



THE IMPACT OF ECONOMIC INFRASTRUCTURE ON LONG TERM ECONOMIC GROWTH IN BOTSWANA

Strike Mbulawa

Faculty of Business and Accountancy, Botho University, Gaborone, Botswana

smint50000@gmail.com or smbulawa2004@myway.com

Abstract: *The growth rate for the Botswana economy has slowed down in recent years. This has been explained by weak global demand in minerals, subdued commodity prices and persistent electricity supply problems. The government is making efforts to diversify the economy to tap from other sources of growth. The government has come with two initiatives to boost growth: increasing expenditure on roads and improved generation of electricity. Literature has failed to agree on the causal linkage between growth and infrastructure development. Previous studies employed different measures of infrastructure development and models resulting in conflicting findings. As a point of departure this study uses a log linear model and different measures of growth and infrastructure to examine the link between the two variables in the context of Botswana. Using vector error correction model and Ordinary Least Squares the study finds that long term economic growth is explained by both measures of infrastructure (electricity distribution and maintenance of roads). The impact of the former was more pronounced than the impact of the later. Evidence supports the infrastructure led growth hypothesis.*

Key words: Economic growth, Botswana, Infrastructure, Vector Error Correction Model

1. INTRODUCTION AND BACKGROUND

Botswana gained independence in 1966 from Britain the time at which the level of infrastructure development and economic growth were considered low. The country had only six kilometers of tarred or bitumen road which has increased to 6925km by the end of 2016 (Botswana statistics, 2016). The government has consistently allocated a huge portion of the



budget to infrastructure development. A slowdown in government expenditure on social and economic infrastructure was witnessed following the global financial and economic crisis in 2008/9. It is against this background that eradication of the backlog became a topical issue in the country's 2016 national budget. The backlog would be addressed by the implementation of the economic stimulus package (ESP). The road maintenance initiatives were expected to boast economic growth and also create employment opportunities. The Ministry of Minerals, Energy and Water Resources, under which rehabilitation of power stations and rural electrification falls in, received 23.1% of the development budget in 2016 which was second largest. This was followed by the Ministry of Transport and communication, housing construction of road and maintenance, which received the third largest at 9.5% of the budget (Matambo, 2016). The levels of expenditure that have been assigned towards the improvement of infrastructure are an indication of the commitment of driving growth. The country is now classified under the upper middle income countries from being one of the poorest in Africa. Botswana has enjoyed a sustained positive economic growth (Figure 1) over the last decade and in 2015 the economy contracted by about 0.3% as compared to the 2014 levels. The economy is expected to grow by about 3.5% and 4.1% respectively in 2016 and 2017. The revenues from the mining sector are expected to drive the expansion of the economy. Among other things, sustained economic growth is guaranteed with the availability of sustainable energy sources (World Bank, 2016). The growth in the economy in the past has been underpinned by availability of huge mineral reserves, good governance and reliance on a market based economy (Leith, 2005, Malema, 2010). The slowdown in rate of economic growth has been due to weak global demand in minerals, subdued commodity prices and persistent electricity supply problems. The growth prospects are hinged, in the medium term, on the government's economic stimulus package, gradual recovery of the diamond market and increased availability of electricity following remedial measures done to the Morupule B power plant (Africa Economic Outlook, 2016).

Figure 1, shows that gross domestic product per capita has been on the rise in Botswana between 1985 and 2015. It showed a steady growth over the period and projections are that the trend will continue being supported by appropriate economic fundamentals. This is despite the slowdown in growth witnessed in 2015.

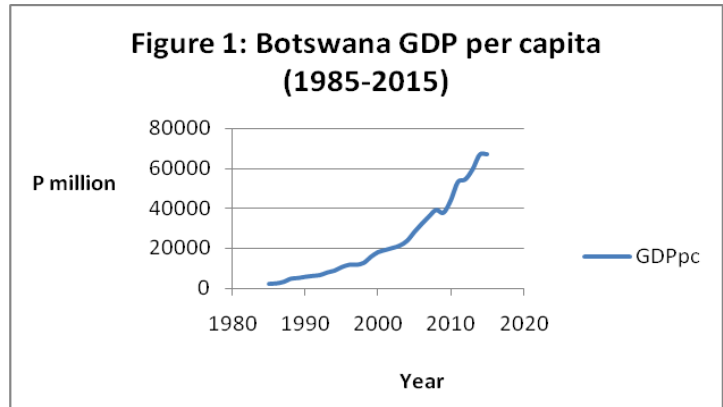


Figure 2 show that maintainance of roads (bitumen, gravel and sand) remained constant up until 2010. This is despite the fact that there were marginal increases in the length of roads maintained. There was steep rise in 2011 due to doubling of the length of gravel and sand roads upgraded to improve accessibility of major business centers. Expenditure on bitumen roads remained stable over the entire period. The sudden jump in 2011 can be explained by the slowdown in 2008/9 due to global economic recession and in 2010 and 2011 budget speech the government increased expenditure on projects like roads and electricity as a way to deal with backlogs.

