International Journal of
Economics
(IJECON)

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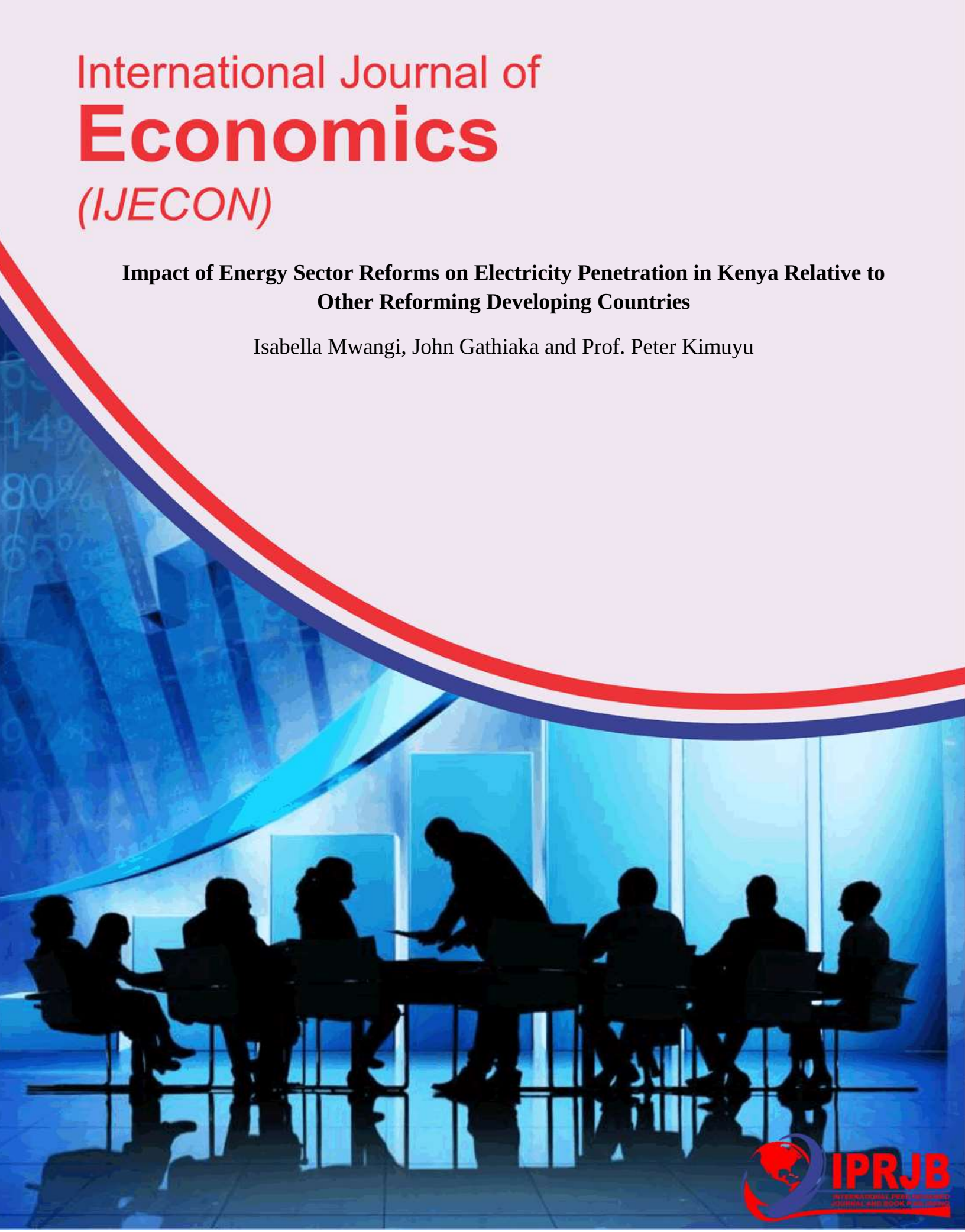

