РОЗДІЛ 3

Макроекономічні механізми

Energy Consumption and Economic Growth in Small Island Economies

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Petroleum is the primary source of energy used in transportation and electricity generation for many small Pacific island economies. Noting the growing demand for transportation and infrastructure services, we investigate the long-run association between petroleum consumption and output per worker in Fiji, a small island economy in the Pacific. We use a Cobb-Douglas framework and the ARDL bounds procedure with sample periods from 1980 to 2013. The results show that a 1 % increase in petroleum consumption results in 0.08 % increase in the long run economic growth. The granger non-causality results show that energy consumption causes economic growth, thus confirming energy-led growth hypothesis. The overall results underscore the need for efficient use of energy in general with the impetus to focusing on renewable energy as an important source of economic growth. We argue that energy in whichever form (renewable or non-renewable) is an integral input for economic growth for small island countries in the Pacific. Furthermore, the country is an importer and redistributor of petroleum to other neighbouring islands. The petroleum products comprise of motor gasoline, jet fuel, kerosene, distillate fuel oil, residual fuel oil, and liquefied petroleum gases (LPG). The operations of airlines, ferries, cruise liners and other types of transportation are linked with tourism industry and heavily rely on petroleum. Also, petroleum is used for generating electricity, and the usage increases during the hot and dry season to support the hydro power plants. Considering Fiji as a reference and petroleum as a major type of energy, the study examines the relationship between energy and economic growth, whilst accounting for capital and labour stock, and structural breaks. This study aims to provide impetus to efficient use and management of energy in the Pacific with the overarching aim to promote economic growth and fostering policies to gradually phase out non-renewable energy sources.

Keywords: petroleum consumption, growth, ARDL bounds approach, causality, structural break, Fiji.

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1 Introduction

The role sustainable energy in driving economic activities is becoming an important point of discussion and controversy. The latter is mostly on the negative impact of fossil fuel such as ozone depletion and green-house gas emissions. Thus, the need and desire for cleaner energy and environment have become instrumental for balanced growth and development.

Although, ideally, renewable energy is preferable, energy from non-renewable sources such as fossil remains an important input for economic activities in many countries. Thus, use and management of energy for growth and development becomes a challenging consideration in the development of sound energy policies. It must be highlighted that for small island economies, petroleum is the main type of energy, although there is a gradual shift towards renewable sources of energy.

The *2016 Pacific Update Conference* on "Inclusive growth for enhanced resilience", developments in renewable energy in the small islands in the Pacific was a key area of discussion[†]. The merits of renewable sources of energy and green industry were discussed. It was noted that renewable energy needs to be promoted in the Pacific because the weather extremity and natural disasters in the region often disrupts the flow of non-renewable sources of energy and the fact that the countries depend heavily on the imported fuel. Additionally, shifting to renewable energy is necessary to support the efforts toward reducing emission and pollution, and the adverse effects of climate change such as sea level rise, which are already experienced in small island countries such as Kiribati, Marshall Islands, and Tuvalu. The conference also highlighted that fossil fuel is a limited resource and the cost of CO_2 is expected to rise dramatically in the coming years and thus a shift towards green industry need to be taken seriously.

Most of the small island countries in the Pacific aim to substantially increase the renewable energy generation by 2020 or 2025. With exception to Federal State of Micronesia and Vanuatu which aims to have 30 % and 65 %, respectively, of the energy generated from renewable sources, all other small and developing island countries in the Pacific targets a 100% renewable energy. However, to date, only Fiji, Papua New Guinea and Samoa have above 30 % of all energy from renewable sources.

Whilst we note the importance of renewable energy in the Pacific, the focus of this study is to highlight the importance of energy in general for economic development. It must be noted that petroleum is a major type of non-renewable energy used many island countries. In retrospect, at a global level in 2012, the petroleum consumption rose from 89,721 to 91,915 thousands of barrels per day and the net global electricity consumption was 19,710 billion kilowatt hours in 2012, which is an increase of 1.6 % from the previous year (EIA, 2014).

With a notable growth in the services sector, particularly tourism, the manufacturing activities, transportation and infrastructure such as road and airport developments, the demand and consumption of energy has never been more important in Fiji. It must be noted that Fiji's fuel imports are about 23 % (2013) of all merchandize imports. The GDP per capita and population of Fiji is just around 8200 PPP-$, and 890,000 people. Fiji is, relative to other neighbouring island countries, richer in terms of natural resources, timber, soils, mineral deposits and fish (CIA, 2015). Furthermore, the country is an importer and redistributor of petroleum to other neighbouring islands. The petroleum products comprise of motor gasoline, jet fuel, kerosene, distillate fuel oil, residual fuel oil, and liquefied petroleum gases (LPG).