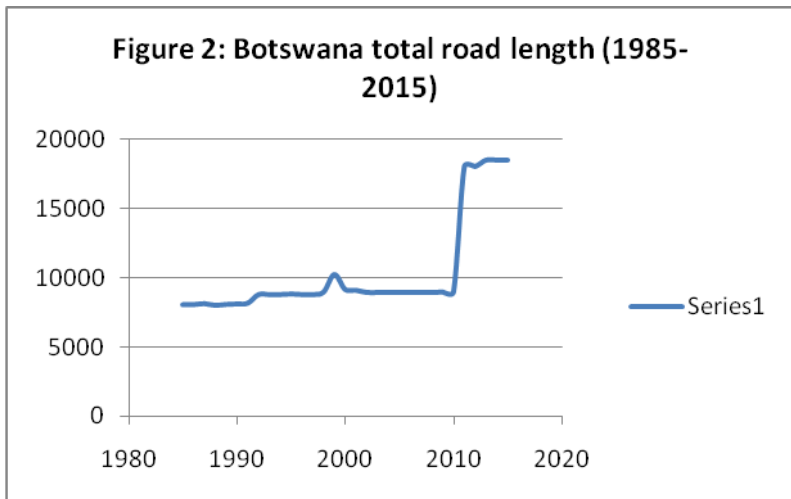
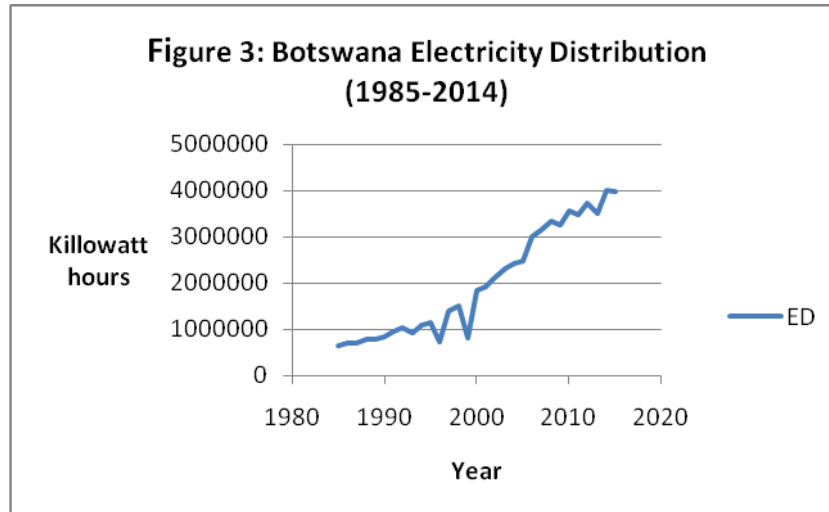


Figure 3 show that distribution of electricity had a steady rise since 1985. This was as a result of the government intensifying efforts to generate more electricity locally and complement by way of imports. More access to electricity has been witnessed since 1985 and this is expected to continue as more power is expected to be generated locally at Morupule B power station. The government has consistently allocated Ministry of Minerals, Energy and Water Resources

and Ministry of Transport and Communications the largest or second largest share of the development budget since 2010.



The impact of infrastructure development on growth has been studied in both developing and developed countries. The availability or absence of infrastructure influences the level of development for a country or region. The quality and type of infrastructure influences the level of productivity of economic agents and economic growth. Infrastructure, from the households' point of view is regarded as final consumption expenditure, while from the firms' point of view it is an intermediate expenditure. The main challenge in literature has been to give a precise definition of infrastructure and providing a breakdown of its components. The problem of definition has limited the analysis done by researchers and hence policy making initiatives. There are two definitions that economists and urban planners have developed. Economic infrastructure has been defined as the infrastructure that promotes economic activity which includes roads, sea ports, airports, railroads, electricity, water supply and sanitation. Social infrastructure has been defined as that which promotes health, education and cultural standards (Fourie 2006). Expenditure on road network helps in the facilitation of easy transportation of goods and economic agents hence contributing to economic growth. Improvement in the transport infrastructure adds to the existing capital stock forming the foundation upon which the economy prospers (Chukwuemeka, Nyewe and Ugondah, 2013). Studies done on infrastructure show that transportation facilities, like railway and roadway, have a positive and significant impact on growth (Canning and Pedroni, 2004, Sojoodi, Zonizi and Nia, 2012, Siyan, Eremionkhale and Makwe, 2015). Similarly, Badalyan, Herzfeld and



Rajcaniova (2014) show that gross fixed capital formation, a proxy for infrastructure, and expenditure on road have positive impact on growth. Their study found bidirectional causality between economic growth and infrastructure investment in both long and short run. Again, Serdaroglu (2016) and Sahoo, Dash and Nataraj (2010) show that total public infrastructure capital investments have a significant boost on economic growth. However, Chukwuemeka, Nyewe and Ugondah (2013) found that expenditure on transport infrastructure has negative impact on growth. Again, Sahoo et al (2010) found unidirectional causality moving from infrastructure development to growth which contradicts previous findings.

