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Energy Provision and Economic Growth in Emerging Economy - South Africa

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ABSTRACT

This paper presents an empirical analysis of public energy access imperative on economic growth in South Africa. The paper is motivated by current paucity of research regarding rural energy provision and economic growth in South Africa. Hence, this research adds a nuanced contribution to the literature by examining the relationship between rural and urban energy provision and economic growth in South Africa. Time series data on public electricity provision for South Africa were collected from 1998 to 2017 from the World Bank economic indicators' data archive. After testing for unit root, a cointegration regression was conducted. Results from the statistical analysis indicate a cointegration relationship between urban and rural energy provision and economic growth in South Africa. This relationship is positive and significant – indicating that increased energy access for urban and rural dwellers is a veritable tool for stimulating economic growth. The paper's finding is germane for public policy makers in charge of public energy provision. The paper highlights the need for improved public energy provision to rural communities. Further research is needed to examine the role of rural energy provision on the growth of informal economy in South Africa.

Keywords: Public Energy Provision, Economic Growth, Urban Energy Access, Rural Energy Access, South Africa, Energy Provision
JEL Classifications: O1, O2, H4

1. INTRODUCTION

Public investments and infrastructure provision are recognized as a veritable avenue for economic growth (Hauptman, 2018; Yilmaz, 2018; Ott and Mihaljek, 2018). One of such public investments is the investment in public energy and its accessibility to both rural and urban dwellers (McCollum et al., 2018). Experts highlight the importance of effective public budgets with symmetry of information in enhancing important public investments (Ott et al., 2019).This paper provides an empirical evaluation of the extent to which public energy provision relates to economic growth in South Africa. The paper is significant given that the South African government is committed to economic growth strategy that accommodates the economic and social welfare of its citizens (Horner, 2016). Prior research evidence suggests that public electricity usage plays a vital role in enhancing economic growth (Ozturk et al., 2010; Tsani, 2010). However, research which examines public energy provision with a slant on the rural energy provision and economic growth is not very common in South Africa.

The paper is therefore motivated by current scantiness of research that focuses on a combined examination of both urban and rural public energy provision and economic growth in South Africa. This research contributes to the literature by examining phenomenon within the South African context. Accordingly, the objective of this paper is to examine whether public energy provision to urban and rural areas does have a relationship with economic growth.

The rest of the paper proceeds as follows. After this introduction, the next section if the paper presents the literature review. Thereafter, the subsequent section discusses the methodology and presents the data analysis and discussions. The last section is the conclusion.

2. LITERATURE REVIEW

Ozturk et al. (2010) applied a panel data of energy usage compared with gross domestic product as a proxy for economic growth for fifty one countries. They classified the countries into three categories of income namely low, middle and upper income countries. Applying the Pedroni cointegration approach of panel data; they find that in all the income grouping of countries, energy usage has a cointegration with economic growth variable. Furthermore, using the panel data causality analysis, the results show a long run causality, which is unidirectional from the GDP to energy usage on the lower income countries, the same result for middle income countries show a bidirectional relationship. However, they found given that the cointegration result for B is <1, they conclude that the relationship between energy usage and economic growth is weak. In a closely related research, Tsani (2010) examine the causality relationship between energy usage and economic growth in Greece. He applied a different method by examining energy consumption at two aggregate levels namely disaggregated and aggregated levels of energy usage. For the aggregated level of energy usage, the empirical finding indicates a unidirectional relationship from energy usage to economic growth (represented by real GDP), however at the disaggregated level, the result indicates a bidirectional causal relationship between industrial and household energy usage and economic growth (Tsani, 2010).

Taking a different look at energy usage, other researchers have instead analysed energy usage and economic growth using a per capita approach; for example, per capital usage of energy was analysed against per capita gross domestic product to see how the two variables cointegrate and their likely causality using data from Tunisia (Belloumi, 2009). Using a Vector Error Correction Model of Granger Causality and cointegration, their analysis found that the two variables have a cointegration of one vector and also found a long-run bidirectional causal relationship between per capita energy usage and per capita gross domestic product; they highlight that the factor causing the long run relationship is the error correction term in the two variables. However, they find that in short run, there is a unidirectional causality from energy to economic growth (Belloumi, 2009).

