COINTEGRATION RELATIONSHIP BETWEEN ECONOMIC GROWTH, EXPORT AND ELECTRICITY CONSUMPTION: EVIDENCE FROM FIJI

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ABSTRACT

Energy dependent small developing island states are besieged to sustain potential rate of growth. This is due to increase in energy prices and lack of evidence based policy on long term sustainable energy use. This paper examines the long run relationship between economic growth, export and electricity consumption in Fiji over the period 1981-2011. Employing Granger causality test it is found that there is cointegrating relationship between economic growth, export and electricity consumption. The casual relationship between the variables was investigated within the error correction model framework. We found that in the long run causality runs from electricity consumption and export to economic growth. Based on this empirical analysis some important policy implications are suggested.

Key Words:

Economic growth, Export, Energy.

JEL Classification: Q43, C34

1. INTRODUCTION

Energy is one of the perquisites for economic development. Countries around the world are now putting measures to ensure energy security and perhaps to become energy independent. On the other side energy prices have been increasing since early 1980s. Many researchers, hence, have moved to examine the short term demand function for energy. The main idea of these studies has been to know how demand for energy responds to changes in prices and income. However, there is very few or no studies at least in pacific island countries (PICs) especially in Fiji that attempts to address the energy issues based on long term perspective. Being an energy dependent country and struggling to obtain potential growth rate of output, gaining insights on to long term growth effect of energy is useful for policy makers to map out appropriate policy strategies. The direction of causality is highly pertinent for policy makers. Therefore it is essential to look at long term relationship between economic growth and energy consumption. This is the main objective of this paper.

In this process we also be inclined address some neglected issues in examining long run relationship between economic growth and energy consumption. One of these issues is omitted

variable bias. Many papers in energy journals have established the relationship between economic growth and energy consumption within bivariate analysis, for example see Payne and Apergis [1] for review. However, this two variable analysis has received a lot of criticism. It is argued that the two variable relationships suffer from omitted variable bias and cointegration test from bivariate analysis could be misleading, see Smyth and Lean [2] for detailed discussion. Wolde-Rufael [3] shows that cointegration results from several African countries differ when additional variables were included. This perhaps explains why till now the debate on long term relationship between economic growth and energy consumption remain inconclusive. We purposely examine the cointegration relationship between economic growth and electricity consumption, adding exports as an extra variable. Though narrow export base, given Fiji's importance of export to rest of the world, electricity consumption is very influential in performance of export sector.

The purpose of this study is to establish if the variables under study are cointegrated, meaning that they share common trend in the long run. This would be an interesting finding in light of the small developing island nation. Secondly we develop error correction model to examine the causal relationship among economic growth, energy consumption and export. By adding export as an additional variable we anticipate to get clearer picture of relationship between economic growth and energy consumption. The literature proposes four different hypotheses of causal relationship. If there is uni-directional relationship from electricity consumption and export to economic growth, than this would imply that export and electricity consumption has direct influence on economic growth. Thus tax policies to reduce energy consumption would have negative impact on economic growth. If there is uni-directional relationship from economic growth to electricity consumption, than reduction in electricity consumption will not necessary have negative impact on economic growth. Bidirectional relationship between economic growth and electricity consumption implies that reduction in electricity consumption will negatively impact economic growth and inturn low economic growth will negatively impact electricity consumption. Finally, there could be no relationship between economic growth and electricity consumption implying that the variables are not cointegrated. The findings of this paper could be useful for policy makers in trade as well as in energy sector.

The remainder of this paper are organised as follows: section 2 gives a brief overview of energy consumption in Fiji. Section 3 provides literature review on economic growth and energy consumption. Section 4 outlines empirical methodology and results. Section 5 provides conclusion with some policy implications.

2. ENERGY CONSUMPTION IN FIJI

Fiji is a small developing island economy with population of less than a million. Its per capita GDP in current price is US$4437. The recent five years trend rate of growth is about 4% per year. The per capita vehicle ratio is increasing in comparison to other developing countries. For example this ratio has increased from 3 per 100 in 1970 to 17 per 100 in 2005. The public and private transport, rental and hire cars and Fiji electricity Authority all use imported gasoline. Since there are no oil fields and refineries in Fiji, all of its crude materials and mineral fuels are imported. The import bill of mineral fuels was FJ$1165.7 million in 2011 which is slightly above 29% of its total imports. Total electricity produce by Fiji electricity authority in 2014 increased by 0.2 percent. Electricity consumption increased by an annual 2.8 percent, driven by domestic – 5.1%, commercial – 2.3% and industrial- 1.9%. The demand for energy has been increasing steadily over time in Fiji. This is due to an increase in income and changes in government policy which enable people to buy pre-used vehicles, governments spending on infrastructure development and increasing demand for electricity from rural areas and increasing number of household population.