Literature shows that there are four hypotheses explaining the energy growth relationship. The growth led energy hypothesis supports the idea that as the country grows more energy is consumed. This suggests that saving energy will not adversely affect economic growth. The energy led growth hypothesis says that the economy grows as more energy is used. This means more of energy should be used to promote growth. A situation where there is no link between the two variables is referred to as neutrality hypothesis. Lastly a situation where there is bidirectional causality is referred to as growth led energy led growth hypothesis (Guttermsen, 2004, Ozturk, 2010, Payne 2009 and Masih 1997). Previous studies have found mixed results on the link between economic growth and electricity consumption. Studies have found bi-directional causality between economic growth and electricity consumption (Kapsrowicz, 2014, Ogundipe and Apata, 2013). Similarly, Ozel and Bayar (2014) found that there is bidirectional causality between economic growth and consumption of electricity and that the later has a positive impact on the former in the long term. Again Lorde, Waithe and Francis (2010) found a bidirectional relationship between the two variables in the long run and a unidirectional causal relationship from energy to economic growth in the short run. This is supported by findings from a study by Olufemi (2015) showing that there is a significant positive relationship between electricity consumption and growth in the long run. Similarly, several studies show that economic growth and electricity consumption have a co-integrating relationship, with electricity having a positive impact on growth (Akomolafe and Danladi, 2014; Ogundipe and Apata, 2013 and Lorde, Waithe and Francis, 2010). Other studies have found unidirectional causality moving from economic growth to electricity consumption (Adom, 2011, Kwakwa, 2012). On the contrary, Akomolafe and Danladi (2014) found a unidirectional causality moving from electricity consumption to economic growth.



However, Sojoodi, Zonizi and Nia (2012) found that electricity consumption has no effect on growth.

Literature fails to agree on the correct measure of infrastructure whether from either a societal or economic point of view. Previous studies have different measures of infrastructure development resulting in conflicting findings. Adebola (2011) using Botswana data found unidirectional causality between electricity consumption and economic growth and a positive connection in the long term. As a point of departure this study uses a log linear model and different measures of growth and electricity consumption. This study uses two variables (electricity distribution and length of roads maintained) capturing infrastructure development to explain economic growth in an emerging market in an attempt to contribute to the discussions in literature. It is not clear on the impact of variables like road infrastructure development on growth. The direction of causality is not conclusive and whether or there is a short or long term link is not clear.

The objectives of the study are to:

1. examine the contribution of infrastructure development to economic growth in Botswana
2. assess if there is short or long run connection between electricity, road infrastructure and economic growth

The study has employed the vector error correction model and finds that there is no evidence of any short run connection between growth and economic infrastructure. Findings in this study are important for policy making since they that show that both measures of infrastructure are important for long run growth in Botswana. However electricity distribution has a greater effect on growth than expenditure on roads. The rest of the study is organized as follows: section two explains the data and methodology employed, section discusses the findings and section 5 concludes and provides policy recommendations.

2. THE THEORETICAL FRAMEWORK

Classical growth theories were developed separately by Adam Smith, David Ricardo and Thomas Malthus. There was little agreement among them but their approach and framework was the same. In their view technological progress, which is dependent on capital accumulation, remains a key determinant of growth until a time when profit become low and



they stop capital accumulation. They developed a production function in which output depends on stock of capital, land or natural resources and labour force ($Y = f(K, L, N)$). They postulated that the economy does not suffer from want of technical knowhow but technical knowledge would continue to increase as the capital stock increases (Smith, 1976, 1986, Ricardo, 1951).

Empirical evidence, as discussed, shows that infrastructure is important in explaining economic growth. The neoclassical theories of growth says that growth is explained by either the savings rate (Harrod-Domar) or the rate of technical progress. These theories aimed to explain the relationship between unemployment and growth in developed countries. The theories assumed that the labour force grows at a constant rate, there is no technological progress and that labour and capital cannot be substituted. Economic growth can only be increased by raising savings or reducing the capital output ratio. The theory does not allow for technical change and it deals with a closed economy. However, technical change allows output to increase even with no change in the rate of savings (Domar, 1966, Harrod, 1939).

