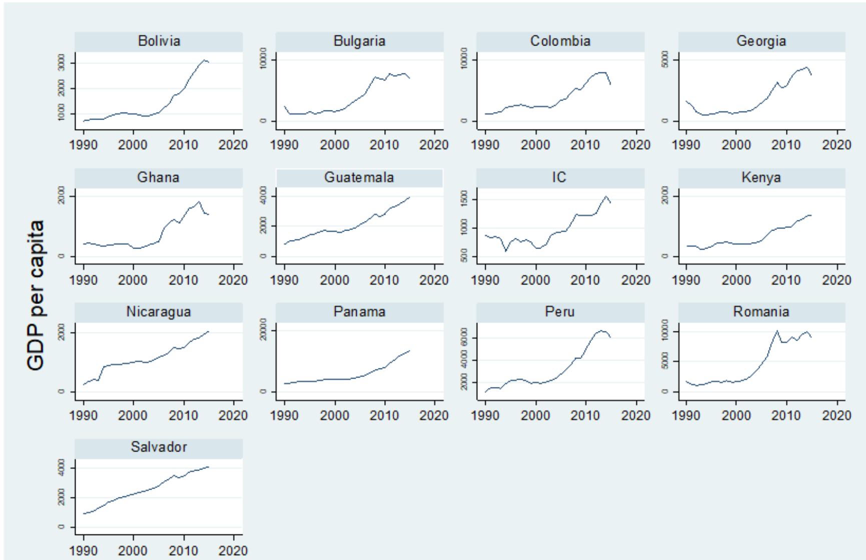

Figure A-1. GDP per capita Time Series Plot

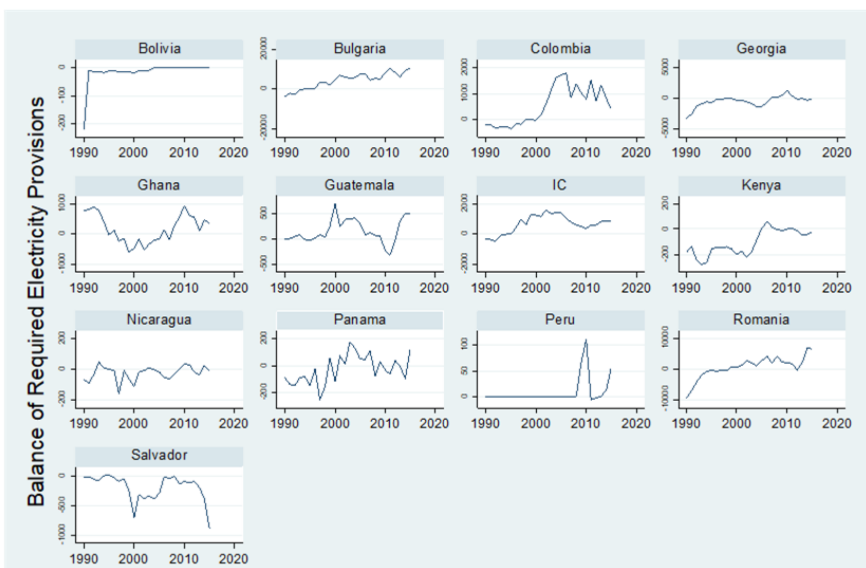

Figure A-2. Balance of Required Electricity Provisions Time Series Plot

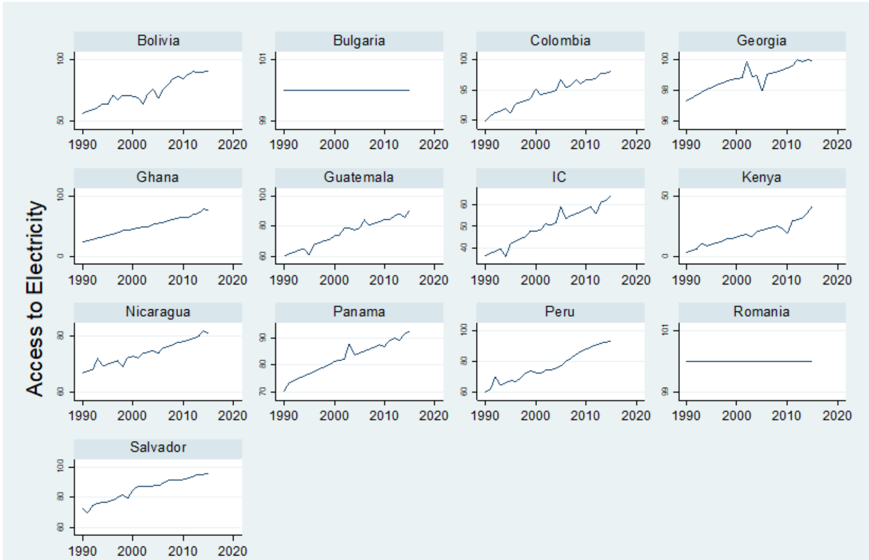

Figure A-3. Electricity Access Level Time Series Plot

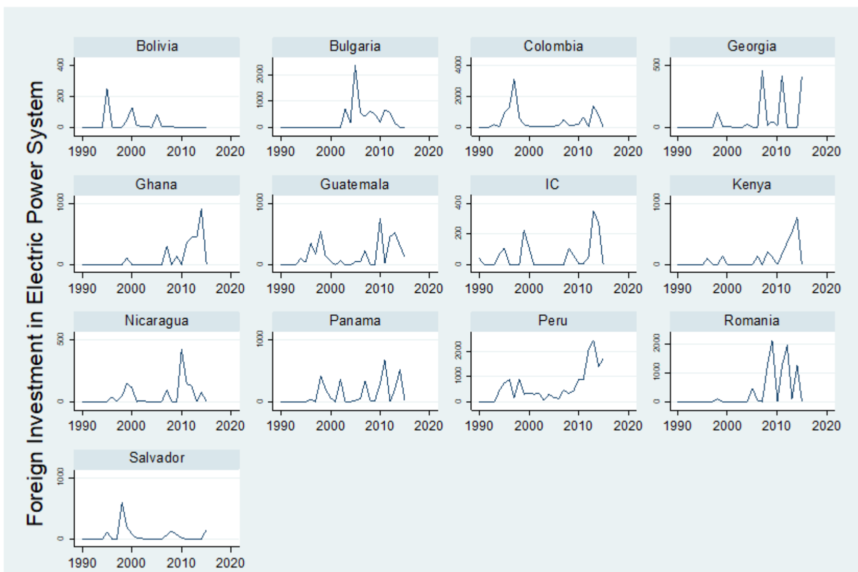

Figure A-4. Foreign Investment in Electric Power System Time Series Plot

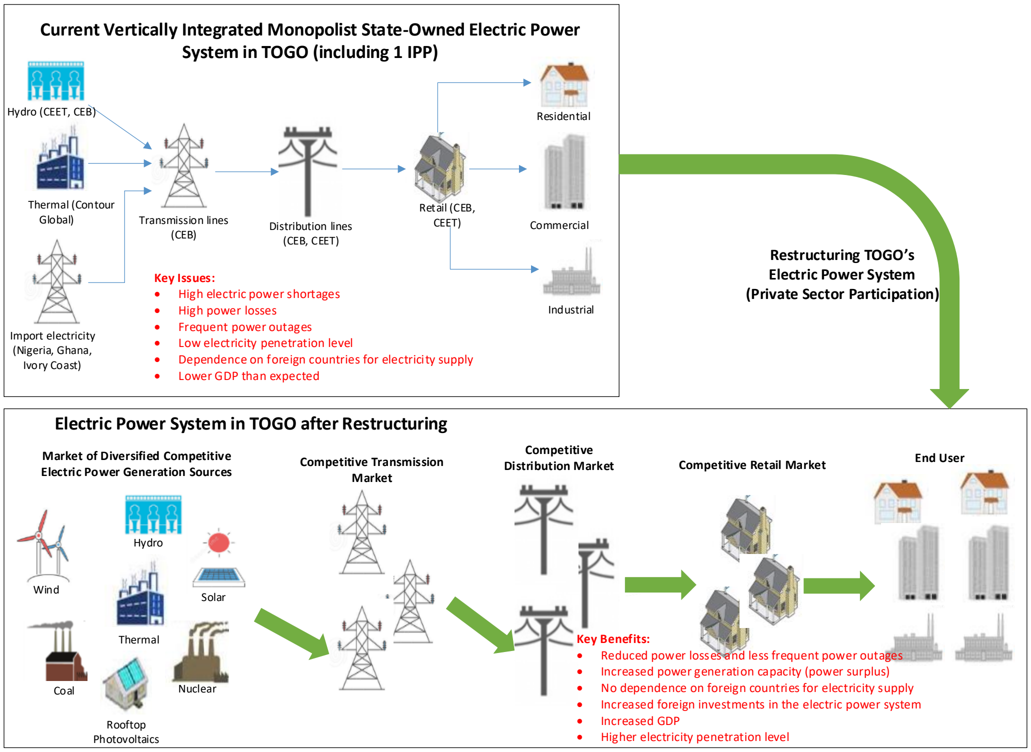

Figure A-5. Current and Recommended Structure of Electricity System in Togo

Table A-1. Summarized Results of Multiple Breakpoints Test

Country	Per capita GDP	Shortage of Electric Power	Electricity Access Level	Foreign Investments
Ghana	2006; 2011	1994; 1997; 2004; 2008	1993; 1998; 2004; 2007; 2012	2011
Ivory Coast	1994; 2000; 2003; 2008; 2013	1993; 1996; 1999; 2007; 2013	1995; 1999; 2005; 2013	no break
