Vol. 1(1), 14-20

Journal of Energy & Environmental Policy Options

The Nexus of Electricity, Economy and Capital: A Case Study of Botswana

Francis Nathan Okurut[a]
Strike Mbulawa[b]

Abstract
This study undertakes an examination of the correlation between electricity consumption and real gross domestic product in Botswana, a nation renowned as the world's leading diamond producer. The research adopts a trivariate approach encompassing capital formation within the analytical framework, spanning the timeframe from 1980 to 2008. The investigative methodologies encompass the Zivot and Andrews (1992) unit roots test, the bound test for cointegration, and the Granger causality test. The findings of the study reveal a unidirectional causality from electricity consumption to real income, aligning with previous research such as the work of Altinay and Karagol (2005). The long-term estimations further substantiate these Granger causality tests by demonstrating a positive association between electricity consumption and real income over an extended period. Additionally, the results indicate a unidirectional causality from capital formation to real income. The implications of these findings suggest that Botswana, being a nation heavily reliant on energy, will witness the impact of its capital formation on the economy being partially contingent on the availability of adequate electricity resources. This underscores the critical role of sustained and robust energy infrastructure in shaping the economic performance of Botswana.
Keywords: Economic growth, Electricity consumption
JEL Codes: C32, O55

1. INTRODUCTION

Electricity plays a pivotal role in contemporary society, serving as a cornerstone for advancements in various sectors such as transportation, manufacturing, mining, and communication. Its significance transcends mere functionality; rather, it stands as a linchpin for both economic growth and an elevated quality of life. This is underscored by its role in enhancing the efficiency of capital, labor, and other production factors. Additionally, the heightened consumption of energy, particularly in the form of commercial energy like electricity, is indicative of a nation's elevated economic status, as posited by Jumbe (2004). This intrinsic connection between electricity and a nation's economic standing has prompted scholars to delve into comprehensive investigations of this relationship across different countries. Originating from the groundbreaking research of Kraft and Kraft (1978), subsequent scholars have predominantly employed causality tests to scrutinize the intricate interplay between electricity consumption and economic development. As time has progressed, the evolution of time series techniques coupled with the availability of extensive electricity consumption data has further spurred research in this domain, as evidenced by studies conducted by Tang (2008), Altinay and Karagol (2005), Shiu and Lam (2004), and Narayan and Singh (2007).

In recent scholarly endeavors focusing on African countries, notable authors such as Akinlo (2009), Odhiambo (2009), Jumbe (2004), Wolde-Rufael (2006), and Squalli (2007) have overlooked Botswana, the world's largest diamond producer. Remarkably absent from these investigations is Botswana, despite its consistent electricity deficit, which peaked at 1174.83 Kilo-watts (KWh) per capita in 2008. This deficit was a consequence of diminishing electricity generation coupled with a persistent rise in electricity consumption. Noteworthy is the fact that Botswana heavily relies on imported electricity, accounting for 80% of its total consumption (Jefferis, 2008). Moreover, the rural access to electricity in Botswana stood at a mere 40.75% in 2008. In response to these challenging conditions, the Government of Botswana initiated the "Vision-2016 plan," with a paramount objective of achieving 100% electrification. This ambitious goal aligns with broader developmental objectives, encompassing enhanced access to education, healthcare, and employment opportunities for the rural and disadvantaged populations. Recognizing capital investment as a fundamental catalyst for realizing this vision, the Botswana Power Corporation took decisive steps in 2007 and 2008, investing 343.4 million pula and 17.3 million pula, respectively, in bolstering the country's electricity infrastructure (Lekaukau, 2007; Rakhudu, 2008).

