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Energy Consumption, Finance and Growth: The Role of Urbanization and Industrialization in South Africa

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ABSTRACT

The paper investigates the relationship between energy consumption, financial development (FD), economic growth, industrialization and urbanization in the case of South Africa for the period of 1970-2014. The study employs Johansen co-integration test and vector error correction model with granger causality test as estimation techniques. The results confirm that there is a long-run equilibrium relationship between these variables in case of South Africa. More so, urbanization, FD, and industrialization are positively correlated to the energy consumption in the long run. The results obtained also shows the long run bi-directional causality between industrialization and energy utilization, FD and energy consumption and also FD and industrialization.

Keywords: Energy, Finance, Growth, Time Series
JEL Classifications: B26, C21, Q43

1. INTRODUCTION

The research on the role of financial development (FD) on economies has been continuously diversifying and developing over the last 2 decades. While some researches are showing positive impacts of FD on the economic growth, others are exhibiting contrary results under different conditions with different methodologies. Some of those research covers cross country analysis, while some others cover single country experiences. Well-developed financial system raises the efficiency of financial sectors and in turn improves the innovations in the financial services delivery system. Also it helps in technology advancement, information cost reduction, and investment profitability (Levine et al., 2000; Bairer et al., 2004; Abu-Bader and Abu-Qarn, 2008). Financial market liberalization also leads to economic growth (Bekaert et al., 2001; 2002; 2005). Investment, consumption and thus production are increased by an efficient financial system hence causes an increase in energy demand (Fung, 2009). Financial market liberalization improves monetary transmission mechanism and also boosts investment and savings, therefore improve economic growth. Some other researchers also argue that financial sector improvement is a result of economic growth (Lucas, 1988; Stern, 1989).

International Energy Agency (2007) reports that between 2005 and 2030 the world primary demand for energy is expected to increase at the rate of 1.8%. Meanwhile India and China jointly accounts 45% of the increase in the demand for energy globally.

Kraft and Kraft (1978) conducted a research and found that in the U.S. during the years 1947-1974, economic growth causes energy demand to grow. Shahbaz and Lean (2012) show the nexus between energy use and nations' growth. Among other important factors which are population growth and industrialization and urbanization. These factors will boost effective utilization of energy. For example, the higher increase in the population size induces urbanization and in turn increases the use of energy.

The aim of this research is to present some facts and findings about South Africa, listed in Next 11 (also known as N11) as one of those promising countries that may become one of the largest economies in the world in next few decades. We primarily evaluate the nexus between FD and energy use. Likewise, evaluating the role of economic growth, urbanization and industrialization with the above context provides a more comprehensive framework on the development of South Africa. We also consider to present the long-run relationships between the variables of this study. The research also aims to document some new findings for South African policy makers and interested scholars.

2. THEORY AND LITERATURE REVIEW

2.1. The Review of the Theory

Minsky (1982; 1986) extended the view through the "Wall Street Paradigm" here, capitalism is perceived as essentially a financial system, an inclined to waves of financial instability and economic flaw. Minsky's theories were extended by Kregel (2008) where he linked them to development as well as presenting exchange rate uncertainty, derivatives and "International dimension" of how the financial construction of an economy is at all times a key component of its development track (Kregel, 1998; 2010; 2014; Burlamaqui and Kregel, 2005). The uniqueness here is not "Financing for development," however it is macro-finance: Incorporation among the way the financial system works and by how it should be planned to successfully foster invention and expansion. The importance of this framework was understood by Schumpeter (1911); meanwhile he never developed it completely. These works were also used by Keynes (1936), as a bond and suggest that effective development procedures are essentially attached with proactive financial structures and strong economic and financial rule oriented in the direction of industrial financing. Suggestions were made that this particular rule and institutional set up allows countries to constantly upgrade their technological and invention competences and occupy in a strategy of succeeding as an approach for exceeding. This means that, development approaches should not be dreams and plans regarding how to meet up with local and/or worldwide benchmark countries; rather should focus on how to exceed them. To catch-up may serve as a temporary approach at least.

Stern (2004) states that energy resource takes different physical form which includes thermal, natural gas, oil, electricity, biomass, wind energy, uranium, water fall, infrared radiation and more. His analysis focuses on the importance of the energy in the country's production. Financial analysts and business people are more concerned about the influence of energy and oil prices on the nation's economy; the main theories of economic growth pays little or no attention toward energy's role or toward the role of energy resources that is said to affect the economy. These extensive deliberations concerning the slowdown in subsequent to oil crises in 1970's are exception. A further important topic in the discussions is about the link between energy utilization and economic growth. Energy use has varying effects on the economy. Energy extraction and treatment reliably include a few structures of natural break, including both geomorphological also, natural disturbance and additionally contamination.