A different dimension of study by Tugcu and Topcu (2018) divide energy into three categories, namely total energy usage, renewable energy usage and non-renewable energy usage in the G7 industrialised nations by applying the nonlinear approach of autoregressive lag combined with the asymmetric genre of causality techniques. They find that the usage of total energy proves to be asymmetrically related to economic growth in the long run, but application of other categorizations produce volatile results. In another similar research, the effect of renewable and non-renewable energy usage was evaluated using a panel data from 29 OECD countries (Gozgor et al., 2018). They applied the statistical technique of panel autoregressive distribution lag (ARDL) followed by a triangulation with the panel quantile regression (PQR) analysis. The results showed a positive relationship between renewable, non-renewable energy consumption and economic growth in the OECD countries (Gozgor et al., 2018). The volatile results reported in Tugcu and Topcu (2018) was not found in Gozgor et al. (2018) possibly due to slight methodological difference in asymmetric and symmetric causality techniques applied in Tugcu and Topcu (2018). However the two results are similar in terms of the relationship with total energy usage. In their research, Adams et al. (2018) examined how two energy types namely renewable and non-renewable energy affect economic growth; they also add the mediating effect of regime type in their model in order to determine the effect of regime type on economic growth jointly with renewable and non-renewable energy effects. They applied the cointegration statistics and error correction model to analyse the heterogeneous panel data. Their results found a long run positive relationship between the variables. However, they note that non-renewable energy has a greater positive effect on economic growth than renewable energy. This is because, they found that a 10% increase in non-renewable energy leads to a 2.11% increase in economic growth, but the same 10% increase in renewable energy only leads to a 0.27 increase in economic growth(Adams et al., 2018). This brings attention to an important energy consumption strand, which is that non-renewable energy seems to be more closer to the greater majority of citizens chiefly because of the cost involvement in renewable energy (Karekezi, 2002).

Kebede et al. (2010) evaluated the link between energy usage and economic growth in 20 Sub-Saharan Africa using a cross-sectional time series data of 25 years. They divided energy into wood fuel usage, petroleum demand and electricity usage. Results from regression analysis show that energy usage is positively related to GDP growth and agricultural growth. Furthermore, they found an inverse relationship between petroleum price, demand for petroleum and industrial growth. They also highlight that differences in regional GDP growth is related to differences in energy usage; this attests to the importance of energy availability and usage on economic growth. In conclusion Kebede et al. (2010) emphasize the need to diversify sources of energy to carter for different sectorial energy needs. Richard (2012) examined the asymmetric relationship between energy consumption per capita and economic growth represented by real GDP per capita in twelve Sub-Saharan Africa for the period of 1971-2008 using a hidden cointegration technique. Their results show that policies on energy conservation can have adverse effect on economic growth in Sub-Saharan African countries. Mohammed et al. (2013) provides a supportive review findings that low level of electricity access contributes significantly to slow development in Sub-Saharan Africa. Ouédraogo (2010) examined the causal direction between electricity usage and economic growth in Burkina Faso for the years 1968-2003. Results from cointegration and causality tests show that electricity consumption in Burkina Faso has a significant causal relationship with economic growth and capital formation, which enhances improved investment. They also found an existence of bidirectional causality between electricity consumption and real GDP.

A related research conducted with data from Turkey and Italy applied a frequency domain causality technique found a causal relationship running from electricity to economic growth in Turkey and Italy (Sicai and Senturk, 2016). However, using the panel-vector autoregression and causality analysis data from South and South-East Asian countries indicates a bidirectional causal relationship for energy usage and economic growth (Rezitis and Ahammad, 2015).

The foregoing indicates the importance of energy in economic development. The following section evaluates the data relating to South Africa, which focusses uniquely on public energy provision and economic growth.

