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Fiscal Decentralization and Energy Consumption: A Race to Decentralization

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Abstract
This study examines the effect of fiscal decentralization, in the form of shifting responsibilities of tax revenues, expenditure and planning from the central government to lower local governments, as well as rapidly rising income, on energy consumption for 47 Kenyan counties over the period 2013 to 2017. This study employs panel methodology and the *ordinary least squares* regression model to investigate this effect in Kenya. The index of fiscal decentralization is measured by the ratio of sub-national revenue to total public revenue. This analysis has policy implications for economic growth, poverty level, race to energy decentralization and energy demand. The study findings demonstrate that higher fiscal decentralization is associated with higher energy consumption in Kenya; the internally generated revenue enhances electricity demand through improved energy infrastructure, energy innovations and connectivity. This can also be attributed to economic resources, administration, service delivery, and infrastructure planning being decentralized to the sub-national level. This underscores the need to provide policies and strategies that will guide the integration of the energy sector into development programmes, plans and processes at the sub-national level to advance energy system decentralization, connectivity and cumulative energy consumption.
Keywords: Energy consumption, Decentralization, Energy efficiency, Sub-national, Taxation
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1 Introduction

The recent global race towards decentralization has gradually been justified on the basis that the transfer of economic resources and energy infrastructure planning and administration to the sub-national level is likely to create greater efficiency in the delivery of energy products and consequently increase economic output (UNDP, 2009; Hanif & Gago-de Santos, 2020). However, in the process of achieving decentralization, a country faces many impediments such as inadequate energy infrastructure, insufficient resources and damage to the environment (Girona et al., 2019; Elheddad et al., 2020; Gisore, 2022). Fiscal decentralization involves mainly delegating expenditure functions, revenue sources and administrative functions to sub-national governments. In a nutshell, fiscal decentralization is anticipated to make decentralized energy resources to be more effective, increase demand and inspire efficiency (Brosio, 2000), and create opportunities for county regimes to mobilize around their energy development policies, plans, programmes and needs (Putnam, 1993; UNDP, 2009) and contribute to better coordination between various stakeholders. In addition, importantly, decentralization is expected to provide each sub-national unit with the autonomy to pursue energy development programmes and policies tailored to its economic potential and identify the competitive advantage of each locality (Hanif & Gago-de Santos, 2020).

The opponents of decentralization argue that federalization can slow energy demand through local elites controlling the energy system; understaffed units; arise in bureaucracy; corruption; and an increase in the cost of energy (Omolo, 2010). This will undermine the performance of counties and lead to inefficiency; and slow energy resource use and production (Akramov & Asante, 2009; OCOB, 2018). These conflicting opinions arise primarily from the perspectives of the potential impact of such policies on the institutional environment of developing countries. Whether the arguments will prevail requires empirical support. However, few available empirical studies provide contradicting and mixed arguments (Akramov & Asante, 2009).

In 2010, Kenya promulgated a new governance system which reconfigured the balance of political and economic power by transferring administrative responsibilities and economic resources from the state to the 47 county governments (GoK, 2010). A decentralized energy sector is characterized by locating energy production facilities and infrastructure closer to the site of energy consumption (Elheddad et al., 2020). Therefore, this will stimulate the optimal use of energy and rise energy efficiency while reducing fossil fuel demand (Gisore, 2017). In recent years public revenue in Kenya has increased significantly, with increased allocation to the sub-national governments and thus rises in energy infrastructure decentralization, production and consumption. In Kenya Per capita, electricity consumption is around 170 kWh, which is much higher than in neighbouring states (60% higher than in Tanzania, twice that in Uganda). Since 2013, fiscal decentralization initiation, total energy consumption has increased by an average of 3.6%/year. However, available energy consumption indicators particularly in electricity demand and use in rural counties (44/47) and by women-owned businesses are not improving substantially (UNDP, 2009; Waweru *et al.,* 2022). It is, therefore, important to examine the interaction between decentralization and energy demand in Kenya, to determine the effects of decentralization on expected outcomes of energy services (SID, 2017; Kibet et al., 2019). In addition, the reviewed empirical literature presents mixed and inconclusive results as well.