Table 1: Import of Minerals fuels, Crude Materials and Electricity production in Fiji.

Years	Mineral Fuels ($million)	Crude Materials ($millions)	Electricity Production (kWh)
2000	332.4	15.9	688
2001	443.5	13.7	726
2002	435.4	13.8	765
2003	463.0	16.3	812
2004	587.0	20.2	816
2005	784.0	21.7	823
2006	1021.5	32.1	690
2007	958.2	24.4	706
2008	1222.1	31.0	718
2009	720.4	25.0	715
2010	1100.5	30.3	764
2011	1165.7	30.5	741

Source: ADB (2012), Reserve Bank of Fiji Quarterly Review (2013).

3. LITERATURE REVIEW

Akinboade and Kumo [4] analysed the energy demand for South Africa using the Autoregressive Distributed Lag (ARDL) bounds testing procedure to cointegration. They analysed the long run relationship and confirmed the cointegration relationship between the variables in energy demand. Rao and Rao [5] estimated the gasoline demand for Fiji with 6 alternative time series techniques. They found long run cointegration in 5 of these techniques however; estimates with all the 6 alternative techniques were very close. Smyth and Lean [6] investigated the relationship among output, export, electricity consumption, capital and labour for Malaysia. They used granger causality test proposed by Toda and Yamamoto (1995). They found evidence of bidirectional causality between output and electricity consumption and export led growth hypothesis. Kwak and Yoo [7] in their analysis found long run cointegrating relationship between economic growth and electricity consumption in Columbia and Venezuela. Chandran et. al. [8] investigated the long run causality between growth and electricity consumption and price in Malaysia. Their results show that in long run growth, electricity and prices are cointegrated. In another study Smyth and Lean [9] examine the relationship among electricity consumption, carbon dioxide emission and out for ASEAN countries by applying Johansen Fisher panel cointegration. They confirmed long run relationship between the variables. Acarvci and Ozturk [10] using Autoregressive Distributed Lag (ARDL) bound test procedure of cointegration and vector error correction model examined the long run and short run relationship between economic growth and electricity for 11 Middle East and North African countries. Their results show that there is no cointegration in Iran, Morocco, and Syria. However, they found evidence of cointegration in Egypt, Israel, Oman, and Saudi Arabia. Further, the result indicates that policies for energy conservation can have little or no impact on economic growth in most of the MENA countries. Narayan and Smyth [11] found positive effects of export and electricity consumption on economic growth in a panel of six Middle Eastern Countries. In another study Narayan and Smyth [12] shows that real income, employment and electricity consumption are cointegrated in long run. However, other studies including Ghosh [13] for India, Hatemi and Irandoust [14] for Sweden have found evidence of unidirectional causality from economic growth to electricity consumption. Shiu and Lam [15] found long run cointegration relation between economic growth and electricity consumption for China. The seminal work of Kraft and Kraft [16] applying VAR model shows evidence of causality running from income to energy consumption in US over the period 1947-1974. Tiwari [17] emphases that while non-renewable energy consumption have negative effect on economic growth , consumption of renewable energy has positive effect on

economic growth in European and Eurasian countries. Payne and Apergis [1] found evidence of bidirectional causality between economic growth and renewable and non-renewable energy consumption for sample of 80 developing and developed countries. Tugcu et al. [18] examined the long run relationship between economic growth and non renewable energy consumption for G7 countries using production function. Their result shows that there is bidirectional causality between economic growth and non-renewable energy in all G7 economies. Payne [19] reviewed the literature on the relationship among economic growth and electricity consumption and shows that evidence on causal relationship between economic growth and electricity consumption is mixed. His analysis revealed that about 23% of the studies supported the growth hypothesis, around 28% supported the conservation hypothesis, 18% supported the feedback hypothesis and 31% of the studies supported the neutrality hypothesis.

4. MODELLING, METHODOLOGY AND RESULTS

To examine the long run relationship among economic growth, export and electricity consumption we apply the Granger causality test. A standard specification if long run cointegration relationship is evidenced to be presented as follows:

$$InGDPPC_t = \alpha + \pi_1 InEXP_t + \pi_2 InELC_t + \varepsilon_t \quad (1)$$

Where:

InGDPPC is natural log of GDP per capita at 2005 prices;

lnEXP is the natural log of ratio of exports to GDP (percent);

lnELC is the natural log of electricity consumption.