[†] http://www.econ.fbe.usp.ac.fj/index.php?id=19727 *and* http://www.econ.fbe.usp.ac.fj/fileadmin/files/schools/ssed/economics/events/Pacific_Update_2016/Updated_Presentations/Plenary5/Plenary5_Bokhwan_Yu_ADBI_2016_Pac_Update.pdf.

The operations of airlines, ferries, cruise liners and other types of transportation are linked with tourism industry and heavily rely on petroleum. Also, petroleum is used for generating electricity, and the usage increases during the hot and dry season to support the hydro power plants (Dornan & Jotzo, 2015).

In efforts to modernize the economy, the government of Fiji is putting strategies and resources to promote energy efficiency and renewable energy (Dornan, 2014a). The renewable energy initiatives have begun with the development of Clay Energy, an organisation which aims to promote the use of renewables and are responsible for the implementation of renewable energy harvesting in the country. Fiji Electricity Authority (FEA) – a state owned enterprise – is the major electricity supplier in the country and also invests heavily in a number of hydropower projects. FEA is currently looking for private-public partnerships with the aim to reach 80 per cent of energy use from renewable sources by 2025 (Lal, 2015). Given the slow transition and partnership, the initiative is expected to take some time to materialise and petroleum will remain the leading source of energy for some time (Dorman, 2014b).

We argue that energy in whichever form (renewable or non-renewable) is an integral input for economic growth for small island countries in the Pacific. Considering Fiji as a reference and petroleum as a major type of energy, the study examines the relationship between energy and economic growth, whilst accounting for capital and labour stock, and structural breaks. This study aims to provide impetus to efficient use and management of energy in the Pacific with the overarching aim to promote economic growth and fostering policies to gradually phase out non-renewable energy sources. This is one of the more important motivations of the study, CO_2 emissions continue to arise (see Figure 2) concurrently with petrol usage in Fiji despite the establishment of hydro-electricity dams since 1983 and the prominence renewable energy sources have played in national development plans post 1996. The remaining sections of the paper are planned as follows. In section 2, we provide a brief literature survey. In section 3, we discuss the framework, data, method, followed by the results in section 4. Lastly, in section 5, some concluding remarks follow.

A brief literature survey

The literature on energy consumption and growth nexus converge on four outcomes (c.f. Payne (2010)). The growth hypothesis (H1) is confirmed on the basis of energy consumption granger causing economic growth. The conservation hypothesis (H2) implies causality from economic growth to energy consumption. The feedback hypothesis (H3) refers to the confirmation of a bi-directional causality between energy and economic growth. The absence of causality in any direction supports the neutrality hypothesis (H4)[‡]. The direction of causality has important implications for policy (Narayan & Singh, 2006; Narayan and Smyth, 2005; Ghosh, 2002; and Asafu-Adjaye, 2000). H1 implies energy conservation policies would prove detrimental to growth; H2 implies energy savings policies are suitable as economies align towards renewable and sustainable energy sources, H3 implies conservation policies and growth policies need to be applied in an appropriate mix while H4 implies that energy is not a growth driver and the country can with ease focus on sustainability and climate change combative policies. The relationship between energy and economic growth is examined in the literature with focus on country-specific, region-specific and panel studies under various theoretical and statistical settings. It must be noted that the variables, functional forms and the subsequent results on the causality nexus vary enormously, and is largely influenced by, inter

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[‡] Causality analysis is an implication of the Granger representation theorem and requires the variables under study to exhibit a cointegrating relationship.

alia, background of a researcher, research motive and energy dynamics in a country or regional settings, sample size, methodology, and structural changes and reforms affecting energy and growth. It is also noted that the empirical studies emphasise on causal time series and panel analysis, on forecasting exercise and policy evaluation. Almost all the empirical investigation normally follows econometric approaches with focus on unit root test, cointegration and error correction (short-run and long-run dynamics) and causality analysis. Additionally, panel studies allow for cross section dependence and panel heterogeneity. Also, some recent studies focus on clean energy, low carbon and green growth (Fang & Chang, 2016).