2 Literature Review

The theoretical significance of decentralization on efficiency and improved energy utilization manifest itself through the delegation of powers as presented in the theoretical works of Tiebout (1956) and Oates (1999). The Tiebout model is based on several decentralization propositions. The first school of thought advances the diversification proposition it upholds that national governments providing a uniform level of energy products and services will cause inefficiency (Oates, 1999). The inefficiency is qualified since different local jurisdictions have different levels of energy source preferences and energy needs (Tiebout, 1956). Brennan and Buchanan (1980) advanced, the second case, the Leviathan restraint argument that as usual, the sub-national units will always aim to maximize tax revenue. For a state to maximize revenue collection the income tax should grow, irrespective of hurting the poor and women-owned businesses. But with the advent of a decentralization system, any desire to increase tax will cause the movement of taxpayers to other devolved units. As a result of sub-national competition, local authorities will always try to attract migrants and maintain the current population by having a friendly tax system and providing environmental and energy infrastructure conditions that can attract investors (Brennan & Buchanan, 1980; Ganaie *et al.*, 2018; Mose, 2022). The third school of thought advanced augmented productivity premise. According to the theorem, decentralization will translate to accountability and transparency at the lower-tier level of government (Oates, 1999). This implies the energy supplier will provide electricity services according to the preference of the population and thus grow demand.

From previous empirical literature, some studies that examined the channels through which decentralization influence energy consumption have produced inconclusive results (Ganaie *et al.*, 2018). From past works, decentralization is expected to stimulate energy consumption positively (UNDP. 2009; Hanif *et al.,* 2020). Alternatively, federalism can slow energy consumption if it is not complemented with improved technology, good governance and transparency at lower tier government (Martinez-Vasquez & McNab, 2006). These empirical studies provide mixed results, therefore, this study is exceptional in the sense that it is carried out to fill the existing void.

2.1 Conceptual Framework

Figure 1 conceptualizes the theoretical structure, which shows the explanatory variables which include fiscal decentralization and economic growth while the dependent variable is energy consumption. In between the dependent and explanatory variables are the intervening elements which are not controlled for in the research.

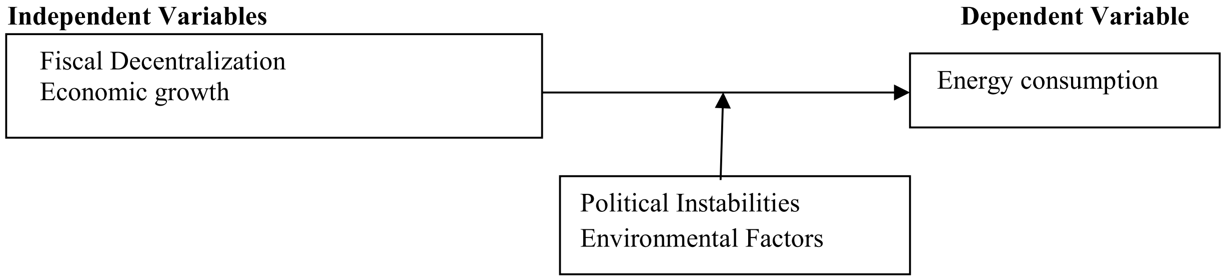

Figure 1: Study Conceptual Framework.

3 Materials and Methods

3.1 Area of Study

The research was carried out in Kenya. Kenya is located in the East African region. Kenya's latitude and longitude are 0.0236° S and 37.9062° E respectively (Gisore, 2021). Both national and sub-national governments have done major infrastructure decentralization in the energy sector across the economy to increase rural connectivity, spur productivity and achieve output growth (Girona et al., 2019). In Kenyan counties, electricity remains the major mode of energy input in the agriculture, service and manufacturing sectors. Figure 2 presents the map of electricity infrastructure across Kenya showing the location of the study area.