3. METHOD AND FINDINGS

In an attempt to determine whether a relationship exists between electricity provision and economic growth in South Africa, the research mimicked previous researchers' application of a quantitative approach. A time series data for 1998-2017 were collected from the World Bank archives of economic indicators (gross domestic product and electricity access) for South Africa (World Bank, 2019). The Granger co-integration approach was used to determine the relationship between the independent variables (urban and rural energy access) and the dependent variable (economic growth) after testing for the likelihood of unit root existence. According to experts' recommendation, the usage of a time series requires non-existence of unit root and/or the existence of stationary data (Duke University, 2019). The application of cointegartion analysis is common in previous studies regarding energy and economic growth (Ozturk et al., 2010; Binh, 2011; Phrakhruopatnontakitti and Jermsittiparsert, 2020; Tang et al., 2016). This paper adds to these previous papers by focusing on an emerging economy South Africa and does this by looking at energy access in two different areas – the rural area energy access and the urban area energy access, this demarcation is not very common in the previous research and therefore adds a methodological nuance to existing research.

Regression Model

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + e$$

Where: Y = Economic growth (GDP); X_1 = Urban electricity access; X_2 = Rural electricity access

β_0 = Intercept; $\beta_1 - \beta_2$ = Regression coefficients; e = Error term.

3.1. Results

In compliance with the recommendation by Duke University (2019), before proceeding to the analysis of possible co-integration, the paper tested for the existence of unit roots or non-stationarity, which gives the impetus to progress to the co-integration regression. From the results in Tables 1-3, it can be seen that the time series variables have no unit root, this is because the null hypothesis for the Dickey-Fuller test unit root test is stated as a = 1 (which is that unit root exists) or that the variable is non-stationary. The associated P-values for unit root in GDP (the dependent variable) shows a $P < 0.04$, which is lower than the research alpha of 0.05. Therefore, the null hypothesis for unit root in GDP is rejected to show that the GDP variable in this paper has no unit root and is stationary.

Similarly, the test for unit roots in the independent variables (urban access and rural access to electricity) show a P-value of 0.19 and 0.15 for urban access and rural access respectively. Since these P-values for the independent variables are both lower than the alpha value of 0.05; the unit root null hypothesis for urban and rural access to electricity, which indicates existence of unit root are rejected to show that there is no unit root in the urban and rural access to electricity variables and hence these independent variables are stationary. Additionally, the unit-root null hypothesis for residuals or (uhat) (Table 4) is also rejected, which shows that the residuals or (uhat) are stationary.

Therefore, the stationarity of the time series variables provided impetus to test for a relationship between electricity access and economic growth using the cointegration relationship. From the results in Table 5, it can be seen that the t-ratio for urban public energy is 2.577 with a P-value of 0.0196, which is less than 0.05 alpha value. In the same vein, the t-ratio for rural public energy is 2.440 with a P-value of 0.0259. This therefore signifies that a cointegration relationship exists between electricity access and economic growth (GDP). A finding that is worth noting from this is that, although both independent variables show a relationship, but a closer look at the urban electricity access variable indicates it has a stronger P-value (0.01) better than the rural electricity

Table 1: Testing for a unit root in GDP

Augmented Dickey-Fuller test for GDP
Including one lag of (1−L)GDP
Sample size 18
Unit-root null hypothesis: a=1
Test with constant
Model: (1−L)y = b0 + (a−1)*y(−1) + ... + e
1st-order autocorrelation coeff. for e: 0.136
Estimated value of (a−1): −0.146061
Test statistic: tau_c(1)=−1.64863
Asymptotic P-value 0.04576

Table 2: Testing for a unit root in UAccElect

Augmented Dickey-Fuller test for UAccElect
Including one lag of (1−L)UAccElect
Sample size 18
Unit-root null hypothesis: a=1
Test with constant
Model: (1−L)y = b0 + (a−1)*y(−1) + ... + e
1st-order autocorrelation coeff. for e: −0.080
Estimated value of (a−1): −0.02362
Test statistic: tau_c(1) = −0.387116
Asymptotic P-value 0.01909