The seminal work in this area was Kraft and Kraft (1978) examining this relationship with US data over 1947–1974 and it found support for the conservation hypothesis. Using monthly US data over 1973–1978, Akarca and Long (1979) found support for the growth hypothesis. Recently, Arora and Shi (2016) using a time varying parameter model with quarterly US data find evidence of bi-directional causality in the 1990's and supporting the conservation hypothesis post 2000. A summary of the reviewed studies in the energy-growth and causality nexus are provided in the sections 2.1–2.4 below. As noted, the results are mixed on the nature of the causal relationship.

The growth hypothesis

Other similar studies include Philippines (Yu & Choi, 1985), Japan (Erol & Yu, 1987), the USA (Stern, 1993; 2000; Bowden & Payne, 2009), India and Indonesia (Masih & Masih, 1996), Singapore (Glasure & Lee, 1998), Turkey, France, Germany (Soytas & Sari, 2003; Altinay & Karagol, 2005), China (Soytas & Sari, 2003; Yuan et al., 2007), Benin, Congo, Tunisia (Wolde-Rufael, 2004; 2006), Tanzania, South Africa, Kenya (Odhiambo, 2009; Kumar & Kumar, 2013a; Kumar et al., 2015b), Nigeria (Akinlo, 2009), Lebanon (Abosedra et al., 2009), Gibraltar (Kumar et al., 2015a), Belgium, Spain (Omri et al., 2015), Malaysia (Azam et al., 2015), Bhattacharya et al. (2015) for 38 countries in the list of renewable energy consumption; Tang et al (2016) for Vietnam; and Hamit-Haggar (2016) for Sub-Saharan Africa with a focus on green energy, Narayan and Singh (2006) in Fiji; Bildirici (2013) for Argentina, Bolivia, Cuba, Costa Rica, Jamaica, Nicaragua, Panama and Peru; Pirlogea and Cicea (2012) in Romania and Spain; Tiwari, Apergis and Olayeni (2015) for 12 Sub Saharan African countries.

The conservation hypothesis

Countries for which the conservation hypothesis is confirmed includes, USA (Kraft & Kraft, 1978; Abosedra & Baghestani, 1989; Menyah & Rufael, 2010), India (Yu & Choi, 1985; Ghosh, 2002), West Germany (Erol & Yu, 1987), Indonesia and Thailand (Masih & Masih, 1996; Yoo 2006; Yoo & Kim, 2006), South Korea and Italy (Oh and Lee, 2001a; Soytas & Sari, 2003), Australia (Narayan and Smyth, 2005), France, Japan (Lee, 2006), Congo (DRC) (Odhiambo, 2009), China (Zhang, 2009), Albania, Bulgaria, Hungary, Romania (Kumar et al., 2014a), Canada, Netherlands and Sweden (Omri et al., 2015), and selected countries in the Asia-Pacific (Fang & Chang, 2016), Coers and Sanders (2013) for 30 OECD countries; Arora and Shi (2016) for the USA.

The feedback hypothesis

Another major strand of research in this nexus supports the feedback hypothesis, a bi-directional causality between (renewable) energy and economic growth. These studies include are Erol and Yu (1987) for Japan, Italy; Hwang & Gum, (1992) for Taiwan; Masih and Masih

(1996) for Pakistan; Ebohon (1996) for Tanzania and Nigeria; Glasure and Lee (1998), Oh and Lee (2004b) and Asafu-Adjaye (2000) for South Korea, Singapore, Philippines and Thailand, Hondroyiannis et al. (2002) for Greece; Soytas and Sari (2003) for Argentina, Ghali & El-Sakka (2004) for Canada; Lee (2006) for USA; Tang (2008) for Malaysia; Wolde-Rufael (2006) for Egypt, Gabon and Morocco; Yoo (2005 and 2006) for Korea, Malaysia and Singapore; Yoo and Kwak (2010) and Shahbaz et al. (2011) for Venezuela, Burkina Faso, Portugal and Pakistan; Bloch et al. (2015) and Bhattacharya et al. (2015) for China; Omri et al. (2015) for Argentina, Brazil and France; and Azam et al (2015) for Indonesia. Recent studies have confirmed feedback hypothesis for Brazil (Al-mulali, Solarin & Ozturk 2016) using biofuel energy consumption,10 largest hydroelectricity consuming countries (Apergis et al., 2016), Turkey (Dogan, 2017), Saudi-Arabia (Mezghani & Haddad, 2017), Germany (Rafindadi &Ozturk, 2017), selected countries in the middle east and north Africa (MENA) (Kahia, Aïssa & Lanouar, 2017), the USA (Carmona et al., 2017), Wang, Li, Fang and Zhou (2015) in China, Ouedraogo (2010) in Burkina Faso; Gurgul and Lach (2012) for Poland; Mishra, Smyth and Sharma (2009) for small south pacific countries.