The Neo Classical growth theories were first introduced by Solow (1956). It assumes that labour is exogenously determined, capital stock does not depreciate, there is smooth substitution between labour and capital, and that there is no need to focus on unemployment which is temporary in nature. The theory says that output is function of capital, labour and knowledge or effectiveness of labour. Technological progress only exists when the amount of knowledge increases over time. The model has been criticized because it fails to incorporate the effectiveness of labour and the inclusion of technology is not justified.

Endogenous growth theory has two main branches: models capturing technological advances that generate externality effects. The production function presents increasing returns to scale to the presence of these spillover effects which emanates from education or knowledge generation (mainly supported by Romer, 1986 and Lucas, 1988). The second branch uses AK technology, where constant returns, due to acquiring capital (physical, human, knowledge) (mainly supported by Rebelo, 1991). Economic growth is, therefore, explained by investment in human capital, innovation and knowledge. The theory primarily shows that long run economic growth depends on policy measures. Policies can affect research and development, education and infrastructure development. Romer (1986) argues that the source of externality



is the stock of knowledge rather than the stock of human capital. Production of goods depends not only on the private knowledge but on the aggregate stock of knowledge.

According to Barro (1990) the level of output can be explained by the flow of government's productive expenditure. The growth model by Lucas (1988) accounts for the effects of human capital accumulation. It argues that growth is higher with more investment in human capital. Thus endogenous growth theories show that economic growth increases with more subsidies on human capital from the government. The theory can also use the production function framework to explain the link between economic growth and expenditure in infrastructure. According to the endogenous growth model (Lucas, 1988, Barro, 1990) any changes to infrastructure have an effect of increasing the steady-state level of output. Expenditure in infrastructure can also be added in the production function (Sahoo, Dash and Nataraj, 2010). Following Pyo (1995) and Lorde, Waithe and Francis (2010) the Cobb –Douglas function can be specified as follows:

$$Y_t = A_t K_t^\alpha Infr_t^\gamma \quad (1)$$

Where economic growth, Y_t , depends on the level of capital, K , and the level of expenditure on infrastructure ($Infr$), elasticities α , β and γ add up to 1. K is composed of human (H) and physical capital (K) and later represents labour, A is technology. Equation (1) can be further developed to incorporate technology. It is assumed that accumulation of total capital (physical and human) induces the accumulation of technology as follows:

$$A_t = B(K_t H_t)^c \quad \text{and } 0 < c < 1$$

The production function will be as follows:

$$Y_t = B(K_t H_t)^{\alpha+c} Infr_t^\gamma \quad (2)$$

3. METHODOLOGY

3.1 Data and variables

The study uses annual time series data for the period 1985 to 2015 obtained from Statistics Botswana (2016). The choice of this period was influenced by the availability of data. Electricity distribution was measured in kilowatt hours which combines both commercial and domestic use; economic growth (GDPpc) was measured as the gross domestic product per



capita at current prices and the total length of roads maintained by the central government, a proxy for infrastructure (trl), was measured as the sum of improvements made to gravel, sand and bitumen roads. The study used two measures of capital: physical capital or gross fixed capital formation (gfcf) includes improvements on land (fences, ditches, drains), purchases of plant and machinery and construction of roads and railway networks; human capital (ter) represented by the total percentage of the population in a particular age group enrolled in a tertiary education institution after successfully completing secondary education.

3.2 Estimation technique and model

The study aimed at assessing the contribution made by investment in infrastructure and electricity consumption to economic growth in Botswana. Using stata 12, the following analysis was employed in assessing the long term connection for the three variables: The study tested for unit root to check the stationarity of the data. This is done so as to avoid using non-stationary data which results in spurious results. The augmented-Dickey-Fuller (1979) was employed for data set at both levels and in first difference. Data is said to be integrated of order one where it becomes stationary after first differencing which is common in time series data. When data is stationary after first differencing a conclusion can be reached that there is a long run connection between variables. This can be confirmed using either the method by Engle-Granger (1987) or the Johansen (1995) cointegration approach. The approach by Johansen requires knowledge of the number of lags in the model which is determined using the method by Tsay (1984) and Nielsen (2001). The number of lags, indicated by an asterisk, is chosen using the Akaike information criterion (AIC), Hannan-Quinn Information Criterion (HQIC) and the Schwarz Bayesian Information Criterion (SBIC) method. The vecrank by Johansen was employed in determining the number of cointegrating equations. The choice is made by comparing the trace statistic with the critical values at either 1% or 5%. This was then followed by estimating the vector error correction model to explain the link between the variables in the long term.