3. EMPIRICAL LITERATURE REVIEW

Sadorsky (2010) examined the nexus between FD and energy utilization in 22 developing countries by using a generalized method of moment's estimation technique for the period of 1990-2006. He found evidence that there is a positive impact of FD on energy consumption. Shahbaz et al. (2012) prescribed enormous and useful result of budgetary advancement on energy utilization in Pakistan. The causality examination demonstrated bidirectional relationship between FD and energy use. Furthermore, Sadorsky (2011) examined the impact of FD on the energy consumption for 9 Central and Eastern European frontier economies for the period of 1996-2006. Employing dynamic panel model, he found out that there is a statistically significant relationship between FD and energy consumption where bank variables have larger impact on energy consumption compared to stock market variables. Islam et al. (2013) found that FD and moreover economic growth have positive impact on energy consumption in Malaysia. Unlike in Pakistan (Shahbaz et al., 2012), they found unidirectional causality running from economic growth to energy utilization in Malaysia. Çoban and Topçu (2013), studied the relationship between FD and energy consumption for European union member states (EU27) for the period of 1990-2011 by using system - generalized method of moments model. They found similar results as Sadorsky (2011) where bank variables have a positive impact on the energy consumption compared to stock market variables only for the new members of the EU27, whereas for the old members of EU27, greater FD leads to increased energy consumption. Rafindadi (2015) found interesting results about the link between FD and energy consumption. He studied Germany for the period of 1970-2013 and employed time series analysis and applied autoregressive distributed lag (ARDL) and vector error correlation model (VECM) granger causality tests. His findings revealed that FD has no impact on the energy consumption in case of Germany. Ali et al. (2015) studied Nigeria for the period of 1972Q1-2011Q4 and applied ARDL bounds testing approach with time series data. Their findings exhibit a negative relationship between FD and the energy consumption in Nigeria.

There is a substantial amount of research outcome on link between energy consumption and economic growth. For a good literature review of empirical findings in this field Ozturk (2010) provided a detailed documentation of the researches conducted for the period between 1947 and 2007. Akinlo (2008) studied the causal relationship between energy consumption and economic growth for 11 countries from Sub-Saharan Africa. He employed ARDL bounds testing procedures and VECM based Granger Causality tests. His findings are mixed for causality tests. Lee and Chang (2008) also research the nexus between energy consumption and economic growth within a multivariate framework for 16 Asian countries for the period of 1971-2002. They employed heterogeneous panel cointegration and panel based error correction models and found that there is a long run unidirectional causality running from energy consumption and economic growth for these countries. Chang (2010) researched the causal links between energy consumption and economic growth including the carbon emission. He used multivariate co-integration tests and VECM and covered the period of 1981-2006. His findings exhibit that economic growth in China induces greater consumption of energy, therefore more carbon emissions. Furthermore, Yuan et al. (2014) also studied China for the period of 1953-2008, employing Toda-Yamamoto to test for granger causality in a vector autoregressive model. They found a bi-directional causality between income growth and energy consumption.

The inclusion of urbanization and industrialization into the energy consumption, finance and growth nexus is to measure or to document the role (or interaction) of urbanization and industrialization on the consumption of the energy. This approach becomes more meaningful when it is studied with the FD. The role of FD on the consumption of energy in urbanized and industrialized areas is a stylized fact. It helps more in the urbanized and industrialized areas to foster the consumption and investment. Credit expansion mainly expands the consumption bundles and investment bundles of those who live in urbanized and industrialized areas by facilitating more liquidity in the financial markets. Shahbaz and Lean (2012) included urbanization and industrialization into the analysis where they employed ARDL bounds testing approach to cointegration and Granger causality tests. The data covered for the period of 1971-2008. Their findings reveal that there is a long run relationship in all 5 variables; energy consumption, economic growth, FD, industrialization and urbanization. Furthermore, they report that there are long-run bidirectional causalities between FD and energy consumption and FD and industrialization, and industrialization and energy consumption. A recent study by Sbia et al. (2017) incorporate the same variables as Shahbaz and Lean (2012) except for the industrialization and studied United Arab Emirates for the period of 1975-2011. They employed ARDL Bounds Testing Approach and VECM granger causality techniques. Their found an inverted U Shape relationship between economic growth and energy consumption whereas FD increases the energy consumption and there is also inverted U Shape relationship between urbanization and energy consumption. The set of variables that are examined as couples exhibits bidirectional relationship in the case of United Arab Emirates.