The neutrality hypothesis

A few studies show evidence of the neutrality hypothesis, where energy and GDP may or may not be cointegrated but may not show any form of causal links plausibly due to (a) data set and timeframe and (b) methods employed. These studies include Akarca and Long (1980), Yu and Hwang (1984), and Yu and Choi (1985) for Kenya, South Africa, Sudan and USA; Masih and Masih (1996) and Glasure and Lee (1998) for Malaysia, Singapore, Philippines and South Korea; Asafu-Adjaye (2000) and Altinay and Karagol (2004) for Indonesia, India and Turkey; Lee (2006), Wolde-Rufael (2006) and Omri et al.(2015) for UK, Germany, Sweden, Algeria, Congo Republic Finland, Hungary, India, Japan and Switzerland (Omri et al. 2015); Azam et al. (2015) for Thailand; Rodríguez-Caballero & Ventosa-Santaulària (2016) for the Latin-American countries; Rahman and Mamun (2016) for Australia; and Shahbaz et al. (2017) for India, Tang (2008) in Malaysia.

Energy-growth nexus in Fiji

The energy growth nexus has previously examined in Fiji by Narayan and Singh (2006). While this has been the only country specific study in Fiji to date over 1971–2002 using annual data, there are some limitations in this study that warrants further investigation. Firstly, the model is specified without clear guidance from economic theory (Easterly et al, 2004) and includes electricity consumption and labour supply as explanatory variables. Investment data is available for the entirety of their sample from the World Development Indicators database which can be used to compute the capital stock series. In doing so, the model would comply with at least some simple extensions of the neoclassical growth theory such as those devised by Rao (2010). The long run income elasticity of electricity consumption is noted at 0.07 while the short run elasticity is noted at 0.02 using the ARDL-Bounds approach. Given that the study finds the existence of a single cointegrating vector, the endogeneity bias is unlikely to arise and the estimates can be considered as reliable even in the absence of potential explanatory variables. Nonetheless, using a well-established theory adds a coherent theoretical framework to empirical studies giving further validity to the results in addition to meeting statistical requirements. Secondly, although the ARDL bounds methods does not require pre-testing for unit roots, it is recommended to carry out this test anyway because the bounds methodology is not applicable with I(2) data. Using multiple unit root tests adds further validity to the results of the ADF test. Lastly, and perhaps most surprisingly, the study does not include any methodology for identifying and including structural breaks especially for a country noted for a history of political crises and natural disasters. In addition, the study is uses data over a decade old. No study, since then at the country specific level has examined the energy-growth nexus in Fiji. Additionally, no study has examined this nexus using petroleum data, in this regard, this study provides first hand, the relationship between petroleum and real output.

Energy consumption-pollution nexus

Energy consumption from non-renewable sources leads to eventual pollution and carbon emissions. Wang, Li, Fang and Zhou (2015) note that China whilst the largest consumer of energy, is also the largest emitter of CO_2. They note that this complicates growth policy as policy makers need to balance the dual goals of growth and sustainability. Not surprisingly, the authors find a unidirectional causality from energy consumption to CO_2 emissions. Similarly, Shahbaz, Bhattacharya and Ahmed (2016) find a positive association between energy consumption and CO_2 emissions in Australia and by Esso and Keho (2016) for Sub-Saharan countries. The natural question arising in this study is the rationale for considering the growth enhancing effects of non-renewable energy because this has the capacity of biasing any possible growth effects. However, in Fiji and other similar economies, non-renewables still plays an important role in facilitating economic activity. Hence, before non-renewable energy sources can be replaced with renewable alternatives, a clear assessment of the causal effects of energy is crucial for formulating appropriate sustainability policy.

Modelling Strategy, Data, & Methodology

Modelling Strategy

The approach follows from the model of Sturm (1998) and Rao (2010) which is closely related to Solow (1956). Recent studies which use this approach includes Kumar and Kumar (2013), Kumar et al. (2014) and Kumar et al. (2015a). The general equation is given as[§]:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} \, , \tag{1}$$

where A is the level of technology, K and L are the capital and labour stock, respectively; α and β are capital and labour shares, respectively. Hence assuming constant returns to scale, $\beta = 1 - \alpha$, we have:

$$y_t = A_t k_t^{\alpha}, \alpha > 0, \tag{2}$$

The model assumes that the development of technology is given by:

$$\Phi_t = A_0 e^{gt}, \tag{3}$$

where A_0represents the initial stock of knowledge (technology) and t is the time and is assumed to grow at a rate of g per period. We introduce petroleum consumption per worker, pet_t and the effect of which on total factor productivity (TFP) is captured when the former is entered as a shift variable (Rao, 2010):

$$\Psi_t = f(pet_t) = pet_t^{\theta}, \tag{4}$$

[§] The Cobb-Douglas model satisfies the Inada conditions that guarantee stability of the economic growth path (Kumar et al. 2017).