IPRJB

International Journal of Economics

ISSN 2518-8437 (Online)
Vol.7, Issue 2, No.4. pp 61 - 71, 2022

www.iprjb.org

Impact of Energy Sector Reforms on Electricity Penetration in Kenya Relative to Other Reforming Developing Countries

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Article History

Received 2nd February 2023

Received in Revised Form 27th February 2023

Accepted 6th March 2023

Abstract

Purpose: There are observable improvements in Kenya's electricity sector since the mid-1990s. Among these are increase in electricity generated and an increase in number of households and institutions connected to the grid. These milestones have been achieved during the reform period. To find out whether these achievements are attributable to the reforms or not is the subject of this paper. This paper carries out an econometric evaluation of the impact of electricity sector reforms in Kenya relative to other four developing countries using panel data over the period 1993 to 2018. The paper assesses the impact of restructuring, unbundling, competition and private sector participation on electricity access.

Methodology: In this study we carried out estimations of the outcome of reforms using panel data. The study period 1993 to 2018 was chosen based on data availability and also the consideration that power sector reforms in Kenya, Uganda, Tanzania and Senegal began after 1993.

Findings: Using fixed effect method the study concludes that competition is key in enhancing access to electricity nationally and in both rural and urban areas. On the other hand, restructuring has a negative impact on both electrification in the four countries under study.

Unique Contribution to Theory, Practice and Policy: Allowing more players and also in the buying of bulk energy for onward transmission and distribution with the aim of ultimately having a fully competitive marketing the sector would therefore improve the power industry outcomes.

Keywords: *Power Sector, Reforms, Electrification, Fixed Effect Method, Developing Countries*

International Journal of Economics

ISSN 2518-8437 (Online)
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INTRODUCTION

It is generally believed that access to clean energy contributes to improvement in quality of life (Bensch2011, Dinkelman 2010 and Grogan,2013).Reliable, affordable, clean and efficient energy is taken as critical for economic development and poverty alleviation (AGECC, 2010). In the absence of modern energy basic services in education, health, agriculture, infrastructure and business are hampered negatively impacting on human and economic development. Research confirms that access to modern energy creates opportunities and avenues for poverty alleviation globally (AGECC, 2010). In-spite of this, globally the proportion of households without electricity is still high particularly in Sub Saharan Africa and in particular in the rural areas. Electricity consumption is also very low in these countries.

Energy poverty is a major challenge in African countries particularly in Sub-Saharan Africa (SSA) despite the region's abundant natural resources (WEO, 2014) SSA is the only region where the population of people without electricity is rising (WEO, 2014). In 2009, population without electricity in SSA stood at 582.2 million people but in 2014 the figure rose to 632 million people. The region is home to 13% of world's population but only 4% of world energy demand (WEO, 2014).The underlying causes vary from low levels of installed capacity, low generation capacity, droughts that reduce hydropower, high costs occasioned by the use of thermal power and conflicts that destroy the already existing infrastructure.

In many countries electrification rate has been rising, more and more people are gaining access to electricity. In Ethiopia for example, electrification rate rose from 17 % in 2009 to 25 % in 2014, Ghana from 60.5 % in 2009 to 72 % in 2014, Uganda from 9 % in 2009 to 42.6% in 2018, Kenya from 23% in 2009 to 75% in 2018, Tanzania from 11.2% in 2009 to 35.6%in 2018 and Senegal from 53.5%in 2009 to 66% in 2018 (IEA 2014, 2009). Electricity access rate in Sub-Saharan Africa as a whole grew from 23% in 2000 to 35% in 2014 (WEO, 2014).

National and regional development policies as well as poverty alleviation strategies have contributed significantly to the increase in access to energy. Most countries in SSA have energy policies and plans for growing the energy sector. The plans set targets for universal access to electricity though this has hardly been achieved (WEO, 2014). More efforts and resources are required to comprehensively address energy poverty.