Accordingly the short run relationship can be examined through an error correction model (ECM) framework:

$$\Delta InGDPPC_t = \alpha + \sum_{i=1}^{n} Y_i \Delta InGDPPC_{t-1} + \sum_{i=0}^{n} \chi_i \Delta InEXP_{t-1} + \sum_{i=0}^{n} Z_i \Delta InELC_{t-1} + \lambda ECM_{t-1} + \varepsilon_t \quad (2)$$

At outset we address 3 issues concerning this model (1) before we undertake empirical analysis. These are (i) the order of integration of the variables under study (ii) the optimal order of VAR (iii) whether EXP and ELC are weakly exogenous with respect to GDPPC.

The results of unit root test are given in table 2. We have used standard ADF test for the variables. The result indicates that all variable are I (1) in levels and I (0) in their first difference. An OLS estimation of the equation (1) yields an estimated residual series ECM. The ADF test on ECM suggests that the estimated residual is stationary at level, indicating the evidence of a long run cointegration relationship. The results in table 2 are self explanatory.

To determine the order of VAR the standard AIC and SBC criteria are used starting with order of 2. AIC indicated a second order but SBC indicated first order. Since our sample size is small we decided to use first order of VAR.

Using first order of VAR we conduct the block non-causality test to find out if EXP and ELC are weakly exogenous to GDPPC. Excluding the intercept, the null that explanatory variables are exogenous was rejected at 5% level. The computed test statistics with p-value in brackets is $X^2(2)$

= 177.65(0.000) this implies that Granger causality estimate of cointegration equation can be normalised in GDPPC.

Table 2: Unit Root Test

Variables	ADF test Statistics	Critical Value (5%)
GDPPC	0.3291(1)	2.9639
lnGDPPC	7.2100(1)	2.9677
EXP	1.9393(1)	2.9639
lnEXP	5.0172(1)	2.9677
ELC	1.1930(1)	2.9639
lnELC	5.2936(1)	2.9677
ECM	5.0209(1)	2.9718

Note: E-Views 8 have been used for the tests. The number of lags used is in the parentheses.

4.1 Estimates of Cointegration Equation

Estimates of cointegration equation with Granger causality is shown in table 3. We have introduced an intercept dummy variable DUM 87206. This dummy variable is 1 for year 1987, 2000 and 2006 and zero for all other times. This was a time of political instability in Fiji. Also without this dummy variable, test for serial correlation was poor. The coefficients of export and electricity consumption are as expected with positive sign and plausible.

Table 3: Long Run estimates

Variables	coefficient	T-statistics	P-Value
C	8320.96	11.0178	0.000
EXP	14.9682	-1.9802	0.057
ELC	4.02301	12.0391	0.000
DUM87206	-21.0167	-0.1375	0.8916

To examine the short run causality among the variables we proceed to apply Granger causality tests within the error correction model framework. The results are reported in Table 4. For the equation (2) with lnGDPPC as dependent variable, the coefficient for the error term (ECM) is negative and significant at 1 percent level. A significant ECM is indicative of long run causality running from export and electricity consumption to economic growth. The magnitude of ECM (-0.22) indicates that adjustment towards the long run equilibrium is about 22 percent per annum. This implies that though these variable deviate in the short run, they will converge to long run equilibrium.

Table4: short Run Estimates

Variables	Coefficient	T-statistics	P-Value
C	39.2136	1.0879	0.2866
lnEXP	7.8151	0.9496	0.3510
lnELC	0.6312	0.6277	0.5356
ECM(-1)	-0.2197	3.4919	0.0017

The summary statistics of this model did not reveal any evidence against the validity of the estimation. The R^2 is about 86%. The Chi square test for serial correlation [$X^2(2)$ =

5.1961(0.07)], normality of residual [X^2=0.4374(0.80)] and heteroscedasticity [$X^2(3)$ = 2.2922(0.51)] were all significant at 5 % level.