Kenya	1993; 1996; 2006; 2009; 2012	1995; 2000; 2005; 2008; 2013	1993; 1998; 2004; 2011	2006; 2012
Peru	1994; 2005; 2008; 2011	no break	1995; 1998; 2005; 2008; 2011	1994; 2012
Bolivia	1996; 2007; 2010; 2013	no break	1993; 1996; 2003; 2007; 2011	no break
El Salvador	1994; 1998; 2003; 2006; 2011	1999; 2003; 2006; 2009; 2013	1993; 1997; 2000; 2006; 2012	no break
Colombia	1994; 2007; 2011	1998; 2001; 2004; 2007; 2012	1993; 1996; 2000; 2005; 2013	no break
Romania	1995; 2001; 2004; 2007; 2013	1993	no break	2008
Georgia	1993; 1996; 2004; 2007; 2011	1993; 1996; 2003; 2007; 2012	1994; 1998; 2006; 2011	no break
Bulgaria	1998; 2001; 2004; 2007; 2011	1993; 1997; 2001; 2007; 2010	no break	2003; 2006; 2013
Guatemala	1995; 2004; 2007; 2010; 2013	1999; 2006; 2013	1996; 2002; 2006; 2012	1996; 1999; 2010
Panama	1998; 2007; 2010; 2013	2001; 2008	1993; 1996; 2000; 2003; 2011	1998; 2010
Nicaragua	1994; 2005; 2008; 2012	1993; 1997; 2001; 2006; 2009	1993; 1999; 2006; 2009; 2013	no break