Electricity Energy Access in Kenya

Electrification of households has been a major policy concern in Kenya since independence, due to the social and economic benefits that are perceived to emanate from it. The Kenyan government has recently focused on mass electrification of the rural areas through various programmes. Among these programmes is the connection to the grid of public facilities such schools, hospitals and market centers and also "last–mile" grid connection.

The Sessional Paper No. 4 of 2004 has over the last 10 years been the main policy document governing the Energy and Petroleum sector in Kenya (National Energy and Petroleum Policy, 2015).The vision of this paper is to encourage access to quality energy service to all at affordable cost while ensuring protection of the environment. This policy document gives guidance upon which cost-effective,

affordable and adequate quality energy service will be availed to the Kenyan economy sustainably over the period 2004-2023 (Republic of Kenya, 2004).

One of the programmes in the Sessional paper is rural electrification that started in 1973 with the objective of improving life quality in rural areas (Republic of Kenya, 2004). The programme has achieved minimal success because of its high cost and mismanagement of financial resources, (Republic of Kenya, 2004). The Energy Act, 2006 facilitated the establishment of Rural Electrification Authority with the objective of hastening rural electrification in Kenya. To facilitate the process, a 5% levy is imposed on electricity consumption and the proceeds used to fund rural electrification.

The Energy Bill 2015 clause 7 states the government is obligated to provide affordable energy to all persons in Kenya. The cabinet secretary for Energy and Petroleum is obligated to implement a strategy that will ensure that all households are connected to electricity by 2030. The Bill requires both the national and county governments to facilitate the achievement of access to modern energy by all.

By June 2016 the customer base had increased from 2,261,064 in March 2013 to 4,890,373, a growth rate of 27% to 56 %. Although this is a great achievement it is far from achieving universal access by 2030.

Reforms initiated in the 1990's by donors have undoubtedly changed the way the power sectors operate today. Restructuring of the state owned power utility, introduction of competition, allowing private sector participation and establishing regulatory authorities may have impacted on the performance of this sector either positively or negatively. Apart from these reforms, other local and global policies have been advanced in the recent past in order to accelerate accessibility and affordability of clean energy by all.

Energy sector in Kenya has seen major transformations arising from the mid 1990's reforms and other government policies. Among the key are the vertical unbundling of the Kenya power and lighting company, establishment of Energy Regulatory Authority, enactment of the Energy Act the participation of the private sector in electricity generation and introduction of competition in power supply. The reforms have been adopted partially, especially in the unbundling of the sector and introduction of competition. Despite the reforms, electricity access in sub-Saharan Africa remains low. The average world electrification rate is 84%, sub-Saharan Africa's rate was 35% in 2014.

LITERATURE REVIEW

The degree to which electricity sector reforms impacts on population is dependent on the ability to access and afford adequate supply of electricity. In many countries electrification rate has been growing over time. Case studies show that, in most parts of the world, electrification was very low prior to the reforms but has since increased significantly. In Sub-Saharan Africa for example, only 8% of rural population had connection to electricity in the year 2000 (Haanyika, 2006). In Tanzania access to electricity in rural areas stood at 1.7% in 1998 and rose to 18%in 2018, Senegal from 9.5% in 1998 to 20% in 2018, Kenya 6.6% to 72% in 2018. In other regions the trend has been almost the same. In Chile for example rural electrification rose from 53% to 76% in a span of 7 years following reform, Peru 5% in 1993 to 20% 1997,(Haanyika, 2006). This may not be exclusively an outcome of the reforms but may be as a result of a combination of other government policies and agenda.

The impacts of reforms on power sector in both developing and developed countries have been examined in several studies. Studies have used different indicators of reforms and performance measures. Findings have also differed among the studies as discussed in this section.

Newberry and Pollit (1997) assessed the achievements or otherwise of one of the first electricity supply industry to embrace reform the then England and Wale. An industry which operated under public ownership from 1948 to 1990 was restructured and privatized in 1990. Among the observable achievement attained in the first six years were: increased labour productivity, increased use of clean energy, drop in cost of power and increase electricity generation and installed capacity.