5. CONCLUSION AND POLICY IMPLICATION

This study has examined the long run cointegration relationship between economic growth, export and electricity consumption in Fiji using time series data over the period 1981-2011. Employing standard granger causality test we find evidence that economic growth, export and electricity are cointegrated. Thus in the long run, electricity consumption is essential for economic growth and development. Government needs to understand the importance of energy and electricity and allocate resources for development of new sources of energy and reduce energy import bill. Investment in solar energy should continue as Fiji has abundance of sunlight. Policy makers must note that taxation to limit energy import would have negative impact on economic growth. Investment in energy infrastructure would be more appropriate so that private sector investment can take place. Further, policy makers should undertake reforms that would open up the energy sector for competition. This will reduce the cost of electricity and attract more investment in export sector.

REFERENCE

[1] Apergis, N. and J. E. Payne, (2012b) "Renewable and non-renewable energy consumption-growth nexus: Evidence from a panel error correction model", Energy Economics, Vol. 34, No. 3, pp. 733-738.

[2] Lean, H.H. and R. Smyth, (2010a) "On the dynamics of aggregate output, electricity consumption and exports in Malaysia: Evidence from multivariate Granger causality tests", Applied Energy, No. 87, pp. 1963-1971.

[3] Wolde-Rufael, Y., (2006) "Electricity Consumption and Economic Growth: A Time SeriesExperience for 17 African Countries", Energy Policy, No. 34, pp. 1106-1114.

[4] Akinboade, O. A., Ziramba, E and Kumo, W L., (2008) "The demand for gasoline in South Africa: An empirical analysis using cointegration techniques", Energy Economics, No. 30, pp.3222-3229.

[5] Rao, B.B. and Rao, G., (2008) "Cointegration and the Demand for Gasoline", Economics and Econometrics Research Institute, No.13.

[6] Lean, H.H. and R. Smyth, (2010b) "On the dynamics of aggregate output, electricity consumption and exports in Malaysia: Evidence from Multivariate Granger Causality test", Applied Energy, No 87, pp. 1963-1971.

[7] Yoo, S.H. and S.Y. Kwak, (2010) "Electricity Consumption and Economic Growth in Seven South American Countries", Energy Policy, No. 38, pp. 181-188.

[8] Chandran, V.G.R., S. Sharma, and Madhavan, K., (2010) "Electricity Consumption-Growth Nexus: The Case of Malaysia", Energy Policy, No.38, pp. 606-612.

[9] Lean, H.H. and R. Smyth, (2010c) "CO2 Emissions, Electricity Consumption, and Output in ASEAN", Applied Energy, No. 87, pp. 1858-1864.

[10] Acaravci, A., Ozturk, I., (2010) "Electricity Consumption-Growth Nexus: Evidence from Panel Data for Transition Countries", Energy Economics, No.32, pp. 604-608.

[11] Narayan, P.K., Smyth, R., (2009) "Multivariate Granger causality between electricit y consumption, exports and GDP: evidence from a panel of Middle Eastern countries", Energy Policy No. 37, pp. 229–236.

[12] Narayan, P.K., Smyth, R., (2005) "Electricity consumption, employment and real income in Australia: evidence from multivariate Granger causality tests", Energy Policy No. 33, pp. 1109–1116.

[13] Ghosh, S., (2002) "Electricity Consumption and Economic Growth in India", Energy Policy, No. 30, pp. 125-129.

[14] Hatemi, A., Irandoust, M., (2005) "Energy consumption and economic growth in Sweden: a leveraged bootstrap approach, 1965–2000", International Journal of Applied Econometrics and Quantitative Studies, Vol. 2, No. 4, pp. 87–98.

[15] Shiu, A., P.L. Lam., (2004) "Electricity Consumption and Economic Growth in China", Energy Policy, NO. 32, pp. 47-54.

[16] Kraft, J. and A., (1978) "On the relationship between energy and GNP", Journal of Energy and Development, No.3, pp. 401-403.
[17] Tiwari, A. K., (2011) "Comparative performance of renewable and non-renewable energy source on economic growth and CO2 emissions of Europe and Eurasian countries: A PVAR approach", Economics Bulletin, Vol. 31, No.3, pp. 2356-2372.
[18] Tugcu, C. T, I. Ozturk and A. Aslan., (2012) "Renewable and non-renewable energy consumption and economic growth relationship revisited: Evidence from G7 countries", Energy Economics, No. 34, pp. 1942–1950.
[19] Payne, J.E., (2010) "A Survey of the Electricity Consumption-Growth Literature", Applied Energy No. 87, pp. 723-731.
[20] Ajaz, W., (2014) "Comparing Economic Feasibility of domestic solar water heater installation in major cities of Pakistan", Advanced Energy: An International Journal (AEIJ), Vol. 1, No. 1, pp. 35-42.

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