Nevertheless, Akinlo's (2009) contention raises concerns about potential omitted variable bias in the context of studies focusing on Botswana. Additionally, existing research on African countries has largely neglected the consideration of structural breaks in unit root tests, an aspect highlighted by the influential work of Perron (1989), which demonstrated that structural changes can significantly diminish the power of unit root tests. The failure to account for such breaks introduces bias, compromising the ability to reject a false unit root null hypothesis. Consequently, this bias, originating

[a] Kyambogo University, Kampala, Uganda
[b] Faculty of Business and Accountancy, Botho University, Gaborone, Botswana

from unit root tests, has ripple effects on the inferences drawn from subsequent cointegration and causality tests. In light of these considerations, this study aims to scrutinize the intricate relationship between electricity consumption and real gross domestic product in Botswana over the period 1980-2008. A key feature of this investigation is the incorporation of capital investment within a trivariate system. Furthermore, the study seeks to adopt the Zivot and Andrews (1992) method to endogenously identify structural breaks while conducting unit root tests. The subsequent sections of the paper are organized as follows: Section 2 provides an overview of electric power in Botswana, and Section 3 presents a concise review of literature related to energy consumption and economic growth. Section 4 outlines the methodology employed in the study, followed by Section 5, which presents the empirical findings. The concluding section summarizes the study's key insights.

The data presented from various sources reveals a declining trend in electricity generation over the years in Botswana. As depicted in Fig. 1, net electricity generation per capita witnessed a decrease from 760.004 KWh in 1992 to 542.6519 KWh in 2001, further plummeting to 308.674 KWh in 2008. A contributing factor to this decline is the gradual reduction in supply from the Botswana Power Corporation (BPC), presumably indicative of the aging power stations and the ensuing maintenance requirements (Jefferis, 2008). Conversely, electricity consumption has exhibited a consistent upward trajectory. In 1992, the per capita electricity consumption was 762.687 KWh, escalating to 1156.209 KWh in 2001, and reaching 1483.508 KWh in 2008. This surge in consumption has exacerbated the electricity deficit over the years, recording figures of 2.682 KWh per capita in 1992, 613.557 KWh per capita in 2001, and 1174.83 KWh per capita in 2008. To address this issue, the government implemented an accelerated rural electrification program, connecting 72 villages between September 1999 and December 2001. Additionally, in the financial year 2006/07, funds were allocated for the electrification of villages. Presently, the rural electrification plan is being addressed through the implementation of two main projects: the 100 Villages and the 30 Villages Electrification Projects.

The efficacy of these efforts will be rendered futile if the targeted variable, electricity, lacks any discernible correlation or positive impact on the economy. This correlation is pivotal in determining whether economic growth is contingent upon energy consumption or vice versa. Causality running from real gross domestic product to electricity suggests that Botswana's economic growth is not solely reliant on energy, whereas causality running from electricity consumption to economic growth implies a dependence of economic growth on energy consumption. Consequently, employing econometric methods becomes imperative to rigorously examine the relationship between electricity and RGDP in Botswana. To lay the groundwork for this analysis, we will first review pertinent existing literature on this subject matter.

2. LITERATURE REVIEW

The exploration of the relationship between energy consumption and economic growth traces its roots back to the pioneering work of Kraft and Kraft (1978) in the context of the USA. For a comprehensive survey of the literature on the energy-growth nexus, one can refer to Ozturk (2010). Subsequent research has witnessed a specific focus on the intricate connection between electricity consumption and economic development by various scholars, including Ghosh (2002), Ho and Siu (2007), Shiu and Lam (2004), and Narayan and Singh (2007). Despite yielding conflicting results, these studies share several commonalities. A conspicuous similarity lies in the widespread use of causality tests to probe the relationship between electricity consumption and economic development. This practice is evident not only in single-country investigations but also in multi-country studies, as demonstrated by the works of Narayan and Prasad (2008), Narayan and Smyth (2009), Yoo (2006), and Chen, Kuo, and Chen (2007). Another shared characteristic is the interpretation of unidirectional causality. When causality runs solely from gross domestic product to energy consumption, it signifies that a country is not exclusively reliant on energy for its economic growth. Consequently, policies aimed at energy conservation can be implemented with insignificant or no adverse effects on economic growth. Conversely, when unidirectional causality runs from real gross domestic product to electricity consumption, it indicates that a country is not entirely dependent on energy for its economic growth. In such cases, energy conservation policies can be implemented with modest or no undesirable effects on economic growth (Narayan and Singh, 2007).