Cubbin and Stern (2006) using OLS and fixed effect estimation models, carried out an empirical investigation of electricity sector in 28 developing countries to find out how establishment of regulatory agency in the power sector impacts on electricity generation capacity and efficiency. The analysis concluded that enactment of a regulatory law and good governance have a positive and significant impact on per capita electricity supply capacity and on levels of efficiency. Privatization and competition have no significant impact on electricity generation capacity.

Zhang, Parker and KirkPatrick (2008) in a study of 36 developing countries on the impact of privatization, competition and regulation on electricity generation came up with similar conclusion as Cubbin and Stern (2006). The findings of this study were that privatization on its own does not lead to either higher labour productivity or higher generating capacity. Privatization is only effective where there is an independent regulator. However, they study suggested that regulation on its own does not result in improved productivity. The analysis concluded that competition has the highest impact in improving labour productivity, capital utilization and electricity generation.

A study by Eberhardt et al (2005)is inconclusive on the effect of power sector reforms on access to electricity. Countries such as Namibia, Tanzania Mali and Uganda have recorded a significant growth in access rate. They note that electrification has grown significantly in almost all countries in the past decade. They however note that most of electrification programmes have been as a result of government or donor support and not reforms. The study observes that private sector involvement can contribute to success in improving the level of access under certain condition for example where clear objectives and incentives are present. On the impact of reforms on power supply the study observes varying effects. In case of Uganda, Mali and Namibia they find significant progress in quality of supply whereas in Ghana and South Africa electricity customers continue to experience power shortages despite the reforms.

The differences in findings may be attributed to various factors among them the different variables used, different measures of reforms, different estimation methods, extent of reform undertaken in different countries and obvious differences between developed and developing countries. Most studies however suggest that competition and an effective regulation in power sector are key in ensuring improvement in performance of the power sector.

METHODOLOGY

In this study we carried out estimations of the outcome of reforms using panel data. In the panel data model, we used dummy variables indicating the period before and after a particular reform. The study period 1993 to 2018 was chosen based on data availability and also the consideration that power sector

International Journal of Economics

ISSN 2518-8437 (Online)
Vol.7, Issue 2, No.4. pp 61 - 71, 2022

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reforms in Kenya, Uganda, Tanzania and Senegal began after 1993. The sector outcomes considered in this study are electricity access per capita .Electricity access per capita is further broken down into electricity access in rural areas as a percentage of rural population and electricity access in urban areas as a percentage of urban population. Data on these variables was obtained from World Bank, Sustainable Energy of all data base.

Power sector reforms assessed in this study were: Regulation, restructuring, competition and private sector participation. Control variables were incorporated in the model to take care of the differences across countries and over time. By including GDP per capita to reflect the economic condition of the countries, we expected GDP per capita to positively impact on both access to electricity and on the amount of electricity generated as people can afford connection fee and afford to demand more electricity with high incomes. Another control was net installed capacity to capture the size of the power sector. Installed capacity was expected to facilitate more connectivity and generation of electricity in the absence of idle capacity. The third control variable was the Political Democratic Index (PolityIV). PolityIV ranged from -10 to 10, where -10 reflected full autocracy and 10 reflected full democracy. It was expected to give an indication of the strength of the institutions, rule of law and degree of political interference in the running of the electricity sector. Polity IV is therefore expected to take a positive sign.

The analytical model was defined as follows;

$Y_{it} = f(R_{it}, Xit)$……1

i =1,…, 4

$Y_{it} = \beta_0 + \beta_1 R_{it} + \beta_2 X_{it} + \alpha_i + \varepsilon_{it}$……..……2

$E(\varepsilon|x) = 0$; $Cov(x_i,\varepsilon) = 0$

Equation 3.1 is a system of four equations. Y_{it} represents the four outcomes of interest at time t, namely: overall country access to electricity per capita, rural electricity access per capita, urban electricity access per capita and electricity generation per capita. The vector of explanatory variables, R, represents the reform variables described in the above section for each country at time t. They include: restructuring, regulation, legislation, private sector participation, competition .The model also includes a set of control variables, X, to take care of the differences across countries that could be correlated with the outcome variable, Y. Possible control variables include:, GDP and installed capacity and PolityIV . β's are the parameters to be estimated, α_i is the country specific residual that differs across countries but remains constant for any particular country and ε_{it} is the classical disturbance term.