The study also employed the method by Engle and Granger (1987) to test if any variables cointegrated. The approach uses two steps as follows: first regress two variables using the equation of the form (model 3).

$$GDPpc_t = \beta_0 + \beta_1 X_t + \mu_t \quad (3)$$



Where GDPpc is the per capita GDP, X is a vector of explanatory variables explaining growth (investment in infrastructure and electricity distribution), β_0 is a constant and β_1 is the vector of coefficient for explanatory variables and μ_t is an identically-independently-distributed error term. The second step involves collecting the error terms so as to test for unit root using:

$$\mu_t = \rho\mu_{t-1} + \nu_t \quad (4)$$

The augmented Dickey Fuller is applied after collecting the residuals (model 4). The null hypothesis is that there is no co-integration and is proved when $\rho = 1$. The MacKinnon (1991) critical values are used to tests the null hypothesis. If the tests prove that the two variables are co-integrated then there is a long run relationship. Once cointegration has been established the study can use Vector Error Correction model to examine the long run connection. When two variables are cointegrated there is a possibility that they are not in equilibrium in the short term. In this case the error term is used to tie the behaviour in the short run to the behaviour in the long run. The relationship is expressed (model 5) as follows:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 \mu_{t-1} + \varepsilon_t \quad (5)$$

Where Δ denotes the first difference operator, ε_t is the random error term, and μ_{t-1} is a one period lagged value of the error term, Y and X are the cointegrating variables. In this case changes in Y depend on changes in X and on the equilibrium error term. The model will be out of equilibrium if the latter is not zero. The value of α_2 determines the speed with which Y changes back to equilibrium in the long term. If the lagged value of error term is zero then Y will adjust to changes in X in the same period. The study estimated (model 6) the following log linear model:

$$LGDPpc_t = \beta_0 + \beta_1 Led_t + \beta_2 Ltrl_t + \beta_3 Lgfcf_t + \beta_4 Lter_t + \varepsilon_t \quad (6)$$

Where LGDPpc is the logarithm of the per capita GDP, Led is the logarithm of the electricity distribution, Ltrl is the logarithm of the total road length, lgfcf is the logarithm of physical capital, Lter if the logarithm of human capital and β^s are the coefficients of explanatory variables.



4. RESULTS AND DISCUSSION

Table 1, shows a summary of 31 observations and it shows that economic growth had the highest annual average while the lowest average annual maintenance was done on roads network. The minimum values ranged between 9.341 and 0.268 being for economic growth and human capital respectively. Physical capital was the most volatile while maintenance of roads was the least volatile during the period. Expenditure on roads and human capital were normally distributed, kurtosis was at least 3, while other variables were non-normally distributed. All the variables were negatively skewed with exception of road maintenance.

Table 1: Summary statistics

Stats	logGDPpc	Loged	Logtrl	Loggfcf	logter
Mean	10.194	6.219	3.992	28.943	0.732
Max	10.825	6.601	4.267	38.725	0.903
Min	9.341	5.812	3.902	15.501	0.268
Sd	0.433	0.279	0.123	5.336	0.175
Skewness	-0.276	-0.041	1.714	-0.204	-1.192
Kurtosis	2.056	1.425	4.157	2.659	3.516
N	31	31	31	31	31

Source: Output from stata 12

Tests for multicollinearity were done in stata and results (Table 2) shows that there was a positive association between economic growth and all variables except electricity distribution. This may be because the measures of infrastructure employed in the study are not complementary. For example a rise on expenditure on roads would result in a rise in economic growth. The expectation is that economic growth is depended on the other variables which are all significant at 5%. The explanatory variables are not correlated among themselves since the correlation coefficients are small.

Table 2: Tests for multicollinearity

	logGDPpc	Loged	Logtrl	Loggfcf	logter
logGDPpc	1.0000				
Loged	-0.1058	1.0000			
Logtrl	0.1481	-0.2508	1.0000		



Loggfcf	0.3662	0.3611	-0.0404	1.0000	
logter	0.4015	0.1818	-0.1721	0.3210	1.0000

Tests for heteroskedasticity

It was also necessary to check if variances for error terms are constant. If the error terms do not have constant variance they are said to be heteroskedastic. The Breusch-Pagan/ Cook-Weisberg test was used to check for the presence of heteroskedasticity. The null hypothesis was that error terms have constant value. Results (Figure 1) gave a value of chi2(1) of 2.05 and the p-value of 0.1522 which shows that there was not enough evidence to reject the null hypothesis. As such results indicate that heteroskedasticity was not a problem.

Figure 1: Tests for heteroskedasticity

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Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of D.logGDPn

      chi2(1)      =      2.05
      Prob > chi2  =      0.1522
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Result in table 3 shows that all the probabilities of MacKinnon were less than 5% after first differencing which leads to the rejection of the null hypothesis of unit root. This means all the first three variables are stationary after first differencing and they can be used in estimations. The last two variables were stationary at levels.