In Jumbe's (2004) investigation of the relationship between electricity consumption and various economic indicators, including overall gross domestic product, agricultural gross domestic product, and non-agricultural gross domestic product, utilizing Malawi data spanning from 1970 to 1999, noteworthy insights emerge. Employing residual-based cointegration, the results suggest that electricity consumption is cointegrated with both gross domestic product and non-agricultural gross domestic product. However, such cointegration is not observed with agricultural gross domestic product. Delving into the Granger causality tests, the findings reveal bidirectional causality between electricity consumption and overall gross domestic product. In contrast, a unidirectional causality is observed, specifically running from non-agricultural gross domestic product to electricity consumption. Furthermore, Jumbe (2004) extends the analysis to examine the elasticity of the variables. The results indicate that the impact of electricity consumption is only significant in the long run. This nuanced understanding of causality and elasticity provides valuable insights into the complex dynamics between electricity consumption and different facets of the economy, contributing to a more comprehensive understanding of the relationship in the Malawian context during the specified period.

In the realm of multi-country studies focusing on Africa, Wolde-Rufael (2006) undertakes an extensive analysis encompassing 17 African countries during the period 1971-2001. The study specifically explores the long-run and causal relationship between electricity consumption per capita and real gross domestic product per capita. Employing the bound test for cointegration and incorporating the causality test proposed by Toda and Yamamoto (1995), Wolde-Rufael's (2006) findings illuminate diverse causal dynamics across the studied nations. The outcomes reveal unidirectional causality flowing from electricity consumption per capita to real gross domestic product per capita for Benin, Congo DR, and Tunisia. Conversely, the results suggest unidirectional causality from real gross domestic product per capita to electricity consumption per capita for Cameroon, Ghana, Nigeria, Senegal, Zambia, and Zimbabwe. The study reports bidirectional causality for Egypt, Gabon, and Morocco, while observing no significant causality for Algeria, Congo Republic, Kenya, Sudan, and South Africa. Another notable multi-country study, conducted by Squalli (2007), delves into the interplay between economic growth and electricity consumption, also including African countries. In contrast to Wolde-Rufael (2006), Squalli (2007) observes unidirectional causality from economic growth to electricity consumption for Algeria, while noting a bidirectional relationship between economic growth and electricity consumption for Nigeria. These nuanced findings contribute to the understanding of the complex relationships between electricity consumption and economic growth across diverse African nations.

3. THE MODEL

In the exploration of the association between electricity consumption and output growth, this study adopts a neo-classical one-sector aggregate production model as proposed by Ghali and El-Sakka (2004). In this model, capital, labor, and energy (in this context, electricity) are considered distinct inputs, suggesting the following relationship:

$GDPit=F(LAit, CAit, ELit)$

Where *GDP* is the aggregate output of real GDP; *CA* is the capital stock; *LA* is the level of employment; *EL is* total electricity consumption, and the subscript *t* denotes the time period. The study computes per capita form of the variables by dividing through by *LA* and then taking the logarithmic form.

This study utilizes annual data spanning the period from 1980 to 2008. The primary data sources include real gross domestic product and gross capital formation data from the World Bank's World Development Indicators 2010. The provided annual data for real gross domestic product per capita and gross capital formation are denominated in US dollars, with the base year set at 2000 (100). To facilitate per capita analysis, the gross capital formation figures are divided by the corresponding population figures from WDI, resulting in per capita values. In alignment with methodologies employed by previous studies, such as Narayan and Smyth (2008), the variable capital formation is utilized as a proxy for the stock of physical capital. Additionally, the data on electricity consumption is obtained from the Energy Information Administration website. To adjust for population differences, this figure is divided by the corresponding population figures from WDI, yielding electricity consumption per capita expressed in kilowatt-hours (KWh). All variables in the study are transformed into natural logarithmic form, facilitating econometric analysis and ensuring robustness in modelling the relationship between these variables over the specified period.