The aforementioned reviews prompt the current study to extend the existing energy literature by the inclusion of urbanization, FD and industrialization to our proposed frame work (model) to explore the interaction with economic growth as well as account for direction of causality for the case of South Africa, a fast emerging economy.

The remainder of this paper is as follows section 3 provides the econometric procedures which includes methodology and data while section 4, dwells on the empirical findings and finally section 5 gives conclusion.

4. ECONOMETRIC PROCEDURES

4.1. Methodology and Data

In this study, a time series econometrics is used to verify the objective of this research. An annual data is used; the research covers the period of 1970-2014. Data is collected from world development indicators (WDI-CD, 2015) and from global FD database. We measure FD as Domestic credit provided by financial sector as a share of gross domestic product (GDP)[1]. Real GDP per capita indicates economic growth, the total energy consumption per capita (kg of oil equivalent) measures the energy consumption, the proxy for industrialization is industrial value added as share of GDP, and the proxy for Urbanization is urban population growth (annual %). Economic growth, Industrialization and Urbanization are employed as control variable.

The log of variables provides a better result when comparing the log-linear specification to the linear function. Therefore, we change all data to its natural logarithm. The fundamental system for vitality demand for energy as modified by Sadorsky (2010), is

$$ENCt = f(FDt,GDPCt,INDt,URBt) \quad (1)$$

- ENC is or indicates the logarithmic form for total use of energy per capita,
- Logarithmic form of domestic credit provided by financial sector is FD,
- Logarithmic form for real GDP per capita is GDPC, IND is logarithmic form,
- For industrial value added as share of GDP, and UPG is logarithmic form of urban population growth rate (annual %).

The empirical route of this paper is given as thus. First, to check for stationarity of all variables and to check the order of integration, we utilize the augmented dickey-fuller (ADF) unit root tests. Second, for us to quantify the long-run relationship between variables, we utilize Johansen co-integration test. Likewise to quantify the way of the relationship among variables, we employ VECM. Finally, to see the course of causality between variables we apply the Granger causality test.

4.1.1. Model Specification

To examine if FD increases energy consumption in South Africa, economic growth, Industrialization and Urbanization are the control variables used in the study.

The equation below shows the log-log model:

$$LnEC = \alpha+\beta_1(LnFD)+\beta_2(LnGDPC)+\beta_3(LnIND)+\beta_4(LnURB)+\varepsilon i \quad (2)$$

Where:
- EC = Energy consumption
- FD = Financial development
- GDPC = Economic growth
- IND = Industrialization
- URB = Urbanization
- εi= Error term
- Ln = Natural logarithm.

4.2. Stationarity Test

Stationarity test helps to show if data within a model are in the same order of integration. Gujarati and Porter (2009) explains that when time series are non-stationary it means that its variance is not constant likewise the covariance not constant over time and this could lead to a spurious and misleading result for the estimated regression. There are several techniques used in checking for stationary, but for this study we employ the ADF basically.

1 Domestic credit provided by financial sector is measured as percentage of GDP. Domestic credit provided by financial sector includes gross credits to different sectors with the exception of net credits to central government. The financial sector includes deposit money banks and monetary authorities and also other financial corporations (Money lenders, finance and leasing corporations, pension funds and foreign exchange companies).

4.2.1. ADF Test

ADF test is type of test that is proposed by Dickey and Fuller (1981) for testing the stationarity of the series included in the study. The ADF is adjusted to rectify for the restrictions of the dickey-fuller test for a higher request autocorrelation function. The ADF procedure takes into consideration a higher request auto regressive process (Greene, 2003). Condition for the ADF can be completed as for the most part utilized model with drift and trend or as just trend. None, with neither trend nor intercept is the least used. The ADF test equation for unit root is shown below.

$$\Delta Yt = \beta_1 + \beta_2 \ t + \delta^* Yt - 1 \sum_{i=1}^{n} \alpha i \, \Delta Y t - 1 + et \tag{3}$$

With,

$$\alpha i = -\sum_{i=0+1}^{n} \delta k \qquad \text{and} \qquad \delta = \left(\sum_{i=1}^{n} \delta t \right) - 1$$

et indicates Gaussian white noise disturbance while ΔYt−1 = (Yt−1-Yt−2).