Table A-2. Chow Test for GDP per capita Using Known Year of Restructuring

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	1997	5.6950	0.0252	5.5361	0.0186	5.6950	0.0170
Ivory Coast	1998	6.4454	0.0180	6.1849	0.0129	6.4454	0.0111
Kenya	1997	10.4575	0.0035	9.4035	0.0022	10.4575	0.0012
Peru	1992	2.4916	0.1275	2.5681	0.1090	2.4916	0.1145
Bolivia	1994	3.6814	0.0670	3.7104	0.0541	3.6814	0.0550
Salvador	1996	29.2200	0.0000	20.7059	0.0000	29.2200	0.0000
Colombia	1994	7.0011	0.0141	6.6552	0.0099	7.0011	0.0081
Romania	1998	14.1141	0.0010	12.0258	0.0005	14.1141	0.0002
Georgia	1997	5.9328	0.0227	5.7435	0.0166	5.9328	0.0149
Bulgaria	1999	18.6651	0.0002	14.9585	0.0001	18.6651	0.0000
Guatemala	1996	14.4612	0.0009	12.2615	0.0005	14.4612	0.0001
Panama	1997	8.3556	0.0080	7.7671	0.0053	8.3556	0.0038
Nicaragua	1998	25.1591	0.0000	18.6422	0.0000	25.1591	0.0000