where $\theta > 0$ represents the elasticity of output with respect to petroleum, hence:

$$A_t = \Phi_t \Psi_t = A_0 e^{gt} pet_t^{\theta}. \tag{5}$$

Finally, including this information in (2), we get:

$$y_t = \left(A_0 e^{gt} pet_t^{\theta}\right) k_t^{\alpha} \ , \tag{6}$$

and taking log of (6), we get the basic model for estimation as:

$$ln\, y_t = \pi + \delta Trend + \vartheta TB + \alpha\, ln\, k_t + \theta\, ln\, pet_t + \varepsilon_t \ , \tag{7}$$

where $\pi = \frac{\phi_1}{1-\sum_{i=1}^{p_1}\gamma_{2i}}$ is the constant, $\delta = \frac{\phi_2}{1-\sum_{i=1}^{p_1}\gamma_{2i}}$ and $\vartheta = \frac{\phi_3}{1-\sum_{i=1}^{p_1}\gamma_{2i}}$ is the coefficient of time ($Trend$) and structural break dummy (TB), respectively; $\alpha = \frac{\sum_{i=0}^{p_2}\zeta_{2i}}{1-\sum_{i=1}^{p_1}\gamma_{2i}}$ is the capital share, and $\theta = \frac{\sum_{i=0}^{p_3}\omega_{2i}}{1-\sum_{i=1}^{p_1}\gamma_{2i}}$ is the elasticity coefficient of petrol consumption per capita. These long-run coefficients can be derived and confirmed using the coefficients of the lag estimates given as:

$$\ln y_t = \phi_1 + \phi_2 T + \vartheta_2 TB + \sum_{i=1}^{p_1}\gamma_{2i}\ln y_{t-i} + \sum_{i=0}^{p_2}\zeta_{2i}\ln k_{t-i} + \sum_{i=0}^{p_3}\omega_{2i}\ln pet_{t-i} + u_t. \tag{8}$$

Data

The data on GDP (gross domestic product), investment and population are sourced from the *World Development Indicators and Global Development Finance* database (World Bank, 2015). The data for output (Y_t) is measured by GDP and gross fixed capital formation is used as a proxy for investment (I_t) in terms of constant Fijian dollars. The petroleum data (in thousand barrels per day) is obtained from *International Energy Statistics* (EIA, 2015) and is converted in litres per year using the conversion metrics provided by EIA (2015).The annual capital stock data, K_t is constructed using the perpetual inventory method:$K_t = (1-\delta)K_{t-1} + I_t$, where $K_0 = \gamma Y_0$,$\delta = 0.01$ is the depreciation rate, $\gamma = 1.10$ is a parameter multiplied with the initial constant GDP(Y_0), to compute the initial capital stock: K_0.[**] The sample size is from 1980 to 2013. Finally, we express the variables in per capita terms and take the log transformation and estimate equation (8).

Method

Unit-Root Tests

We apply the Augmented Dickey-Fuller (1979) (ADF), the Phillips-Perron (1988) (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (1992) (KPSS), unit root tests respectively. Apart from the conventional tests, we apply the Perron (1997) and Zivot-Andrews (1992) tests to examine structural breaks in the series. Furthermore, we apply the innovational and additive outlier tests in four scenarios to comprehensively examine the break period which is included as a dummy variable whilst performing the cointegration test. The test is done in four cases: (a) with a trend specification of intercept and break in intercept only;(b) a trend specification

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[**] The values of δ and γ are set arbitrarily (c.f. Kumar et al., 2014, 2015a).

of intercept and trend with breaks in the intercept; (c) a trend specification of intercept and trend with a break in trend and intercept terms, and (d) a trend specification of intercept and trend with breaks in the trend term only. The Perron (1997) and Zivot and Andrews (1992) break tests determine endogenously, a single data specific break. For each possible structural break date, the optimal number of lags in a Dickey-Fuller type unit root test equation is chosen with the option of minimising the computed test statistic to derive candidate breaks. Among the identified candidate breaks, the break minimising the computed test statistic is chosen as the optimal break. We also observe the dynamic stability of the parameters by plotting the CUSUM or CUSUMSQ and examining the bounds.