T denote the time while β stands for intercept. To avoid serial correlation problem between variables, we determine the lagged number empirically, doing so avoid a biased estimation of δ.

Null hypothesis for ADF test is H_0: δ = 0 which means that there is a unit root in the series (not stationary) while the alternative H_1: δ < 0 that is to say that series is stationary.

The ADF is employed to check if variables have a random walk or not. Mostly the null hypothesis shows that there exists a unit root, and that series is not stationary. At level, failure to reject the null hypothesis (δ = 0) then we need to take the first difference to make non stationary series stationary. Rejecting the null hypothesis implies that series is stationary.

4.3. Co-integration Test

Since variables in this area of research are not stationary at levels form, they may show trend or seasonality, or trend and seasonality. In this model, for the long run analysis and for us to be able to analyze variables relationship we introduce the co-integration test. Then we employ the co-integration test for us to check if there exist any relationship between the used variables in this study (Granger, 1981; Ding et al., 1993). Johansen and Juselius (1990) trace statistics indicates there is a co-integration vector between various variables. Another co-integration strategy, Engle and Granger (1987) is a co-integration method by and large acknowledged to be substandard to Johansen test. To fathom the issue of endogeneity of multiple explanatory variables, the Johansen and Juselius (1990) statistics is used and the endogeneity issue is resolved by allowing the vector auto regressive and error correction model with restrictions of lags. The following defines the J&J co-integration test with lags.

$$\Delta Xt = \Gamma 1 \Delta Xt-1 + ... + \Gamma n-1 \ \Delta Xt-n+1 + \Pi Xt-n+\mu + et \tag{4}$$

From the equation above, Π shows the quantity of co-integrating vector rank (r) found by testing if the eigenvalue (λi) are not quite the same as zero factually. For calculating the trace statistic, (Johansen and Juselius, 1990; Johansen, 1988) proposed that utilizing the eigenvalues of Π extents from most extreme to least. A long-run relationship utilizing the Johansen co-integration test, we look at the estimated and critical trace statistics value and compare it with the H_0 started by Osterwald (1992). At the point when the statistical value found is more than the critical point, we then reject the H0 implying there exists a co-integration in the series; else we fail to reject H_0 meaning that there is no co-integrating vector. Λ trace is shown as per the following equation:

$$\Lambda \text{ trace} = -T\Sigma(1-\lambda i) \tag{5}$$

4.4. Error Correction Model

For variables to have a likely convergence in the long-run, they should be co-integrated at same level form for a long-run relationship. Also by adjusting with time, equilibrium in the short-run is prone to meet over the long run with time. With VECM technique is utilized. The error correction term (ECT) is required to be statistically different from zero which demonstrates a workable ECM system. These show how fast the variables are adjusted towards their long-run values. Assuming variables are all I ~ (1).

Yt variation towards the trend in the long-run pattern is appeared in the stated equation above, the variation is brought about by the comparing variation in Xt, and near to its long run trend. ECT is given:

≈(Yt−θ Xt−1)

The discrepancy between the long run and short run is shown using the error correction model:

$$\Delta X \ = \ \mu + \alpha\beta' Xt - 1 + \sum_{i=0}^{k-1} \alpha i \, \Delta Xt + 1 + \varepsilon t \tag{6}$$

$$\begin{aligned} \Delta lnECt = \beta_0 &+ \sum\nolimits_{i=0}^{k-1} \beta_1 \Delta lnECt - j + \sum\nolimits_{i=0}^{k-1} \beta_2 \ \Delta lnFDt - j \\ &+ \sum\nolimits_{i=0}^{k-1} \beta_3 \Delta lnGDPCt - j \\ &+ \sum\nolimits_{i=0}^{k-1} \beta_4 \Delta lnINDt - j \\ &+ \sum\nolimits_{i=0}^{nk-1} \beta_5 \Delta lnURBt - j + \varepsilon t \end{aligned}$$

5. EMPIRICAL FINDINGS

In this section, we demonstrate the outcome and examinations of the study. As stated before, both at level and at first deference, the ADF test is used. Its results are shown in Table 1; it indicates that the variables are non-stationary; hence it has a unit root at level. Using the first difference to test, result shows that at 1st difference, it is stationary and the variables are integrated of order 1[2].

2 For interested audience the Philip Perron (PP) unit root gave same results as ADF and can be made available on request.