Table A-3. Chow Test for Shortage/Surplus of Electric. Using Year of Restructuring

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	1997	6.7571	0.0157	6.4498	0.0111	6.7571	0.0093
Ivory Coast	1998	29.6535	0.0000	20.9168	0.0000	29.6535	0.0000
Kenya	1997	12.8474	0.0015	11.1470	0.0008	12.8474	0.0003
Peru	1992	0.2388	0.6295	0.2574	0.6119	0.2388	0.6251
Bolivia	1994	8.1462	0.0088	7.5983	0.0058	8.1462	0.0043
Salvador	1996	4.9414	0.0359	4.8677	0.0274	4.9414	0.0262
Colombia	1994	6.7442	0.0158	6.4388	0.0112	6.7442	0.0094
Romania	1998	25.8017	0.0000	18.9799	0.0000	25.8017	0.0000
Georgia	1997	10.7032	0.0032	9.5883	0.0020	10.7032	0.0011
Bulgaria	1999	48.5563	0.0000	28.7640	0.0000	48.5563	0.0000
Guatemala	1996	3.0310	0.0945	3.0922	0.0787	3.0310	0.0817
Panama	1997	5.9868	0.0221	5.7903	0.0161	5.9868	0.0144
Nicaragua	1998	0.8773	0.3583	0.93339	0.3340	0.8773	0.3490

Table A-4. Chow Test for Foreign Invest. in Electricity Using Year of Restructuring

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	1997	2.3049	0.1420	2.3843	0.1226	2.3049	0.1290
Ivory Coast	1998	0.5324	0.4727	0.5704	0.4501	0.5324	0.4656
Kenya	1997	1.9412	0.1763	2.0223	0.1550	1.9412	0.1635
Peru	1992	1.9119	0.1795	1.9928	0.1580	1.9119	0.1668
Bolivia	1994	0.6437	0.4303	0.6881	0.4068	0.6437	0.4224
Salvador	1996	0.4979	0.4872	0.5338	0.4650	0.4979	0.4804
Colombia	1994	1.3990	0.2485	1.4730	0.2249	1.3990	0.2369
Romania	1998	3.2490	0.0840	3.3011	0.0692	3.2490	0.0715
Georgia	1997	1.7964	0.1927	1.8767	0.1707	1.7964	0.1802
Bulgaria	1999	4.5539	0.0433	4.5172	0.0336	4.5539	0.0328
Guatemala	1996	3.2149	0.0856	3.2685	0.0706	3.2149	0.0730
Panama	1997	4.1337	0.0532	4.1318	0.0421	4.1337	0.0420
Nicaragua	1998	2.5847	0.1210	2.6593	0.1029	2.5847	0.1079

Table A- 5. Chow Test for Electricity Access Level Using Year of Restructuring

Country	Breakpoint	F-statistic	Prob. F	Log likelihood ratio	Prob. Chi-Square	Wald Statistic	Prob. Chi-Square
Ghana	1997	33.5706	0.0000	22.7489	0.0000	33.5706	0.0000
Ivory Coast	1998	51.4098	0.0000	29.7670	0.0000	51.4098	0.0000
Kenya	1997	23.8248	0.0001	17.9267	0.0000	23.8248	0.0000
Peru	1992	6.3955	0.0184	6.1423	0.0132	6.3955	0.0114
Bolivia	1994	13.5389	0.0012	11.6304	0.0006	13.5389	0.0002
Salvador	1996	19.9577	0.0002	15.7345	0.0001	19.9577	0.0000
Colombia	1994	18.2400	0.0003	14.6982	0.0001	18.2400	0.0000
Romania	No Break						
Georgia	1997	31.2064	0.0000	21.6587	0.0000	31.2064	0.0000
Bulgaria	No Break						
Guatemala	1996	36.3880	0.0000	23.9912	0.0000	36.3880	0.0000
Panama	1997	40.0529	0.0000	25.5230	0.0000	40.0529	0.0000
Nicaragua	1998	25.6662	0.0000	18.9091	0.0000	25.6662	0.0000

Chow Test Plot of GDP per capita Based on a Priori Known Restructuring Year as Breakpoint