Table 3: Results for unit root

Variables	Levels		First difference	
	Test statistic	Probability	Test statistic	Probability
LogGDPn	4.448	1.0000	-3.422	0.0102
Loged	-1.120	0.7071	-8.978	0.000
Logtrl	-0.352	0.9178	-5.571	0.000
Logter	-4.381	0.0003	-4.546	0.000
Loggfcf	-3.198	0.0201	-4.122	0.0000

Source: Output from stata 12



Results in Table 4 show that, using the Akaike information criterion (AIC), Hannan-Quinn Information Criterion (HQIC) and the Schwarz Bayesian Information Criterion (SBIC) method, the maximum number of lags is 4.

Table 4: Lag order selection

Selection-order criteria								
Sample: 1989 - 2015								
Number of obs = 27								
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	60.7326				1.1e-08	-4.12834	-4.05699	-3.88837
1	165.787	210.11	25	0.000	3.1e-11	-10.0583	-9.63013	-8.61844
2	186.77	41.967	25	0.018	5.1e-11	-9.76074	-8.97582	-7.12107
3	247.809	122.08	25	0.000	6.7e-12	-12.4303	-11.2886	-8.59075
4	327.134	158.65*	25	0.000	6.7e-13*	-16.4543*	-14.9559*	-11.415*

Source: Output from stata 12

The two step approach by Engle-Granger was also employed, complementing the Johansen approach, and results (Table 5) show that the variables are cointegrated. The p-values were all less than 5%. This result is the same as the one found using Johansen approach (Table 6).

Table 5: Test for cointegration – Engle-Granger two step procedure

Variables	Test statistic	Probability value	Lag length
GDP percapita, Total road length	-3.163	0.0222	4
GDP percapita, electricity distribution	-3.711	0.0040	4

Source: Output from stata 12

The study tested for the cointegration using the method by Johansen. Results (Table 6) show that there is one cointegrating equation which was selected using Trace statistics.

Table 6: The number of cointegrating equations

Johansen tests for cointegration						
Trend: constant						
Sample: 1990 - 2015						
Number of obs = 26						
Lags = 4						
maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value	1% critical value
0	30	120.7388		39.9486	29.68	35.65
1	35	131.7384	0.57092	17.9494*1	15.41	20.04
2	38	137.98725	0.38164	5.4517	3.76	6.65
3	39	140.71311	0.18916			

Source: Output from stata 12



In order to examine the long run connection between the variables the study employed VECM approach. Results in Table 7 show that all the coefficients were positive and significant. The model used was in logarithms, thus findings show elasticity between any two variables. A 1% increase in electricity consumption would lead to a 0.4511% increase in economic growth while an increase in the maintenance of road infrastructure would lead to a 0.3402% rise in economic growth. The impact of electricity consumption on growth is higher in magnitude than the impact of expenditure on road infrastructure. Similarly the 1% change in human and physical capital would result in 0.1693% and 0.0092% change in economic growth. An increase in infrastructure variables has a huge impact on growth than a similar change in capital. The results also show that economic growth adjusts in the same period to changes in both variables. This was explained by short run adjustment parameters, not reported, which were insignificant with but with correct signs.

Table 7: The Vector Error Correction Model

Beta	Coef	Std.err	Z	p-value
LogGDPnD1.	1			
LogedD1.	0.4511	0.0134	19.81	0.000*
LogtrID1	0.3402	0.0227	23.45	0.000*
Loggfcf	0.0092	0.0018	29.62	0.000*
Logter	0.1693	0.0034	28.10	0.000*
Cons	0.0440			

*significant at 5%, ** significant at 10%

Source: Output from stata 12

Model 6 was also estimated using OLS, in stata, and results are presented in table 8. The model was correctly specified with a probability of less than 1% and value of R^2 0.8911 which suggest growth is being explained well by the explanatory variables included in the model. Again, the all the explanatory variables are significant and with expected signs. Results show that a 1% increase in electricity distribution leads to a 1.3521% increase in GDP per capita and a 1% change in total road length maintained leads to a 0.4852% increase in economic growth. The increases in output as a result of a change of physical and human capital are both significant at 10% and 5% respectively. Findings confirm the earlier findings



that economic growth changes more with a change in infrastructure than changes in capital. OLS shows that infrastructure and capital have a positive impact on growth.