Table 1: ADF unit root test

Variables	Level	1st Difference	Results
LNFD	−2.336954	−7.535791*	I (1)
LNENC	−1.889063	−6.317481*	I (1)
LNGDPC	−1.229395	−4.368106*	I (1)
LNIND	−2.188388	−5.439104*	I (1)
LNURB	−2.143065	−4.236102*	I (1)

LNFD means natural log value of Domestic credit to private sector by banks, LNEC is natural log value for energy consumption, LNGDPC is natural log value for GDP per capita, LNIND is natural log value for industrial value added, and LNURB is natural log value for urban population growth. *Means stationarity at 1% and it stands for rejection of null at 1%. E-view 8.0 is used for the calculations and results

5.1. Co-integration Results

At level, the variables were not stationary using the ADF unit root test, so we need to take the first difference of the variables. After the first difference we observed that the variables were stationary. To see the long run relationship we employed the Johansen co-integration test here.

The Johansen co-integration test in Table 2a and b use both the trace and the maximum eigenvalues. For the trace statistics, it's indicated that 4 co-integrated equations at 0.05 levels and the maximum eigenvalue show 4 co-integrated equations. Thus we conclude that the variables are co-integrated and have a long run equilibrium relationship. Since there is co-integration, we proceed to run the restricted VECM estimation.

5.2. VECM Estimation

Running VECM is necessary after the variables are all integrated of same order that is, I (1) showing a long run relationship. We have to check for the short run causality and dynamics and this is done using VECM test. The speed of the adjustment in the variables is shown by ECT. The ECT coefficient(s) is required to be statistically different from zero and negative showing the causal effects in the long-run, also it's likely to convergence and the error term correction mechanism efficiency (Bannerjee et al., 1998).

If there is a presence of co-integration it means there exist a long run relationship between the variables in this study. The error correction model combines the short run effects with the long run and show how much the previous disequilibrium is removed in the present year. The Table 3 presents the VECM results for the variables used in this study.

Table 3 depicts the error correction estimation. In this study we used lag 4 as prescribed by the most parsimonious model based on the most efficient information criterion. The result above shows that in the short run, FD is significant in lag 1 and 2, GDPC is significant in lag 3, IND is significant in all lags[3]. Our empirical result shows that the ECT which shows the speed of adjustment is negative and statistically significant. This shows that the short run value of ENC will converge to its long run by 2.0301% every year or annually. The R-square is 87.2076% and this shows that the coefficient of determination accounts for 87.2076% of the variation in energy consumption as explained by FD, GDP, industrialization and urbanization. This suggests that the remaining 12.7924% is determined by other factors which are not included in the model. All the variables are significant in the long-run. Also the F-statistics shows that the variables are jointly significant.

5.3. Short-run Granger Causality Test

After the co-integration test and ECM analysis was carried out, we found that the variables are co-integrated. Next step is the Granger causality test; as seen in Table 4 shows the result. The null hypothesis concludes that there exists no causal relationship between variables against its alternative; the alternative concludes that independent variable granger causes the dependent variable. If we reject the null hypothesis which mean we accept the alternative that states that independent variable granger cause the dependent variable.

We have different methods for lag selection and it includes Schwartz information criteria, Akaike information criteria and a consecutive methodology of Hsiao (1979). Pindyck and Rubinfield (1991) proposed that it is best to utilize diverse lag structure. In this study we attempt the lag lengths somewhere around (1) and (4) since we have limited observations.

From the ECTt−1 results obtained form the previous table, it shows that ECTt−1 is significant and also has a negative sign in the energy-equation, financial-equation and industrialization-equation. FD and the use of energy bi-directional causal relationship is shown by the granger causality result in Table 4. This indicates that when domestic credit provided by financial sector is easy and affordable for individuals, this increases the acquisition of electrical appliances and in turn increases the usage of electricity there by increasing the use of energy. Likewise, an increase in energy consumption prompts more monetary and speculation exercises subsequently, increases the demand for financial services which additionally prompts financial improvement.

The bidirectional relationship between FD and energy utilization demonstrates that industrialization is caused by FD by giving simple access of monetary assets to commercial ventures or firm. Meanwhile, increment in industrialization expands the demand for financial assets thus prompt FD. Additionally a development in industrialization builds need for energy. The outcome likewise demonstrates a bi-directional relationship between energy utilization and economic development.

Results also show a bidirectional causal relationship between energy consumption and economic growth in the short-run. This implies that energy conservation polices may not adversely affect the economic growth. The result also shows that energy use also granger causes urbanization so economic growth and urbanization also has feedback effect. The demand-side hypothesis is confirmed as economic growth granger causes FD.