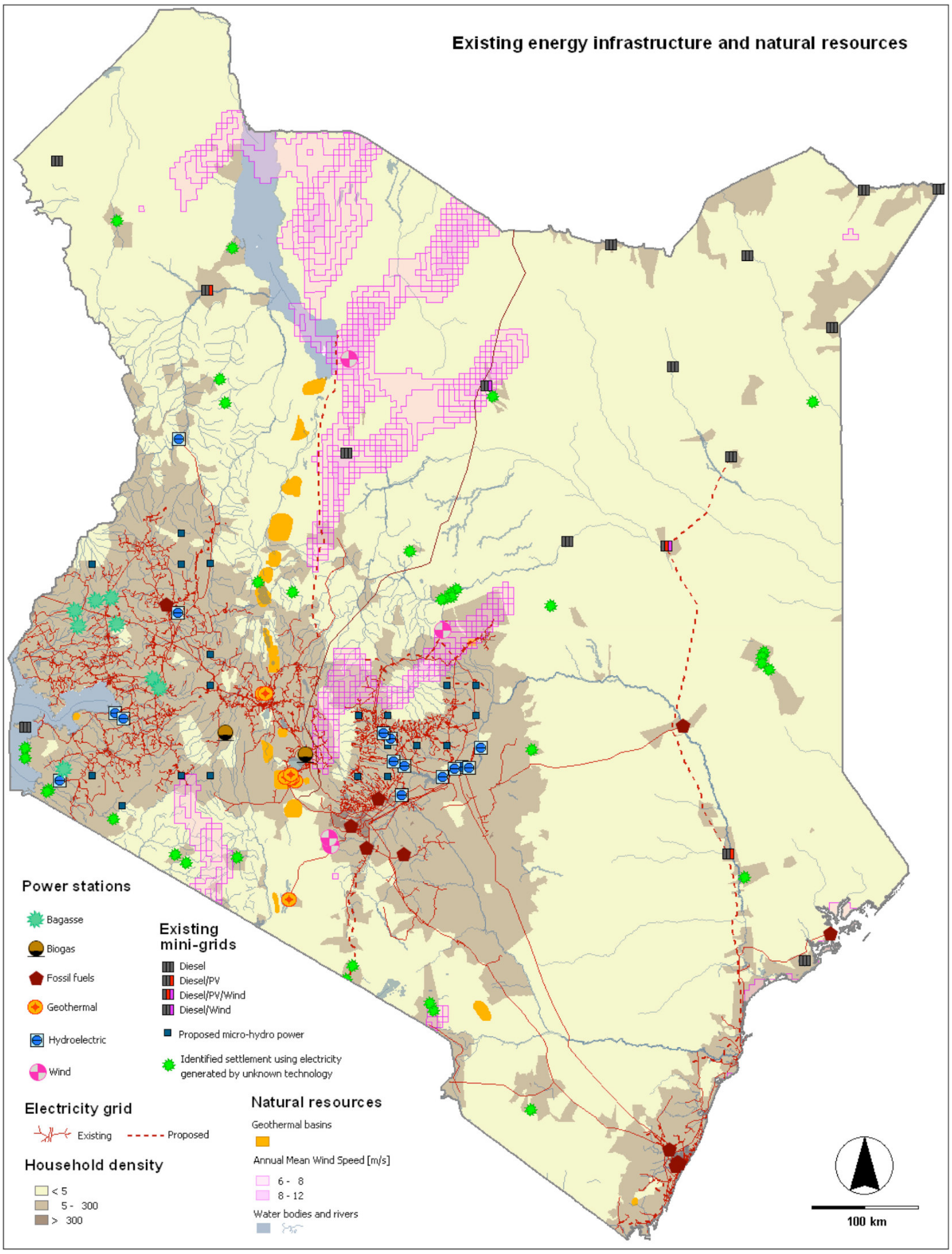

Figure 2: Map showing the energy infrastructure in Kenya.
Source: Girona et al. (2019).

3.2 Data Description
The study employed secondary data obtained from various sources, such as the Gross county product 2019 report, Kenya power publications, Economic surveys and County budget implementation review reports over the period from 2013 to 2017 using cross-county panel data research design. The description of variables and data sources is given in Table 1.

Table 1: Description of Data Variables

Variables	Description	Unit of Measurement	Source
$y_{i,t}$	Economic growth	Real Gross County Product growth	Gross County Product report 2019
$f_{i,t}$	Fiscal decentralization	The ratio of sub-national government tax revenue to total government tax revenue	County Budget Implementation Review Reports 2013-2017
$e_{i,t}$	Energy consumption	Annual electricity consumption in Kilowatts	Kenya power reports 2013-2017

Economic Growth: As established in the economic development literature, this study used real Gross County Product (GCP) growth as the measure of economic growth at sub-national levels (Kibet et al., 2019; Ganaie et al., 2018). The real GCP variable data was obtained from the Economic Survey reports and Gross County Product 2019 report.

Fiscal Decentralization: According to Keynesian theory, tax revenue decentralization can improve energy consumption through improved demand, efficiency, connectivity and funding of energy infrastructure development. The fiscal decentralization variable was obtained from County Budget Implementation Review reports.

Energy Consumption: Energy input is critical for sub-national economic development (Wen-Cheng, 2016). Following research by Wen-Cheng (2016), electricity consumption in Kilowatts by county was used as a proxy of energy utilization. Data were retrieved from the Kenya Power publications and literature.