Cointegration, long- and short run analysis

Next, we examine the long-run association (cointegration) using the auto-regressive Distributed Lag (ARDL) bounds approach developed by Pesaran et al. (2001). There are many advantages of using the method (Ghatak & Siddiki, 2001; Pesaran et al., 2001; Narayan, 2005; Odhiambo, 2009; Al-Mulali et al., 2014; Kumar et al., 2014). These include: (a) the method works well with small sample size and avoids endogeneity bias; (b) the method can be applied with I(0), I(I), or fractionally integrated variables; (c) all variables can be assumed to be endogenous when examining cointegration; and (d) the long-run and short-run parameters are estimated in a single step. The following vector error–correction model is estimated:

$$\Delta \ln y_t = \phi_0 + \vartheta_0 T + \vartheta_1 TB + \phi_2 \ln y_{t-1} + \phi_3 \ln k_{t-1} + \phi_4 \ln pet_{t-1} + \sum_{i=1}^{p_1} \gamma_{1i} \Delta \ln y_{t-i} + \\ + \sum_{i=0}^{p_2} \delta_{1i} \Delta \ln k_{t-i} + \sum_{i=0}^{p_3} \theta_{1i} \Delta \ln pet_{t-}i + \varepsilon_t. \qquad (9)$$

Equation (9) is estimated by the OLS technique. The bounds test for cointegration is conducted through a hypothesis test of linear restrictions on the lagged level variables in (8). Specifically, the null of no long run relationship $\{\phi_2 = \phi_3 = \phi_4 = 0\}$ is tested against the alternative of the presence of a cointegrating relationship $\{\phi_2 \neq 0;\ \phi_3 \neq 0;\ \phi_4 \neq 0\}$ with either the F or Wald statistics. Cointegration exists if $\mathrm{F} > upper\ critical\ bound$, cointegration does not exist if $\mathrm{F} < lower\ critical\ bound$ while an inconclusive outcome is reached if, lower critical bound $< F < upper\ critical\ bound$.

Once cointegration is established, the respective short- and long-run models are estimated. The coefficient of an independent variable in the log-linear model can be interpreted as an 'elasticity of output with respect to the given independent variable'. The error correction term in the dynamic estimation measures the speed of adjustment from equilibrium deviations caused by previous period shocks. Hence, for convergence to occur, the coefficient of the error-correction-term should fall between 0 and negative 1.

Causality Analysis

For long run causality, the MWALD test developed by Toda and Yamamoto (1995) is used. Zapata and Rambaldi (1997) note that both likelihood ratio test and Wald test are very sensitive to the specification of the short run dynamics in error-correction model (ECM) even in large samples. Furthermore, they noted that given the performance of the tests in larger samples, the MWALD test has better appeal because of its simplicity

In order to employ the MWALD test, we pre-specify the maximal order of integration (d_{max}) for the series in the system and the optimal lags order (k) for the VAR. We use d_{max} because it performs better than other orders of d_{max} (see Dolado & Lutkepohl, 1996) and because d_{max} represents the maximum order of integration which is usually 1. To ascertain the causality direction between tourism and economic growth, an augmented VAR model within a setting of $k + d_{max}$ lags is estimated.

We use the Toda and Yamamoto (1995) approach as the Granger non-causality test in this study. Advantages of this approach include (a) causality can be identified despite any order of integration, whether I(0), I(1) or even I(2), (b) causality can be identified independent of cointegration and (c) it works in sync with the ARDL bounds method making use of information such as (i) lag length and (ii) maximum order of integration from the unit root tests[††]. This test of causality is made possible by estimating the following VAR system (equations 10-12).

$$\ln y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \ln y_{t-i} + \sum_{j=k+1}^{\delta_{max}} \alpha_{2j} \ln y_{t-j} + \sum_{i=1}^{k} \alpha_{3i} \ln k_{t-i} + \sum_{j=k+1}^{\delta_{max}} \alpha_{4j} \ln k_{t-j} + \\ + \sum_{i=1}^{k} \alpha_{5i} \ln pet_{t-i} + \sum_{j=k+1}^{\delta_{max}} \alpha_{6j} \ln pet_{t-j} + u_{1t} \tag{10}$$