The model could be explicitly written as follows:

$Y_{it}=(Restr_{it},Reg_{it},Leg_{it},PSP_{it},C_{it}.GDP_{it},IC_{it},PolityIV_{it})$ ……3

Equation 3.3 could be presented as a loglinear model as follows:

$\ln Y_{it}=\beta_0 + \beta_1 Restr_{it} + \beta_2 Reg_{it} + \beta_2 Leg_{it} \beta_3 PSP_{it} + \beta_4 C_{it} + \beta_5 ln\, GDP_{it} +$
$\beta_6 \ln(IC)it, + \beta_7 Polity\, IV_{it} + \alpha_i + \varepsilon_{it}$……..4

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Where: $Y_{1\text{-}4(it)}$ represents the three dependent variables namely; national electrification rate, rural electrification rate and urban electrification rate. $Restr_{it}$ represents restructuring, Reg_{it}represents regulation, Leg_{it}represents legislation, PSP_{it} represents private sector participation, C_{it} represents competition, GDP_{it} represents gross domestic product, IC_{it} represents installed capacity, $PolityIV_{it}$ represent democratic index, i and t represents the country and time.This equation is a fixed effect model whose estimation was chosen using Hausman test.

Data Source

Data employed in the study was taken from World Bank national accounts, IEA, Center for Systemic Peace and various national accounts. It spanned from 1993 to 2018. The following table gives a description of the variables and the data source of each.

Table 1: Variable Description, Measurement and Source

Variables	Description	Source
Independent variables		
$Y_{1(it)}$	Percentage of households connected to electricity.	World Bank-Electricity Access Database
$Y_{2(it)}$	Percentage of rural households connected to electricity.	World Bank– Electricity Access Database
$Y_{3(it)}$	Percentage of urban households connected to electricity.	World bank– Electricity Access Database
Dependent variables		
GDP_{it}	Gross Domestic Product per capita (constant 2010 US$)	World Bank national accounts
IC_{it}	Total net installed capacity of electric power plants.	Various countries national accounts
$PolityIV_{it}$	Political Democratic Index ranges from -10 to 10.	Center for Systemic Peace www.systemicpeace.org/polity
Reg_{it},	Dummy variable, 0 for period before the reforms, 1 for the period after the reforms.	International Energy Agency (IEA)
$Restr_{it}$	Dummy variable, 0 for period before the reforms, 1 for the period after the reforms.	International Energy Agency (IEA)
C_{it}	Dummy variable, 0 for period before the reform, 1 for the period after the reform	International Energy Agency (IEA)
PSP_{it}	Dummy variable, 0 for period before the reform, 1 for the period after the reform	International Energy Agency (IEA)
Leg_{it},	Dummy variable, 0 for period before the reform, 1 for the period after the reform	International Energy Agency (IEA)

Source: Author

RESULTS AND DISCUSSION

Equation 4 was estimated for the three dependent variables: national access to electricity, rural access to electricity and urban access to electricity. Adjustments were made in each model to take care of heteroskedasticity, autocorrelation problems identified in post estimation stage. The following tables present the regression results.

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Vol.7, Issue 2, No.4. pp 61 - 71, 2022

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For each of the dependent variables five models were estimated to capture the effect of each additional reform on the dependent variables. The reforms are added in the order in which they were introduced in Kenya's electricity sector.