4. UNIT ROOT TEST

Traditionally, unit root tests have been explored through the Augmented Dickey-Fuller test (ADF), introduced by Said and Dickey (1984), and the Phillip and Perron (PP) test (Phillip and Perron, 1988), both designed to control for serial correlation. However, Perron (1989) demonstrated that the presence of structural change can significantly diminish the power of unit-root tests. To address this limitation, he proposed a unit root model that incorporates an exogenous structural break. Criticism of the exogenous structural break arises from its potential susceptibility to arbitrary date selection. In response to this concern, Zivot and Andrews (1992) presented a modification of Perron's (1989) original test by introducing the concept that the precise time of the structural break is unknown. Instead, they advocate for a data-dependent algorithm to substitute Perron's subjective procedure in determining break points. Zivot and Andrews (1992) developed three models for testing unit roots, providing a more robust approach to account for structural breaks in time series data.

5. ARDL Cointegration

Following the stationarity test, the study proceeds to the cointegration test, employing the bound tests of the autoregressive distributed lag approach, as articulated by Pesaran and Shin (1999) and extended by Pesaran, Shin, and Smith (2001). The selection of this technique is driven by several considerations. In contrast to the conventional Johansen cointegration method, which employs a system of equations to estimate long-run relationships, ARDL utilizes a single reduced-form equation. This characteristic streamlines the estimation process. Additionally, ARDL does not necessitate pre-testing variables, allowing implementation regardless of whether the underlying variables are I(0), I(1), or fractionally integrated. This flexibility significantly reduces the complexity of establishing the order of integration among the variables. Another advantage lies in the simultaneous estimation of both long and short-run parameters, eliminating the challenge associated with the Engle-Granger method, where testing hypotheses on the estimated coefficients in the long run is not feasible. Procedurally, ARDL involves investigating the existence of a long-run relationship through the use of unrestricted error correction models (UECMs). This approach enhances the efficiency and robustness of the cointegration analysis, providing a comprehensive understanding of the relationships among the variables under consideration.

6. CAUSALITY TEST

In 1988, Granger integrated the concept of cointegration into the examination of causality. With cointegrated variables, Granger asserted that causal relationships among variables can be effectively investigated within the framework of the Error Correction Model. The short-run dynamics are encapsulated by the individual coefficients of the lagged terms, while the error correction term encapsulates information about long-run causality. In this context, the significance of each explanatory variable lag indicates short-run causality. Conversely, a negative and statistically significant error correction term is interpreted as indicative of long-run causality. Therefore, the ECM provides a comprehensive framework for analyzing both short-run and long-run causality relationships between cointegrated variables.

7. DIAGNOSTIC TEST

The study employs various diagnostic tests to assess the robustness and validity of the estimated model. The Breusch-Godfrey test is utilized to examine the null hypothesis of no autocorrelation, offering advantages over the Durbin-Watson test, which tends to lose power in the presence of a lagged dependent variable. For assessing normality, the study adopts the Jarque and Bera tests (Jarque and Bera, 1980), which encompass assessments of skewness and kurtosis. This test, being a weighted average of squared sample moments, is distributed as Chi-Squared with two degrees of freedom under the null hypothesis. To test the functional form of the equation, the study employs the Ramsey RESET test (Ramsey, 1969), which examines whether additional terms of the regressor variables are significant in the auxiliary regression. The significance of these additional variables serves as an indicator of model misspecification. Additionally, diagnostic tests include the Autoregressive Conditional Heteroscedasticity test to detect heteroscedasticity. These comprehensive diagnostic assessments enhance the reliability and validity of the model, ensuring that potential issues such as autocorrelation, normality, and functional form are adequately addressed. To assess the stability of parameters and regressions, the study employs the Brown, Durbin, and Evans (1975) tests, commonly referred to as cumulative sum and cumulative sum of squares tests. These tests rely on recursive regression residuals. The CUSUM and CUSUMSQ statistics are updated recursively and plotted against the model's break points. The stability of coefficients in a given regression is indicated when the plots of these statistics fall within the critical bounds of 5% significance. In general, CUSUM and CUSUMSQ tests are conducted through graphical representation. This approach offers a visual tool for assessing the stability of model parameters over time, providing insights into potential structural breaks or changes in the relationships captured by the regression model.