Table 3: Testing for a unit root in RAccElect

Augmented Dickey-Fuller test for RAccElect
Including one lag of (1−L)RAccElect
Sample size 18
Unit-root null hypothesis: a=1
test with constant
Model: (1−L)y = b0 + (a−1)*y(−1) + ... + e
1st-order autocorrelation coeff. for e: −0.008
Estimated value of (a−1): −0.295232
Test statistic: tau_c(1) = −2.35072
Asymptotic P-value 0.01561

Table 4: Testing for a unit root in uhat

Augmented Dickey-Fuller test for uhat
Including one lag of (1−L)uhat
Sample size 18
Unit-root null hypothesis: a=1
Model: (1−L)y = b0 + (a−1)*y(−1) + ... + e
1st-order autocorrelation coeff. for e: −0.010
Estimated value of (a−1): −0.416388
Test statistic: tau_c(3)=−2.42132
Asymptotic P-value 0.04525

Table 5: Co-integrating regression

Cointegrating regression				
OLS, using observations 1998-2017 (t=20)				
Dependent variable: GDP				
	coefficient	**std. error**	**t-ratio**	**P-value**
const	−25507.2	8600.71	−2.966	0.0087 ***
UAccElect	288.310	111.865	2.577	0.0196 **
RAccElect	76.2526	31.2480	2.440	0.0259 **
Mean dependent var		5246.838	S.D. dependent var	1685.936
Sum squared resid		14709524	S.E. of regression	930.1968
R-squared		0.727628	Adjusted R-squared	0.695584
Log-likelihood		−163.4615	Akaike criterion	332.9230
Schwarz criterion		335.9102	Hannan-Quinn	333.5061
rho		0.635442	Durbin-Watson	2.016766

access with a P-value of 0.02. This implies that urban electricity access has a higher propensity to influence economic growth in an emerging economy South Africa. This is visible in the regression co-efficient, which shows that a unit increase in urban access to electricity will result to a 288.3 unit increase in economic growth (GDP) and that a unit increase in rural electricity access will result to a 76.2 unit increase in economic growth (GDP). In Table 5, the Durbin Watson statistics of 2.01 indicates absence of autocorrelations and the R-squared of 72% shows a fairly good fit between the independent variables and the dependent variable in the regression line. This fit accentuates the low p-values which indicate that electricity access does influence economic growth in South Africa. In Table 5, the model selection parameters namely the Schwarz criterion, the Hannan-Quinn and the Akaike criterion are all in the range of 300; further research that may use South African data should therefore compare these values against the values obtained by using another method of analysis and be able to selected the best model based on the method that offers the lowest of Schwarz criterion, the Hannan-Quinn and the Akaike criterion.

The finding from this research is consistent with the findings of similar research that were conducted in other countries, which found a relationship between energy access and economic growth (Ozturk et al., 2010; Ozturk, 2010; Mohammed et al., 2013; Gozgor et al., 2018; Kebede et al., 2010). However, the uniqueness of this present research finding is its concentration on one emerging economy – South Africa and with a unique result that emerged from the demarcation between rural energy access and urban energy access, which suggests that urban energy is more influential on the GDP than rural energy access. This finding calls for more study using other emerging countries.

4. CONCLUSION

The relationship between energy usage and economic growth has been widely studied in other countries. This paper contributes in a unique way by studying the relationship between government provision of energy to rural and urban dwellers and economic growth in South Africa. A cointegration regression was used to analyse the data collected from 1998 to 2017. Results from the analysis showed a positive and significant relationship between public energy provision to both urban and rural dwellers and economic growth in South Africa. This implies that, much as urban energy provision is important, rural energy provision is also vitally important for economic growth as this carters for rural dwellers who need energy to engage in small scale business activities.

The paper's finding is germane for public policy makers in charge of energy provision. The paper recommends the need for an enhanced energy policy, which supports an improved public energy access to rural communities in South Africa. Further research is recommended to examine the role of rural energy provision on the growth of informal economy in South Africa and toward the achievement of Agenda 2030 poverty reduction goal.

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