Table 2: Fixed Effects Estimates of the Impact of Reforms on Access to Electricity in Kenya

variables	Model 1	Model 2	Model 3	Model 4
GDP	10.440(6.984)	11.046(7.806)	10.966(7.833)	11.175(9.411)
Installed Capacity	13.658**(6.425)	13.638**(6.554)	13.537**(5.522)	15.246**(5.985)
Polity IV	3.918**(1.949)	4.047(2.425)	4.016**(2.016)	2.621**(1.320)
Restructuring/Unbundling	-7.808(5.361)	-7.788(5.399)	-7.789(5.476)	-6.691**(2.299)
Private sector participation		-0.8261(36.76)	-0.826(3.684)	1.634(2.891)
Regulation			0.250(4.965)	-5.823(2.940)
Competition				19.096***(2.940)
Constant	-135.27***(22.189)	-138.765***(0.1079)	-137.698***(21.996)	-153.116***(33.393)
R squared	0.6793	0.6796	0.6797	0.7707

Notes: Stderrors In The Parenthesis,* $P < 0.1$, ** $P < 0.05$, And *** $P < 0.01$.

Source: Author's Computations Using Data from World *Bank National Accounts, IEA, Center for Systemic Peaceand Various National Accounts*

In the first model access to electricity in Kenya variable was regressed on control variables; GDP, installed capacity, Polity and on unbundling which was the first reform to be implemented in Kenya in 1997. GDP had the expected sign but was found to be insignificant. Installed capacity and Polity IV(representing the strength of the institutions) were positive and significant at 95% confidence level. Unbundling was not significant. The Installed capacity and polity are associated with increase in access to electricity. In the second model we add private sector participation reform. The first two independent power producers came into operation in 1997 in Kenya. The two reform measures; Unbundling and private sector participation are not significant. These results suggest that private sector participation and unbundling together are not associated with increased electrification. In the third model regulation variable representing in case of Kenya, the commencement of operation of Electricity Regulatory Board in 1998 is added to the model. The inclusion of Regulation reform variable in the model results in installed capacity and polity variables being positive and significant suggesting that the two control variables positively impact on access to electricity.

The overall model includes all the four reform variables and the three control variables. Restructuring/unbundling of the power sector is negative and significant while competition is positive and significant. Regulation and private sector participation are not significant. This indicates that introduction of competition particularly in the supply side has contributed to the acceleration of electrification in the countries under this study. Restructuring on the other had appears to have had

negative impact on access to electricity. These findings are consistent with those of other studies such as (Zhang,Parker and Kirkpatrick (2008).

Impact of Reforms on Access to Electricity in Rural Areas

In the next analysis the study sought to find out whether these findings apply to the rural areas. The same models were regressed with access to electricity in rural areas as the dependent variable. The results are presented in table 3.7.

Table 3: Fixed Effects Estimates of the Impact of Reforms on Access to Electricity in Rural Areas

variables	Model 1	Model 2	Model 3	Model 4
GDP	2.229(7.299)	2.957(8.506)	3.221(7.818)	3.449(7.708)
Installed Capacity	15.989***(6.450)	15.964***(6.548)	19.297***(5.531)	18.162***(6.087)
Polity IV	2.955(1.883)	3.110(2.453)	3.211(1.887)	1.688(1.279)
Restructuring/Unbundling	-10.110(6.657)	-10.085(6.681)	-10.081(6.638)	-8.883**(4.388)
Private sector participation		-0.9943(4.426)	-0.994**(4.569)	1.689(3.463)
Regulation			-0.824(5.773)	-7.779**(3.807)
Competition				20.833***(4.94)
Constant	-105.791***(41.595)	-109.996(-1.94)	-113.511**(35.397)	-130.331***(28.037)
R squared	0.5291	0.5296	0.5299	0.6451

Notes: Stderrors In The Parenthesis * $P < 0.1$, ** $P < 0.05$and *** $P < 0.01$.