3.3 Econometric Model

The study adopted the modified fashion of Balaguer and Cantavella-Jorda's (2002) econometric model to capture the effect of decentralization on energy consumption. The empirical model has been used in several studies by Ng *et al.* (2019) and Gisore (2022) to investigate the outcome of several macroeconomic indicators. This study modified the Balaguer and Cantavella-Jorda (2002) model as shown:

$$lne_{i,t} = \alpha_0 + \alpha_1 lnf_{i,t} + \alpha_2 lny_{i,t} + \mu_t \qquad [1]$$

Where E_t is energy consumption proxied by electricity demand at the sub-national level, F_t is defined as Fiscal decentralization proxied by the ratio of local revenue to total revenue, Y_t is economic growth measured by the annual real GCP growth variable, μ_t is the stochastic term, ln is the natural log, α_0 is the constant term, α_1 *and* α_2 are coefficients associated with the logarithms of F and Y, respectively. Logs (ln) of the study variables were used during the estimation of the model to allow for estimation coefficients to be interpreted as elasticities.

3.4 Data Analysis

The panel unit root test was employed to check if the variables are non-stationary and if the time series variable possesses unit root to reduce the chances of misleading findings. For this study, if decentralization is highly persistent, the decentralization series in each local unit may suffer from a unit root and the resulting estimates would be inconsistent. Harris and Tzavalis unit root test was employed in this study since it has superior test power for the long-run relationships in panel data than Im-Pesaran and Shin, which begin by specifying a separate ADF regression for each cross-section with individual effects and no time trend.

$$\Delta y_{it} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \qquad (2)$$

Where $i = 1, \ldots, N$ and $t = 1, \ldots, T$

The second step is to check if the variables have a long-run relationship; this study applied the Kao co-integration test. The cointegration procedures proposed by Kao make use of estimated residual from the hypothesized long-run regression of the following form:

$$y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \ldots + \beta_{Mi} x_{Mi,t} + e_{i,t} \qquad (3)$$

for t = 1,…..,T; i = 1,….,N; m = 1, …., M,

Where; T is the number of observations over time,
N is the number of cross-sectional units in the panel,
M is the number of regressed variables

In this setup, α_i the fixed effects parameter varies across individual cross-sectional units. The same is true of the slope coefficients and member-specific time effects $\delta_i t$.

The study adopted the panel ordinary least squares (OLS) technique to analyse the relationship between the study variables. Panel data can be estimated by two methods, fixed or random effect model as selected by Hausman (1978) test. One advantage of the fixed effects model is that it allows the unobserved individual effects to be correlated with the included variables. Some diagnostic estimation analyses were applied in the empirical model to qualify the result.

4 Results and Discussion

4.1 Panel Unit Root Results

Harris–Tzavalis (HT) unit root test was conducted to rule out the presence of non-stationary time series, in level and at the first difference, and the result is reported in Table 2.

Table 2: HT Unit Root Results

Variable	Statistic	Z	P-Value	Variable	Statistic	Z	P-Value	Order of I
lny	-0.676	-12.8***	0.001					I(0)
lnf	0.163	-4.8***	0.000					I(0)
lne	0.447	-0.747	0.228	$\Delta ln\ e$	-0.094	-5.9***	0.000	I(1)

Notes: *The null hypothesis is that the series is non-stationary or the series has a unit root. Indicates *** 1% significance level and ** 5% significance level.*

The results in Table 2 indicate that all the study variables are stationary at their level except energy consumption. Thus the null hypothesis of non-stationary for all cannot be rejected and hence the data series contains a unit root. But, it becomes stationary after the first difference implying that the variables are integrated of orders one, I (1).

4.2 Panel Cointegration Test

Usually, after differencing, variables tend to lose the long-run relationship and so a cointegration test is being conducted to establish whether variables have got long-run relationships after differencing. Since some variables were found to be stationary at the level and others stationary after first differencing, conducting a cointegration test was impossible since the variables were now not integrated in the same order.

4.3 Regression Results

A fixed-effects model is used based on the results (Table 3) of the Hausman (1978) test. The fixed effect estimation method has been used in previous studies including Lin and Liu (2000) and Gisore (2021). Table 3 presents the fixed effect regression results based on the panel data methodology.