8. RESULTS AND FINDINGS

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for GDP, capital, and electricity are presented in Table 1. Both the ADF and PP tests yield consistent outcomes. At the level, the null hypothesis that the variables are nonstationary cannot be rejected for any of the series. However, upon differencing the data for the first time, the null hypothesis that the series contain a unit root is rejected for all variables, with GDP reaching significance at the 10% level. This implies that GDP, capital, and electricity are integrated of order one I(1). It is noteworthy, though, that these results may be subject to validity concerns due to potential structural breaks. Consequently, the study proceeds with a methodology that explicitly considers the presence of structural breaks in the time series data.

Table 1: ADF and PP tests for unit roots

Variables	Levels		First differences	
	ADF	PP	ADF	PP
GDP	-1.980	-2.321	-2.742*	-2.754*
CA	-0.907	-0.471	-4.068***	-4.043***
EL	-0.971	-1.700	-4.201***	-8.381***

The results of the Zivot and Andrews (1992) model A and model B unit root tests, accounting for one unit root in the presence of structural breaks, are presented in Table 2. Interestingly, the findings align with the unit root tests conducted without considering structural breaks. Consequently, we are unable to reject the null hypothesis of a unit root at the 10% level or better, reinforcing the conclusion that the series are at least integrated of order one (I(1)). The study identifies break dates for GDP, noting 1987 and 1989 for the intercept and slope, respectively. For capital, break dates are observed in 1988 and 1993 for the intercept and slope, respectively. Lastly, for electricity, break dates for the intercept and slope are 1989 and 1992, respectively. Notably, these break periods correspond to the time when the Southern African Development Community was formed on August 17, 1992. This development holds particular significance as South Africa, the largest economy in Africa and Botswana's primary electricity supplier, played a pivotal role in the establishment of the Southern African Development Community.

The results of the bounds test for cointegration, along with critical values provided by Pesaran and Pesaran (1997), are presented in Table 3. The bounds test indicates the presence of a cointegration relationship. Specifically, at a 10% significance level, we reject the null hypothesis of no cointegration when GDP is the dependent variable. However, when capital and electricity are the dependent variables, no cointegration is observed. The identification of a cointegrating relationship among GDP, capital, and electricity implies the existence of Granger causality in at least one direction. However, it does not provide information regarding the direction of temporal causality among these variables. The outcome underscores the interconnectedness of these economic factors and the potential influence they may exert on each other over time.

Table 2: Zivot–Andrews test for unit roots

Variables	Model A		Model B	
	Z-A	Break	Z-A	Break
GDP	-4.686	1987	-4.141	1989
CA	-4.726	1988	-4.001	1993
EL	-4.795	1989	-3.566	1992

Table 3: Bounds tests for cointegration

Dependent Variable	F-Statistics	10% I(0)	10% I(1)	5% I(0)	5% I(1)	1 I %(0)	1% I(1)
GDP	4.634*	3.182	4.126	3.793	4.855	5.288	6.309
CA	2.210	3.182	4.126	3.793	4.855	5.288	6.309
EL	1.742	3.182	4.126	3.793	4.855	5.288	6.309