$$\ln k_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} \ln y_{t-i} + \sum_{j=k+1}^{\delta_{max}} \beta_{2j} \ln y_{t-j} + \sum_{i=1}^{k} \beta_{3i} \ln k_{t-i} + \sum_{j=k+1}^{\delta_{max}} \beta_{4j} \ln k_{t-j} + \\ + \sum_{i=1}^{k} \beta_{5i} \ln pet_{t-i} + \sum_{j=k+1}^{\delta_{max}} \beta_{6j} \ln pet_{t-j} + u_{2t} \tag{11}$$

$$\ln pet_t = \omega_0 + \sum_{i=1}^{k} \omega_{1i} \ln y_{t-i} + \sum_{j=k+1}^{\delta_{max}} \omega_{2j} \ln y_{t-i} + \sum_{i=1}^{k} \omega_{3i} \ln k_{t-i} + \\ \sum_{j=k+1}^{\delta_{max}} \omega_{4j} \ln k_{t-j} + + \sum_{i=1}^{k} \omega_{5i} \ln pet_{t-i} + \sum_{j=k+1}^{\delta_{max}} \omega_{6j} \ln pet_{t-i} + u_{3t}. \tag{12}$$

The presence of causality can be found through standard hypothesis testing procedures. Specifically, we reject the null hypothesis of the absence of causality if the p-value of the χ^2 test of restriction falls within the 1–10 % level of significance. Hence, in (10), Granger causality from $In\ k_t$ to $In\ y_t$ $(In\ k_t \to In\ y_t)$ implies that $\alpha_{3i} \neq 0 \forall i$, Granger causality from $In\ pet_t$ to $In\ y_t$ $(In\ pet_t \to In\ y_t)$ is implied if $\alpha_{5i} \neq 0 \forall i$.The maximum lag length (*l*) for this test is the sum of the maximum order of integration and the maximum lag length of the ARDL method. For stability and robustness of the non-causality procedure, the inverse roots of the AR (auto-regressive) characteristics-polynomial-diagram,I_R should lie within the positive and negative unity i.e. $-1 \leq I_R \leq 1$. If $-1 \geq I_R \geq 1$, this can be corrected by (a) appropriate lags (for exogenous variables) greater than those of endogenous variables, (b) a trend variable and/or (c) structural break or 'pulse' dummies as exogenous (instruments) variables in the VAR system.

Empirical Results

Descriptive-statistics and correlation-matrix

Table 1 presents the descriptive statistics and correlation matrix. We note that $ln\ pet$ is positively correlated with $ln\ y$ and $ln\ k$.

Unit root

Unit root results based on the ADF, PP and KPSS tests are presented in Table 2, $\ln y_t$, $\ln k_t$ and $\ln pet_t$ are noted first difference stationary, or equivalently, they are$I(1)$. In Table 3, we present the structural break tests results based on Perron (1997) and the Zivot and Andrews (1992) single point break test. Moreover, we also apply the Innovational and Additive outlier break point unit root tests that account for multiple break points in the series (Table 4).

[††] A possible drawback is identifying the correct order of integration with robust and efficient unit root tests, to this end; we undertake multiple unit root tests and ascertain the true order of integration from them.

Table 1

Descriptive Statistics & Correlation Matrix

Statistics	In y_t	In k_t	In $petrol_t$
Mean	8.581	9.601	6.440
Median	8.568	9.601	6.371
Maximum	8.775	10.29	7.134
Minimum	8.371	8.595	6.048
Std. Dev.	0.128	0.456	0.331
Skewness	-0.120	-0.286	0.942
Kurtosis	1.697	2.154	2.719
Jarque-Bera	2.485	1.477	5.139
Probability	0.289	0.478	0.077
Observations	34	34	34
In y_t	1.000	-	-
In k_t	0.884	1.000	-
In $petrol_t$	0.727	0.537	1.000

Source: Authors' estimation in Eviews 9.