Table 3: The Fixed Effects Results

Variable	Coefficient	Standard error	t- Statistics	P-value
$lnf_{i,t}$	0.08603***	0.031455	2.735	0.0088
$lny_{i,t}$	0.43923***	0.151606	2.897	0.0057
Cons	5.84745***	0.738163	7.922	0.0001
Wooldridge Test	F(1,46) = 69.8196***		Prob > F = 0.0000	
Wald Test	F(47) = 63.0050***		Prob > F = 0.0000	
Goodness of fit	R^2 = 0.7786		Adjusted R^2 = 0.7641	
Hausman test	Chi-square (2) = 38. 4749***		P-value(F) = 0.0000	
Durbin-Watson	= 1.968365			

*Notes: *** indicates significance at 1 per cent, ** indicates significance at 5 per cent, * indicates significance at 10 per cent.*

The regression results revealed that the effect of decentralization on energy consumption is positive and significant in 47 counties. The finding implies that a one percentage point increase in fiscal decentralization level will induce a 0.09 percentage point increase in energy utilization at the sub-national level. The results mean that improving the decentralization level to the optimal point will increase the use and availability of energy resources in counties. Decentralization will encourage energy innovations and efficiency, and thus increase demand and reduce the cost of energy. This is attributed to the ability of local revenue to finance energy infrastructure decentralization and thus improve energy input productivity, connectivity and output. This can be explained by the ability of decentralization to provide necessary resources and bring energy programmes closure to the end user and increase efficiency in resource use and transmission. A decentralized energy system is characterized by locating energy production facilities closer to the site of energy consumption and allowing for optimal use of energy (UNDP, 2009; Girona et al., 2019). In addition, decentralization allows local actors to participate in making energy sector decisions such as identifying the energy programme and processes. The result is in agreement with the findings of UNDP (2009), Gisore (2017), Girona et al. (2019), Hanif *et al.* (2020) and Elheddad et al. (2020) on the positive relationship between study variables. In contrast, Martinez-Vasquez and McNab (2006) reported a negative link attributed to higher taxes implemented to finance energy decentralization processes. According to the Leviathan restraint proposition, with the advent of decentralization, tax increases will cause the movement of taxpayers to other devolved units with better business conditions, lower taxes and low energy prices (Brennan & Buchanan, 1980; Ganaie *et al.*, 2018).

The coefficient of economic growth was found to have a positive effect on energy consumption in counties. Fiscal decentralization is a part of the gross county product (GCP) and thus any changes in fiscal decentralization will adjust the effect of energy consumption as well as output. Shuaibu and Oladayo (2016) noted that high economic growth enables a county to generate more revenue and resources that can be directed towards enhancing energy infrastructure development and transmission initiatives. One of the most important drivers of enlarged energy use is the increase in disposable income of the local population which thus increases energy expenditure. In addition, an increased budget for devolved infrastructure development like hydroelectric power, telecommunication and roads will induce more productivity in the local economy (Mose, 2022). Productivity will grow as a new process of production or energy technology or power is introduced and diffuses through the local economy. Improved economic activities will improve disposable income, local revenue and energy infrastructure development and stimulate energy use (Ihugba, 2014).

From the result, heteroscedasticity and autocorrelation were a problem but the study used Huber–White standard errors to correct them. The adjusted R squared is 0.7641. This means that about 76% of the changes in energy consumption are explained by the explanatory variables that are included in the regression equation. This indicated that the overall goodness of fit was satisfactory.

5 Conclusions

This study set out to estimate empirically the effects of fiscal decentralization on energy consumption in Kenyan counties, 2013-2017. The finding of this study has established the critical role of decentralization in positively influencing electricity demand at the sub-national level through improved energy efficiency, rises in energy innovation and involving local actors in energy planning processes. This has been qualified by the ability of decentralization to provide necessary economic and financial resources, and able to bring energy resources closure to the end user, and increase efficiency in resource use. However, policymakers may need to obtain the optimal level of decentralization that fosters energy efficiency and demand. Excessive fiscal decentralization through tax increases will harm public support for sustainable energy programmes and policies. This study has further identified the importance of economic growth in explaining the increase of energy demand as attributed to an increase in disposable income of the local population.

From regression results, energy policies, strategies and resources should be directed at encouraging the decentralization of financial resources, administration and infrastructure planning processes. Borrowing from fiscal decentralization theories the energy sector needs to decentralize electricity and energy resources. A decentralized energy system is characterized by locating energy production facilities closer to the site of energy demand to grow connectivity, consumption, energy use efficiency and reduce poverty. This will involve deploying energy sources locally as well as expanding electricity services to remote areas at affordable costs. Decentralized power systems seek to put power sources closer to the end user and encourage consumer sovereignty. End users are spread across the county including the most remote areas, so sourcing energy generation in a similar decentralized manner can reduce transmission and distribution inefficiencies and related environmental and economic costs. However, policymakers may need to find the optimal level of decentralization that fosters energy innovations, grow connectivity, accelerates the race to decentralization, improves energy demand and have local public support.

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