Table 4 presents an analysis of short-run and long-run Granger causality, along with the long-run estimates. The study identifies long-run causality from electricity to GDP, with no feedback from GDP. As per the interpretation provided by Nayaran and Prasad (2007), this suggests that a reduction in electricity consumption could lead to a decrease in income. The long-run estimates derived from the Autoregressive Distributed Lag model further support the Granger causality tests by indicating a positive and statistically significant association between electricity and GDP in the long run. To be specific, the results suggest that for every 1% increase in electricity, there is a 1.06% increase in GDP, significant at the 5% level. These findings carry significant implications for the Botswana economy, indicating a high dependence on energy. This aligns with expectations, considering Botswana's substantial electricity requirements, particularly in the context of diamond mining. The results underscore the pivotal role of energy, particularly electricity, in driving economic activity in the country.

Table 4: Causality and long run estimates

Variable	Granger causality results				Long run estimates		
	ΔGDP	ΔCA	ΔEL	ECT(-1)	GDP	CA	EL
ΔGDP	-	6.939**	1.778	-1.767*	-	-0.338	1.063**
ΔCAL	8.272**	-	0.878	-	-	-	-
ΔEL	2.030	0.542	-	-	-	-	-

Table 5: Diagnostics tests

Test Statistics	LM test	F-test
Serial Correlation	CHSQ(1) = 0.064 [0.800]	F (1, 15) = 0.037 [0.850]
Functional Form	CHSQ(1) = 0.233 [0.630]	F(1, 15) = 0.135 [0.718]
Normality	CHSQ(2) = 1.276 [0.528]	N/A
Heteroscedasticity	CHSQ(1) = 1.784 [0.182]	F(1, 24) = 1.768 [0.196]

The absence of feedback from GDP in the Granger causality analysis may indicate a potential misalignment in the focus of the economy on the electricity sector in Botswana. In simpler terms, while regular growth in electricity supply is crucial for boosting economic output, additional income or economic growth does not seem to translate into sufficient capital investment in the electricity sector, thereby failing to stimulate additional electricity consumption. This finding is further corroborated by the results regarding capital, which demonstrate no causality flowing from capital to electricity. Moreover, the study observes that in the long run, capital Granger causes GDP with a short-run feedback. The long-run estimates reveal that capital has a negative and statistically insignificant impact on GDP, suggesting a nuanced relationship between capital and electricity. Consequently, we interpret this to mean that capital formation will have a more pronounced impact on the economy if there is sufficient and reliable electricity in the economy. The interconnectedness of these variables highlights the importance of aligning capital formation efforts with the availability and reliability of electricity to optimize their impact on economic growth in Botswana.