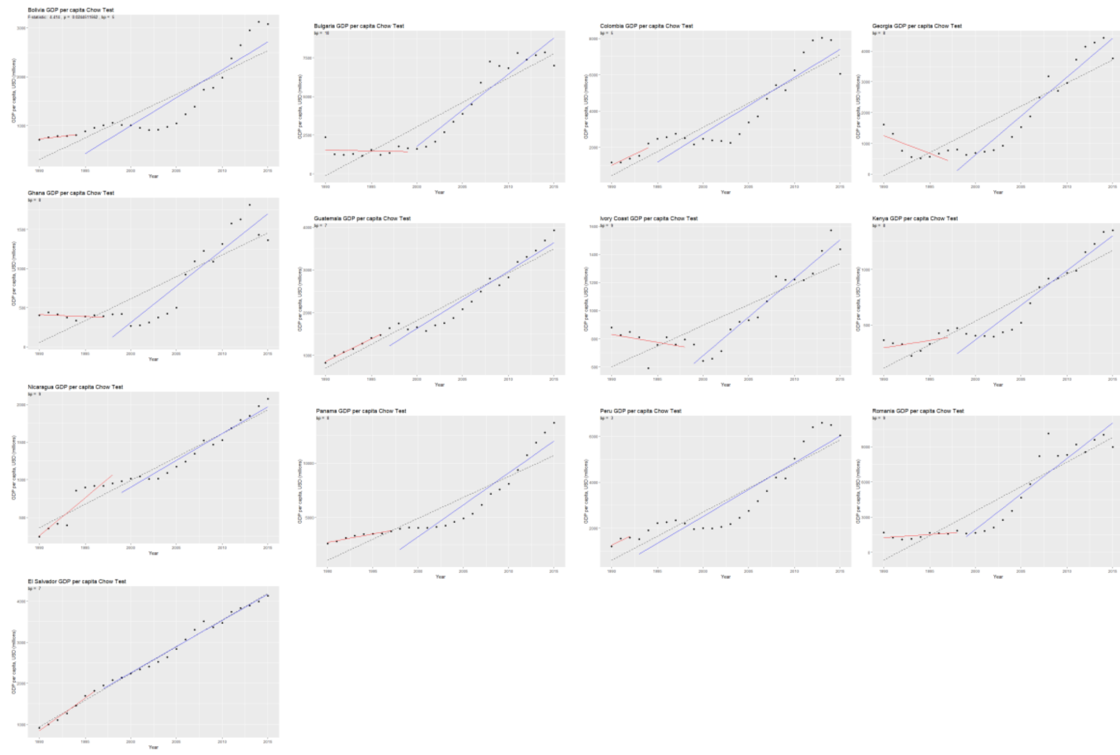

Figure A-6. Chow Test Plot of GDP per capita

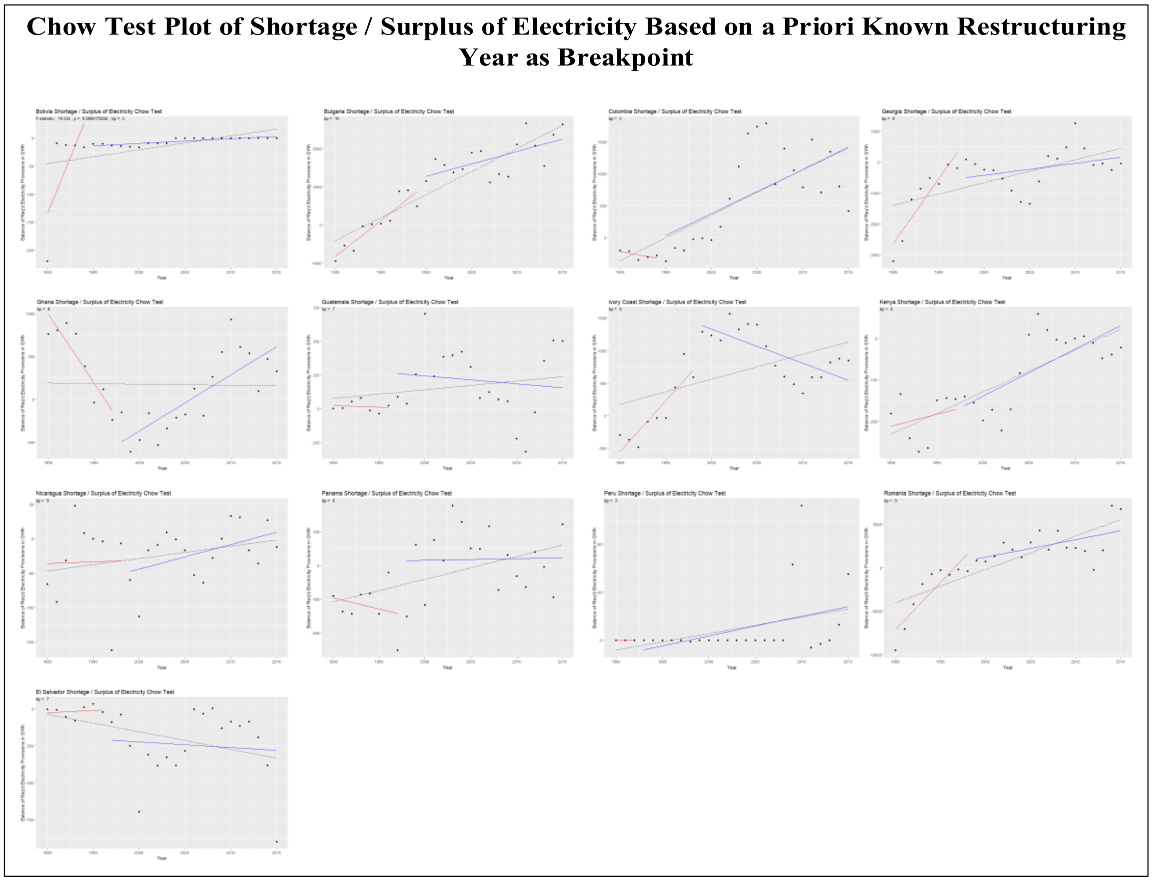

Figure A-7. Chow Test Plot of Shortage / Surplus of Electricity

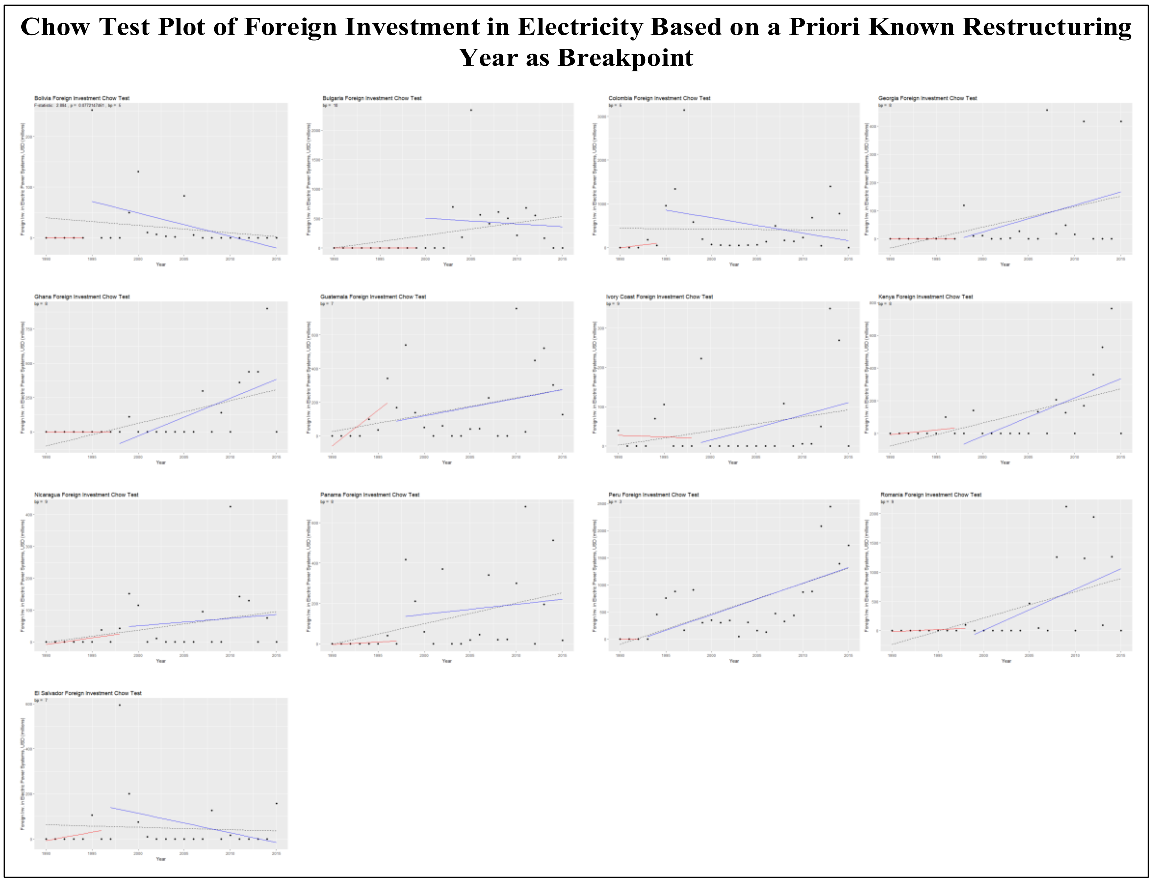

Figure A-8. Chow Test Plot of Foreign Investment of Electricity

Chow Test Plot of Electricity