6. CONCLUSION

The FD – energy – economic growth nexus literature has received well documented studies in the past decades. However, there has been no consensus in the literature on the direction of causality.

3 For the brevity of space see appendix 1 for full version of VECM results reflecting all lags.

Table 2a: Johansen co-integration test (a) statistical trace

Hypothesized number of CE(s)	Eigenvalues	Trace statistic	0.05 critical value	Probability
r=0	0.89776	209.4261	88.80380	0.0000
r≤1*	0.821186	125.0444	63.87610	0.0000
r≤2*	0.581618	61.35227	42.91525	0.0003
r≤3*	0.419315	29.11190	25.87211	0.0191
r≤4	0.215933	9.000661	12.51798	0.1803

Table 2b: Maximum eigenvalues

Hypothesized number of CE(s)	Eigenvalue	Max-Eigen statistic	0.05 critical value	Probability
r=0	0.897776	84.38169	38.33101	0.0000
r≤1*	0.821186	63.69217	32.11832	0.0000
r≤2*	0.581618	32.24036	25.82321	0.0062
r≤3*	0.419315	20.11124	19.38704	0.0392
r≤4	0.215933	9.000661	12.51798	0.1803

*Indicates rejection at 5% significance level

Table 3: ECM results

Long-run causality	Coefficient	Standard error	t-statistic
LENC(−1)	1		
LFD(−1)	<0.000	<0.000	<0.000
LIND(−1)	−0.6722	0.1200	−5.5910
LURB(−1)	0.3390	0.0900	3.7576
Short-run causality			
DLNC(−1)	0.185	0.229	0.808
DLFD(−1)	−1.570	0.480	−3.270
DLGDPC(−1)	−0.0263	0.298	−0.088
DLLIND(−1)	−2.919	0.767	−3.806
DLURB(−1)	0.007	0.137	0.0543

ECM: Error correction model

Table 4: Granger causality test result

Null hypothesis	Observations	F-statistic	Probability
LNFD does not granger cause LNENC	40	0.21387	0.8085
LNENC does not granger cause LNFD		1.28709	0.2888
LNGDPC does not granger cause LNENC	40	0.50310	0.6090
LNENC does not granger cause LNGDPC		1.11023	0.3408
LNIND does not granger cause LNENC	40	0.25185	0.7788
LNENC does not granger cause LNIND		2.92992	0.0666
LNURB does not granger cause LNENC	40	1.25055	0.2988
LNENC does not granger cause LNURB		0.25234	0.7784
LNGDPC does not granger cause LNFD	43	1.18580	0.0575
LNFD does not granger cause LNGDPC		1.632207	0.0034
LNIND does not granger cause LNFD	43	3.08213	0.1676
LNFD does not granger cause LNIND		6.63302	0.0013
LNURB does not granger cause LNFD	43	1.85586	0.1702
LNFD does not granger cause LNURB		1.42415	0.2533
LNIND does not granger cause LNGDPC	43	4.74050	0.0145
LNGDPC does not granger cause LNIND		0.26330	0.7699
LNURB does not granger cause LNGDPC	43	4.03145	0.0258
LNGDPC does not granger cause LNURB		0.42076	0.6596
LNURB does not granger cause LNIND	43	2.18410	0.1265
LNIND does not granger cause LNURB		1.87793	0.1668

Our study about South Africa, a fast growing economy in Africa, increase in her energy consumption has been noticed which is aggravated by rising population. It is on the above premise, that this present study assesses the interaction among energy consumption, FD economic growth, industrialization and urbanization for the case of South Africa. The present study uses ADF and PP unit root for stationarity and Johansen to verify the presence of long-run relationship among the noted series above. The study also employs VECM for short-long run dynamic relationship in case of disequilibrium and finally we used Granger causality test to capture for direction of causation for data period of 1970-2014 for South Africa.

Empirical evidences from the Johansen estimation reveal that there exists long-run equilibrium relationship among the noted variables under review. According to the granger causality estimation, it is seen that there is bi-directional causality between FD and industrialization and between industrialization and energy utilization in the long-run.

The finding from the current study resonates with the works of Shahbaz and Lean (2012) and Shahbaz et al. (2012) who also study different countries like Tunisia and Pakistan respectively. The authors posited that developed financial system with little or no restriction should be encouraged as it has ripple positive effect on the economy. However, the pertinent role of industrialization and urbanization cannot be ruled out in the development transition of any economy. Thus, we make a claim that the above study arms the policy and decision makers with ample information for decisive decision making in South African economy.