9. CONCLUSION

The study aims to explore the intricate relationship between electricity consumption per capita and real gross domestic product per capita in Botswana, incorporating capital formation within a trivariate system over the period 1980-2008. The selection of Botswana for this investigation is particularly noteworthy, as no prior research has been conducted on this topic in the context of the largest diamond-producing country. This choice is prompted by Botswana's persistent electricity deficit and its substantial reliance on electricity from South Africa. In contrast to previous studies on Africa, the present research introduces a methodological innovation by incorporating structural breaks into the analysis. The Zivot and Andrews (1992) approach is employed to endogenously identify structural breaks, offering a more nuanced understanding of the underlying dynamics. This methodological refinement precedes the application of the bound test for cointegration and Granger causality tests, providing a comprehensive assessment of the relationships among the variables. Additionally, the study furnishes long-run estimates to enhance the interpretation of the findings. The results suggest the existence of long-run causality from electricity consumption to real gross domestic product, with no reciprocal feedback from real gross domestic product. The long-run estimates further affirm the Granger causality tests by revealing a positive and significant association between electricity consumption and real gross domestic product in the long run. This research contributes novel insights into the intricate dynamics between electricity consumption, capital formation, and economic output in Botswana, shedding light on the country's unique challenges and opportunities in the energy sector. In summary, the findings imply that Botswana exhibits a high dependency on energy, particularly electricity, which aligns with the economy's reliance on electricity for mining activities. Addressing and improving the electricity infrastructure could potentially enhance income generation in the country. Moreover, the results indicate a unidirectional causality from capital formation to real gross domestic product, with a negative and insignificant coefficient for capital formation in the long run. This suggests that capital formation's impact on the economy is contingent upon having a sufficient and reliable electricity supply. Additionally, the forecasting results raise concerns about the potential worsening of the electricity gap in Botswana if the current situation persists. Consequently, it becomes evident that an electricity policy emphasizing long-term supply security is crucial for fostering sustainable economic growth in the country. Addressing these challenges and optimizing the synergy between electricity supply and economic activities will be essential for Botswana's overall economic development. In light of these findings, we strongly recommend that authorities in Botswana prioritize and accelerate efforts to diversify electricity sources and enhance management strategies. Solar energy emerges as a promising and sustainable alternative, offering the added advantage of being more cost-effective when generated locally. Diversifying into solar energy can significantly reduce Botswana's reliance on external sources, particularly Eskom. Furthermore, in the realm of electricity management, expediting the privatization of the Botswana Power Corporation (BPC), particularly in the generation sector, is crucial. Allowing private generation companies to enter the electricity supply market in Botswana will not only attract much-needed private capital into the sector but will also stimulate healthy competition. This competitive environment can empower large consumers to choose their electricity supplier, fostering innovation and efficiency in the electricity supply market. In summary, a comprehensive approach that integrates solar energy diversification and the acceleration of BPC privatization, particularly in generation, will be instrumental in addressing the current electricity challenges in Botswana and promoting a more sustainable and competitive energy landscape.

REFERENCES

Altinay, G., Karagol, E. (2005). *Electricity Consumption and Economic Growth: Evidence from Turkey*. *Energy Economics* 27, 849-856.

Bowerman, B., O'Connell, R. (1979). *Time Series and Forecasting: An Applied Approach.* New York, Duxbury Press.

Brown, R., Durbin, J., Evans, J.M., (1975). Techniques for Testing the Constancy of Regression Relationships over Time. *Journal of the Royal Statistical Society* 37, 149-172.

Chen, S.T., Kuo, H.I., Chen, C.C. (2007). The Relationship between GDP And Electricity Consumption In 10 Asian Countries. *Energy Policy*, 35, 2611–2621.

Chow, G. (1960). *Tests of Equality between Sets of Coefficients in Two Linear Regressions. Econometrica* 28(3), 591-605.

Ghali, K.H., El-Sakka, M.I.T., (2004). Energy Use and Output Growth in Canada: A Multivariate Cointegration Analysis. *Energy Economics*, 26, 225-238.

Ghosh, S., (2002). Electricity Consumption and Economic Growth in India. *Energy Policy*, 30(2). 125-129.

Granger, C.W.J., (1988). Causality, Cointegration and Control. *Journal of Economic Dynamics and Control*, 12, 551-559.

Gujarati, D., (2003). *Basic Econometrics*. *Fourth edition*. McGraw Hill Publishing Company.

Ho, C.Y., Siu, K.W., (2007). A Dynamic Equilibrium of Electricity Consumption and GDP in Hong Kong: An Empirical Investigation. *Energy Policy*, 35(4), 2507-2513.

Jarque, C., Bera, A. (1980). Efficient Tests for Normality, Homoscedasticity and Serial Independence of Regression Residuals. *Economics Letters*, 6, 255-259.

Jefferis. K., (2008). *Summary of Economic Developments.* BIFM Economic Review 1st Quarter, 2008.

Johansen, S., Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration with Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics*, *52*, 169-210.

Jumbe, C.B.L., (2004). Cointegration and Causality between Electricity Consumption and GDP: Empirical Evidence from Malawi. *Energy Economics*, 26, 61-68.

Kraft, J., Kraft, A. (1978). On the relationship between energy and GNP. *Journal of Energy and Development,* 3, 401-403.