Source: Author's From World *Bank National Accounts, IEA, Center for Systemic Peace and Various National Accounts Data*

In the first model where we look at the impact of unbundling on access to electricity in rural areas, the findings indicate that installed capacity has a positive and significant impact. This model also suggests that GDP, polity and restructuring have positive but insignificant impact on access to electricity in rural areas. In the second model we incorporate both Restructuring and private sector participation reform variables, the regression results show that both variables have no significant impact on rural households' access to electricity. Adding Regulation reform in the third model, private sector participation has a negative and significant impact on rural electricity access while installed capacity indicates a positive and significant impact. The negative impact for the Kenyan case could be explained by the resultant high tariffs occasioned by operations of thermal generators by the private sector investors. In the fourth model which incorporates all the reform variables and the control variables, we find restructuring and regulation to have a negative and significant impact while installed capacity and competition positively and significantly influence rural access to electricity. Zhang, Parker and Kirkpatrick (2002), came up with a similar conclusion as regards competition, however in their study regulation and privatization had an insignificant impact on service penetration.

Impact of Reforms on Access to Electricity in Urban Areas

The same models were regressed as above with access to electricity in urban areas as the dependent variable respectively. The results are as in table 3.8 below.

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ISSN 2518-8437 (Online)
Vol.7, Issue 2, No.4. pp 61 - 71, 2022

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Table 4: Fixed Effects Estimates of the Impact of Reforms on Access to Electricity in Urban Areas

variables	Model 1	Model 2	Model 3	Model 4
GDP	16.779(13.124)	17.530(13.466)	16.396(13.374)	16.501(14.716)
Installed Capacity	8.188*(4.895)	8.163(5.152)	6.734(4.712)	7.590(4.895)
Polity IV	3.851***(1.298)	4.011**(1.658)	3.579**(1.489)	2.880**(2.35)
Restructuring/Unbundling	-8.417(2.791)	-8.392***(2.742)	-8.411*** (2.781)	-7.861***(1.764)
Private sector participation		-1.024(2.519)	-1.025 (1.447)	0.207(1.810)
Regulation			3.542*(2.124)	0.499(1.661)
Competition				9.568***(0.773)
Constant	**-110.170* (59.480)**	**-114.501* (60.121)**	**-99.396* (59.156)**	**-107.121 (67.971)**
R squared	0.8038	0.8046	0.8144	0.8505

Notes: Stderrors in the parenthesis * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

Source: Author's from World *Bank national accounts, IEA, Center for Systemic Peaceand various national accounts data*

Unlike in rural areas regression analysis where installed capacity comes out as key in accelerating electrification, in the case of urban areas, strength of institutions capture through polity is highly significant in the four models as shown in the table above. Restructuring of the power sector appears to have contributed negatively to the rate of electrification. Competition on the other hand has a positive impact on electrification both in rural and urban areas.

Conclusion

Many developing countries have undertaken electricity sector reforms with the aim of improving the sector's outcomes. Based on available data from international and local sources this study assessed the effects of some of the reform measures (unbundling of the sector, introduction of an independent regulator in the sector, allowing private sector players in the industry and introduction of competition) undertaken so far in four developing countries on anticipated sector outcomes. This study focused particularly on outcomes that impact directly on the households, namely access to electricity. The study covered the period 1993 to 2018.

The empirical findings of this study consistently show that competition in the sector is important in promoting access to electricity nationally, in rural areas and also in urban areas. The findings further show that unbundling does not necessarily accelerate electrification nationally or in both rural and urban areas. The results also suggest that regulation has negatively impacted on rural electrification in the four countries under study. This is however not the case for urban areas where neither Private sector participation nor regulation appear to impact on electricity access. Private sector participation, Regulation and competition have had no impact on electricity supply.

Competition in this sector appears to be key in enhancing overall access to electricity. This is an important observation given the fact that at the time of this study the level of competition in this sector was very minimal. In the four countries, competition was introduced as an intervention intended to

accelerate generation of renewable energy. The four countries operate on a single buyer model, where all energy generated is purchased by one buyer for onward transmission and distribution. Given the findings of this study, these countries would benefit from continued reform in the area of competition, allowing more players in generation and also in the buying of bulk energy for onward transmission and distribution with the aim of ultimately having a fully competitive market. Overall competition seems to be quite effective in improving this sector's outcomes.

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