Table 8: Ordinary Least Squares (OLS) estimations

LogGDPnD1.	Coefficient	p-value
LogedD1.	1.3521	0.000
LogtrlD1	0.4852	0.047
Loggfcf	0.0342	0.067
Logter	0.1235	0.002
Constant	-0.3450	0.215

Pro>F = 0.000; R-squared 0.8911, Adj R-squared 0.8730

Source: Output from stata 12

The results from this study are consistent with previous studies (Chingoiro and Mbulawa 2016, Owolabi 2015 and Ahmed, Abbas and Ahmed 2013) showing that expenditure on infrastructure results in long term growth. Thus improvements in the road network creates a platform upon which the economy thrives in attaining high levels of growth and hence other spillover effects like poverty reduction can be realized as well. Findings are also consistent with other studies (Akomolafe and Danladi, 2014; Ogundipe and Apata, 2013) showing that as the distribution of electricity improves in the country economic agents tend to produce more goods and services than before. Clearly, findings show that in the case of Botswana the infrastructure led growth hypothesis holds which asserts that energy consumption leads to growth.

5. CONCLUSION AND RECOMMENDATIONS

The study has examined the contribution of infrastructure development on economic growth in Botswana and also assessed if there is short or long run connection between electricity, road infrastructure and economic growth. The study employed OLS and the vector error correction model using data for the period 1985 to 2015. The study shows that infrastructure (measured by improvement in road network and electricity distribution) contributes to high economic growth in the long term. Clearly the results support the infrastructure led growth hypothesis. Again results show that capital is also important for enhancing growth initiatives.



Thus any conservation strategy on development of infrastructure will retard growth. As much as the development of roads contributes to economic growth electricity distribution should be intensified and power cuts should be minimized to boost economic growth. The government needs to take a cautious approach in its effort to conserve electricity distribution. Thus expansion in the production of electricity locally to increase supply from local sources is desirable for Botswana. It is recommended that the government improve capital by subsidizing human capital development to avoid reduction in consumption which may adversely affect the level of growth.

6. REFERENCES

1. Adebola, S, S. (2011), Electricity consumption and economic growth: Trivariate investigation in Botswana with capital formation, *International Journal of Energy Economics and Policy*, 1(2), pp 32-46.
2. Adom, P, K. (2011), Electricity consumption-economic growth nexus: The Ghanaian case, *International Journal of Energy Economics and policy*, 1(1), pp 18-31
3. Africa Economic Outlook (2016), Botswana Economic Outlook. Available at: <http://www.afdb.org/en/countries/southern-africa/botswana/botswana-economic-outlook/> (Accessed on 08 November 2016)
4. Akomolafe, A, K, J. and Danladi, J. (2014), Electricity consumption and economic growth in Nigeria: A multivariate investigation, *International Journal of Economics, Finance and Management*, 3(4), pp 177-182
5. Badalyan, G, Herzfeld, T. and Rajcaniova, M. (2014), Transport infrastructure and economic growth: Panel data approach for Armenia, Georgia and Turkey, Paper presented at the 142nd EAAE Seminar Growing success, Agriculture and rural development in an enlarged EU, Convius University of Budapest, May 29-30, 2014.
6. Barro, R. (1990). Government spending in a simple model of exogenous growth. *Journal of Political Economy*, 98 (1990), 103-125. <http://dx.doi.org/10.1086/261726>
7. Canning, D. and Pedroni, P. (2004), The effects of infrastructure on long run economic growth. Available at: <http://web.williams.edu/Economics/wp/pedroniinfrastructure.pdf> (Accessed on 05 November 2016)



8. Chingoiro, S. and Mbulawa, S. (2016), Economic growth and infrastructure expenditure in Kenya: A granger causality approach, *International Journal of Social Science Studies*, 4(9), pp 1-8.
9. Chukwuemeka, A, Nyewe, A, N. and Ugondah, N, C. (2013), Public spending on transport infrastructure and economic growth in Nigeria, 1981-2010, *Journal of Sociological Research*, 4(2), pp 438-446.
10. Dickey, D. A., and W. A. Fuller. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* 74: 427–431.
11. Domar E.D. (1966). *Essays in the Theory of Economic Growth*, 272 pp. New York, NY, USA (first publication 1957). [This book presents a Keynesian growth theory].
12. Engle, R. F. and Granger, C. W. J. (1987) “Co-integration and Error Correction: Representation, Estimation, and Testing”. *Econometrica*, vol. 55, pp. 251-276.
13. Fourie, J. (2006). Economic infrastructure: a review of definitions, theory and empirics. *South African Journal of Economics* (74), 530-556.
14. Guttormsen, A.G. (2004), *Causality between Energy Consumption and Economic Growth: Department of Economics and Resource Management, Agriculture University of Norway. Norway.*
15. Harrod R.F. (1939). An essay in dynamic economics. *Economic Journal*, **49**, 14-33. [This paper constructs a growth model based on Keynesian ideas].
16. Johansen, S. (1995), *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*. Oxford: Oxford University Press.
17. Kasperowicz, R. (2014), “Electricity Consumption and Economic Growth: Evidence from Poland” *Journal of International Studies*, 7(1), pp. 46-57. DOI: 10.14254/2071-8330.2014/7-1/4
18. Kwakwa, P, A. (2012), Disaggregated energy consumption and economic growth in Ghana, *International Journal of energy economics and policy*, 2(1), pp 34-40.
19. Leith, J.C. (2005) “Why Botswana prospered.” Montreal & Kingston: McGill-Queen’s University Press.
20. Lorde, T, Waithe, K. and Francis, B. (2010), The importance of electricity energy for economic growth in Barbados, *Energy Economics*, 32(2010), pp 1411-1420.