Lekaukau. C., (2007). *Board of Directors Chairman's Address.* Botswana Power Corporation Annual Report 2007, 11.

MFDP, (2003). *National Development Plan 9.* Ministry of Finance and Development Planning (Bostwana) Government Press. 2003.

MMEWR, (2003). *Preliminary Investigation on Electricity Supply Industry Restructuring.* Ministry of Minerals, Energy and Water Resources.

P.K., Prasad, A. (2008). Electricity Consumption-Real GDP Causality Nexus: Evidence from a Bootstrapped Causality Test for 30 OECD Countries. *Energy Policy* 36, 910-918.

Narayan, P.K., Singh, B. (2007). The Electricity Consumption and GDP Nexus for the Fiji Islands. *Energy Economics*, 29, 1141-1150.

Narayan, P.K., Smyth, R. (2005). Electricity Consumption, Employment and Real Income in Australia Evidence from Multivariate Granger Causality Tests. *Energy Policy* 33, 1109-1116.

Narayan, P.K., Smyth, R., (2008). Energy Consumption and Real GDP in G7 Countries: New Evidence from Panel Cointégration with Structural Breaks. *Energy Economics*, 30, 2331-2341.

Perron, P. (1989). The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica*, 57, 1361-1401.

Pesaran, M.H., and Shin, Y. (1999). Autoregressive distributed lag modelling approach to cointegration analysis, in: S.Strom (Ed.), Econometrics and Economics Theory: The Ragnar Frisch Centennial Symposium, chapter 11, Cambridge University Press.

Pesaran, M.H., Pesaran, B. (1997). Working with Microfit 4.0: Interactive Econometric Analysis. Oxford University Press, Oxford.

Pesaran, M.H., Shin, Y., Smith, R.J., (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics* 16, 289-326.

Phillips, P., Perron, P. (1988). Testing for a Unit Root in Time Series Regressions. *Biometrika,* 75, 335-346.

Rakhudu. E., (2008). *Board of Directors Chairman's Address.* Botswana Power Corporation Annual Report 2008, 14.

Ramsey, J., (1969). Tests for Specification Errors in Classical Linear Least Squares Regression Analysis. *Journal of the Royal Statistical Society,* 31(2), 350-371.

Said, E., Dickey, D. (1984). Testing for Unit Roots in Autoregressive Moving Average Models of Unknown Order. *Biometrika,* 71, 599-607.

Shiu, A., Lam, P.L. (2004). Electricity Consumption and Economic Growth in China. *Energy Policy* 32, 47-54.

Squalli, J., (2007). Electricity consumption and economic growth: bounds and causality analyses of OPEC members. *Energy Economics* 29, 1192-1205.

Tang, C.F., (2008). A Re-Examination of the Relationship between Electricity Consumption and Economic Growth in Malaysia. *Energy Policy,* 36(8), 3077-3085.

Toda, H., Yamamoto, T. (1995). Statistical Inferences in Vector Autoregressions with Possibly Integrated Processes. *Journal of Econometrics,* 66, 225-250.

Verbeek, M., (2004). *A Guide to Modern Econometrics Second Edition*. West Sussex, John Wiley Sussex.

Wolde-Rufael, Y., (2006). Electricity Consumption and Economic Growth: A Time Series Experience for 17 African Countries. *Energy Policy,* 34, 1106-1114.

Yoo, S., (2005). Electricity Consumption and Economic Growth: Evidence from Korea. *Energy Policy,* 33(12), 1627-1632.

Yoo, S., (2006). The Causal Relationship between Electricity Consumption and Economic Growth in ASEAN Countries. *Energy Policy*, 34, 3573-3582.

Zivot, E., Andrews, D. (1992). Further Evidence of the Great Crash, the Oil-Price Shock and the Unit-Root Hypothesis. *Journal of Business and Economic Statistics,* 10, 251-270.