Access Level based on a Priori Known Restructuring Year as Breakpoint

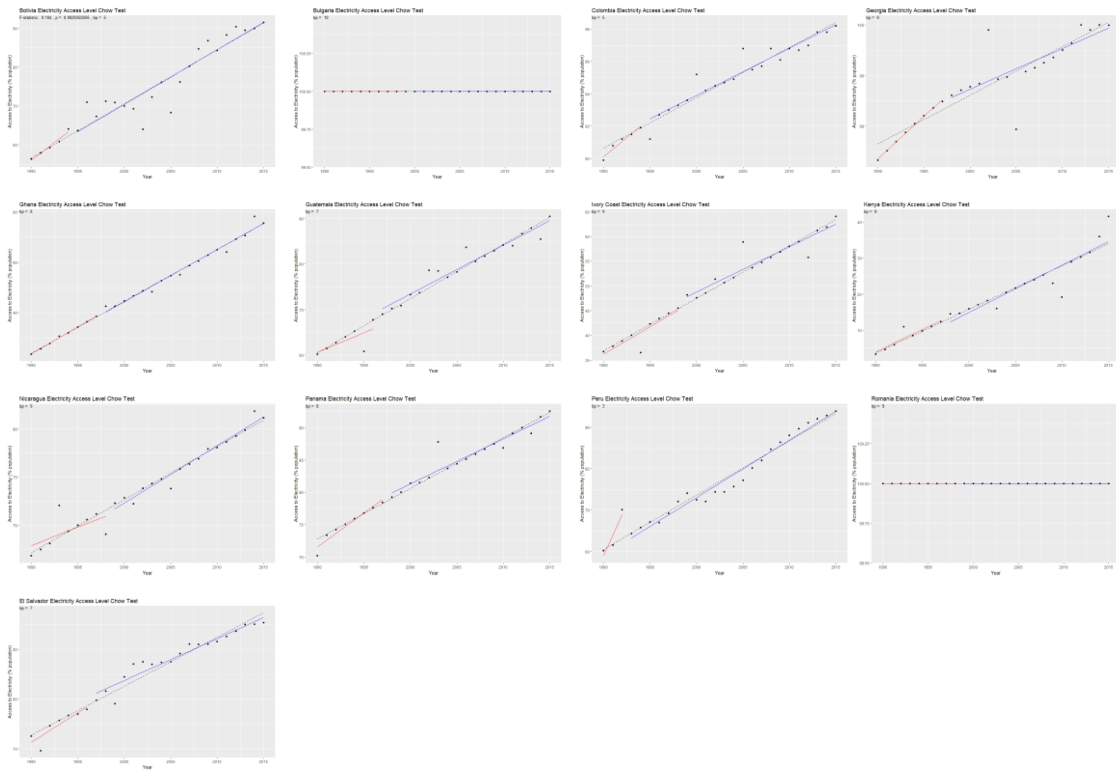

Figure A-9. Chow Test Plot of Electricity Access Level