21. Lucas, R. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22 (1988), 3-42. [http://dx.doi.org/10.1016/0304-3932\(88\)90168-7](http://dx.doi.org/10.1016/0304-3932(88)90168-7)
22. Malema, B. W. (2010). Education and employment of women: Are they arsenals in the fight against HIV/AIDS? *International Journal of Human Development and Information System*. 3, (1-2), 103-111.
23. Masih, A.M.M., Masih, R., (1997), On temporal causal relationship between energy consumption, real income and prices; some new evidence from Asian energy dependent NICs based on a multivariate cointegration/vector error correction approach. *Journal of Policy Modeling*, 19 (4), 417–440.
24. Matambo, O, K. (2016) Botswana 2016 Budget Speech, Ministry of Finance and Development Planning. Available at: <http://www.finance.gov.bw> (Accessed on 06 November 2016).
25. Nielsen, B. (2001), Order determination in general vector autoregressions. Working paper, Department of Economics, University of Oxford and Nuffield College. <http://ideas.repec.org/p/nuf/econwp/0110.html>.
26. Ogundipe, A, A. and Apata, A. (2013), Electricity consumption and economic growth in Nigeria, *Journal of Business Management and Applied Economics*, II (4), pp 1-14.
27. Olufemi, O, J. (2015), The effects of electricity consumption on industrial growth in Nigeria, *Journal of economics and sustainable development*, 6(13), pp 54-59
28. Ozel, H, A. and Bayar, Y. (2014), Electricity consumption and economic growth in emerging economies, *Journal of Knowledge management, economics and information technology*, IV(2), pp 1-18.
29. Ozturk, I., (2010), A literature survey on Energy-Growth Nexus. *Energy Policy*, 38(1), 340-49.
30. Payne, J.E., (2009), On the dynamics of energy consumption and output in the US. *Applied Energy* 86 (4), 575–577.
31. Rebelo, S. (1991), Long run Policy Analysis and Long run growth, *Journal of Political Economy*, 99(3), 500. Doi:10.1086/261764
32. Ricardo, D. (1951). On foreign Trade. In Sraffa, P. and Dobb, M, H. (eds). *The works and correspondence of David Rocardo*, 1, Cambridge, UK, Cambridge University Press.



33. Romer, P, M. (1986), Increasing returns and long run growth, *The Journal of political economy*, 94, 1986.
34. Sahoo, P, Dash, R, K. and Nataraj, G. (2010), Infrastructure development and economic growth in China, *Institute of development economies, Discussion paper Number 261*.
35. Serdaroglu, T. (2016), The relationship between public infrastructure and economic growth in Turkey, *Kalkinma Bakanligi Ekonomi Calisma Tebligleri Series, No 2016/02*.
36. Siyan, P, Eremionkhale, R. and Makwe, E. (2015), The impact of road transportation infrastructure on growth in Nigeria, *International Journal of management and commerce innovations*, 3(1), pp 673-680.
37. Smith, A. (1976). *An Inquiry into the Nature and Causes of the Wealth of Nations*, 1st Ed, Vol 2 of the *The Glasgow Edition of the Works and Correspondence of Adam Smith*, Edited by Campbell, R, H, Skinner, A, S and Todd, W, B, Oxford: University Press.
38. Smith, A. (1986). (1776). *The Wealth of Nations*. London: Penguin Books.
39. Statistics Botswana (2016), *Selected statistical indicators 1966 – 2016*. Available at: <http://www.cso.goc.bw>
40. Sojoodi, S, Zonizi, F, M. and Nia, N, M, A. (2012), The role of infrastructure in promoting growth in Iran, *Iranian Economic Review*, 16(32).
41. Tsay, R. S. (1984), Order selection in nonstationary autoregressive models. *Annals of Statistics* 12: 1425–1433.
42. World Bank (2016), *An overview of the Botswana economy*. Available at: <http://www.worldbank.org/en/country/botswana/overview> (Accessed on 08 November 2016)