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APPENDIX

Appendix 1: Error correction model

Cointegrating equation	Cointequation1	Cointequation2	Cointequation3		
LENC(−1)	1.000000	0.000000	0.000000		
LFD(−1)	0.000000	1.000000	0.000000		
LGDPC(−1)	0.000000	0.000000	1.000000		
LIND(−1)	−0.672222	1.157020	−0.430197		
	(0.12022)	(0.02954)	(0.12349)		
	[−5.59141]	[39.1620]	[−3.48360]		
LURB(−1)	0.339909	−0.125211	0.818264		
	(0.09046)	(0.02223)	(0.09292)		
	[3.75762]	[−5.63261]	[8.80636]		
@TREND (70)	−0.010723	−0.013583	−0.004955		
	(0.00138)	(0.00034)	(0.00142)		
	[−7.75877]	[−39.9946]	[−3.49056]		
C	−5.526538	−8.516656	−7.716028		
Error correction	D (LENC)	D (LFD)	D (LGDPC)	D (LIND)	D (LURB)
Cointequation1	−2.030083	−2.158559	−0.038132	−0.122204	0.242179
	(0.44232)	(0.61767)	(0.40076)	(0.48368)	(0.70716)
	[−4.58967]	[−3.49469]	[−0.09515]	[−0.25266]	[0.34247]
Cointequation2	1.936623	−2.840129	0.810236	0.971337	0.384862
	(0.60329)	(0.84246)	(0.54661)	(0.65970)	(0.96452)
	[3.21010]	[−3.37123]	[1.48230]	[1.47238]	[0.39902]
Cointequation3	1.887709	1.975126	−0.001239	−0.114603	−0.909415
	(0.50538)	(0.70574)	(0.45790)	(0.55264)	(0.80799)
	[3.73520]	[2.79866]	[−0.00271]	[−0.20737]	[−1.12553]
D (LENC(−1))	0.185439	1.955671	−0.486207	−0.231107	0.463437
	(0.22927)	(0.32016)	(0.20773)	(0.25071)	(0.36655)
	[0.80883]	[6.10841]	[−2.34061]	[−0.92182]	[1.26433]
D (LENC(−2))	0.164335	2.390392	−0.348518	−0.564697	−0.047909
	(0.28016)	(0.39122)	(0.25383)	(0.30635)	(0.44790)
	[0.58658]	[6.11008]	[−1.37302]	[−1.84329]	[−0.10696]
D (LENC(−3))	−0.287835	1.518549	−0.271970	−0.402988	−0.237783
	(0.28981)	(0.40471)	(0.26258)	(0.31691)	(0.46334)
	[−0.99318]	[3.75223]	[−1.03575]	[−1.27161]	[−0.51319]
D (LENC(−4))	−0.221458	0.509615	−0.248889	−0.150607	0.229523
	(0.21727)	(0.30340)	(0.19685)	(0.23758)	(0.34736)
	[−1.01929]	[1.67967]	[−1.26433]	[−0.63391]	[0.66076]
D (LFD(−1))	−1.570962	1.460217	−0.557168	−0.577359	−0.761134
	(0.48040)	(0.67085)	(0.43526)	(0.52532)	(0.76805)
	[−3.27010]	[2.17666]	[−1.28007]	[−1.09906]	[−0.99099]
D (LFD−2))	−1.180668	1.385342	−0.596291	−0.646048	−0.476428
	(0.38003)	(0.53069)	(0.34432)	(0.41557)	(0.60758)
	[−3.10678]	[2.61046]	[−1.73178]	[−1.55463]	[−0.78414]
D (LFD(−3))	−0.264253	1.269851	−0.258306	−0.498186	−0.676565
	(0.31247)	(0.43634)	(0.28311)	(0.34169)	(0.49957)
	[−0.84569]	[2.91020]	[−0.91239]	[−1.45802]	[−1.35430]
D (LFD(−4))	−0.028591	0.649735	−0.050767	−0.120281	−0.591047
	(0.20857)	(0.29126)	(0.18898)	(0.22808)	(0.33346)
	[−0.13708]	[2.23076]	[−0.26864]	[−0.52737]	[−1.77245]

(Contd...)

Appendix 1: ***(Continued)***

Cointegrating equation	Cointequation1	Cointequation2	Cointequation3		
D (LGDPC(−1))	−0.026364	−0.674743	0.631018	0.109696	−1.182249
	(0.29891)	(0.41741)	(0.27082)	(0.32686)	(0.47789)
	[−0.08820]	[−1.61650]	[2.32999]	[0.33561]	[−2.47391]
D (LGDPC(−2))	−0.468152	−0.760331	−0.219977	0.475555	0.350725
	(0.32895)	(0.45936)	(0.29804)	(0.35971)	(0.52592)
	[−1.42317]	[−1.65520]	[−0.73807]	[1.32205]	[0.66688]
D (LGDPC(−3))	0.748269	−0.035109	0.084729	−0.469655	−0.161251
	(0.34249)	(0.47827)	(0.31031)	(0.37451)	(0.54756)
	[2.18480]	[−0.07341]	[0.27305]	[−1.25404]	[−0.29449]
D (LGDPC(−4))	0.208660	0.178641	0.116233	0.549057	−0.718864
	(0.38629)	(0.53943)	(0.34999)	(0.42241)	(0.61758)
	[0.54017]	[0.33117]	[0.33210]	[1.29983]	[−1.16400]
D (LIND(−1))	−2.919529	1.704808	−0.754816	−0.853789	−1.137170
	(0.76705)	(1.07114)	(0.69498)	(0.83877)	(1.22633)
	[−3.80619]	[1.59158]	[−1.08610]	[−1.01790]	[−0.92729]
D (LIND(−2))	−2.958576	1.040542	−0.895423	−1.396362	−0.768906
	(0.69419)	(0.96939)	(0.62896)	(0.75910)	(1.10984)
	[−4.26194]	[1.07340]	[−1.42365]	[−1.83950]	[−0.69281]
D (LIND(−3))	−1.573558	0.603488	−0.588154	−0.775909	−0.554936
	(0.60944)	(0.85105)	(0.55218)	(0.66643)	(0.97436)
	[−2.58197]	[0.70911]	[−1.06515]	[−1.16428]	[−0.56954]
D (LIND(−4))	−1.340540	−0.224375	−0.137021	−0.431687	−1.782588
	(0.39744)	(0.55500)	(0.36009)	(0.43460)	(0.63541)
	[−3.37298]	[−0.40428]	[−0.38052]	[−0.99330]	[−2.80542]
D (LURB(−1))	0.007473	−0.409415	0.049721	0.132241	0.941741
	(0.13771)	(0.19231)	(0.12477)	(0.15059)	(0.22017)
	[0.05426]	[−2.12897]	[0.39849]	[0.87816]	[4.27735]
D (LURB(−2))	−0.330503	−0.875995	0.100055	0.337722	−0.075566
	(0.19347)	(0.27017)	(0.17529)	(0.21156)	(0.30932)
	[−1.70828]	[−3.24237]	[0.57079]	[1.59632]	[−0.24430]
D (LURB(−3))	−0.081393	−0.399395	0.101137	0.001022	0.445902
	(0.14913)	(0.20826)	(0.13512)	(0.16308)	(0.23843)
	[−0.54577]	[−1.91780]	[0.74849]	[0.00626]	[1.87016]
D (LURB(−4))	−0.304196	−0.851379	−0.080698	0.352931	0.274899
	(0.18833)	(0.26299)	(0.17063)	(0.20594)	(0.30109)
	[−1.61527]	[−3.23736]	[−0.47294]	[1.71380]	[0.91302]
C	0.003374	−0.099105	0.024518	0.012874	0.026322
	(0.01729)	(0.02414)	(0.01566)	(0.01890)	(0.02764)
	[0.19516]	[−4.10514]	[1.56530]	[0.68102]	[0.95231]
R^2	0.872076	0.907990	0.724760	0.754713	0.853379
Adjusted R^2	0.645749	0.745203	0.237796	0.320744	0.593971
Sum square residuals	0.007152	0.013947	0.005871	0.008552	0.018281
Standard error equation	0.023456	0.032754	0.021252	0.025649	0.037500
F-statistic	3.853167	5.577771	1.488324	1.739093	3.289726
Log likelihood	105.6976	93.34229	109.3484	102.3901	88.33594
Akaike AIC	−4.416089	−3.748232	−4.613427	−4.237305	−3.477618
Schwarz SC	−3.371169	−2.703312	−3.568508	−3.192385	−2.432698
Mean dependent	0.005496	0.019585	0.003416	−0.008805	0.000312
Standard deviation dependent	0.039409	0.064889	0.024342	0.031121	0.058851
Determinant residual covariance (dof adjusted)		3.39E-17			
Determinant residual covariance		1.82E-19			
Log likelihood		535.8057			
Akaike information criterion		−21.50301			
Schwarz criterion		−15.49472			