Table 2

Unit root tests

Variables	ADF		PP		KPSS	
	Level	1st difference	Level	1st difference	Level	1st difference
Exogenous: Constant & Trend						
In y_t	-3.380[0]^{C}	-7.660[0]^{A}	-3.319[1]^{C}	-7.6005[2]^{A}	0.112[3]^{B}	0.101[1]^{A}
In k_t	-2.200[1]	-7.897[0]^{A}	-8.373[4]^{A}	-9.170[3]^{A}	0.151[3]^{C}	0.151[3]^{C}
In $petrol_t$	-3.002[4]	-3.848[0]^{B}	-1.865[3]	-3.880[1]^{A}	0.095[4]^{A}	0.130[2]^{B}
Exogenous: Constant						
In y_t	0.077[1]	-7.436[0]^{A}	-0.3937[0]	-7.405[1]^{A}	0.613[5]^{C}	0.175[1]^{A}
In k_t	-4.657[0]^{A}	-8.951[0]^{A}	-3.329[3]^{B}	-10.55[3]^{A}	0.691[5]^{C}	0.470[3]^{C}
In $petrol_t$	-1.672[1]	-3.914[0]^{A}	-1.4875[3]	-3.944[1]^{A}	0.380 [4]^{B}	0.130[2]^{A}
Exogenous: None						
In y_t	1.145[0]	-7.230[0]^{A}	1.365[1]	-7.076[3]^{A}	-	-
In k_t	8.511[0]	-4.896[0]^{A}	5.763[3]	-4.242[3]^{A}	-	-
In $petrol_t$	-0.140[1]	-3.978[0]^{A}	-0.121[2]	-4.007[1]^{A}	-	-

Notes: Critical values of the ADF and PP tests are based on Mackinnon (1996) while the KPSS is based on Kwiatkowski et al. (1992). The optimal lag and bandwidth used is based on the Schwarz Information Criterion (SC). The null hypothesis for the ADF and the PP unit root test is of the presence of a unit root while for the KPSS is that a series is stationary. A, B and C denotes stationarity at the 1 %, 5 % and 10 % levels, respectively. -: Not applicable.

Source: Authors' estimation in Eviews 9.

Given that different periods of breaks from the different tests result, we include the breaks from these approaches for each series. Hence, we set the break dummy to one for the output per capita series for the years 1992, 1993 and 1994. We note that in 1992, Fiji's first general elections after the military coup of 1987 coup exerted a positive impact on the economy since it marked the return of democracy and increased the confidence in the Fijian economy. The coup in 1987 had severed Fiji's 113 year old constitutional links with the British monarchy. Furthermore, in 1992, Fiji participated in the summer Olympics which was held in Barcelona, Spain. The participation was a medium through which Fiji made known its international presence and also flagged the return to democracy through general election. Moreover, in 1994, the second general election after the events of 1987 took place and the final return to parliamentary democracy. In essence, the periods 1992–1994 marked Fiji's return to democracy and efforts to regain investor confidence which were important signals for positive economic growth.

Table 3

Break-point unit root tests

Variables	Perron (1997)				Zivot & Andrews (1992)			
	Level		1st difference		Level		1st difference	
	PP Stat	TB	PP Stat	TB	ZA Stat	TB	ZA Stat	TB
Intercept only								
In y_t	-3.594[0]	1993	-9.354[0]^A	1989	-3.652[0]	1994	-9.461[0]^A	1989
In k_t	-17.98[0]^A	1997	-9.251[0]^A	1994	-4.438 [1]	1998	-9.236[0]^A	1995
In $petrol_t$	-4.613[4]	2001	-4.424[4]	2007	-4.574 [4]	2000	-5.166[0]^A	2007
Trend only								
In y_t	-4.376[0]	1985	-9.920[0]^A	1990	-	-	-9.794[0]^A	1990
In k_t	-7.444[0]^A	2008	-6.097 [0]^A	2007	-2.997[1]	2006	-7.557[0]^A	2007
In $petrol_t$	-3.574[4]	1989	-3.828[4]	2001	-4.859[4]^A	1993	-4.588[0]^B	2003
Intercept & trend								
In y_t	-4.536[0]	1988	-9.813[0]^A	1990	-4.608[0]^C	1989	-10.01[0]^A	1991
In k_t	-1.492[0]^A	1998	-7.590[0]^A	1995	-4.471[1]	1998	-7.941[0]^A	1995
In $petrol_t$	-5.512[4]^B	1995	-3.568[4]	2001	-4.731 [4]	1991	-5.151[0]^B	2007

Notes: Lag length used is indicated in parenthesis. A, B and C indicate stationarity after controlling for structural breaks at the 1, 5 and 10 per cent levels, respectively. -: Not applicable
Source: Authors' estimation using Eviews 9.

Table 4

Break-point unit root tests – Innovational and Additive outlier

Variables	Innovational Outlier				Additive Outlier			
	Level		1st difference		Level		1st difference	
	IO Stat	TB	IO Stat	TB	AO Stat	TB	AO Stat	TB
Trend specification: Intercept only Break specification: Intercept only								
In y_t	-1.996[0]	1992	-7.611[0]^A	1999	-2.197[0]	1998	-7.839[0]^A	1998
In k_t	-6.684[0]^A	1997	-9.904[0]^A	1998	-0.137[8]	1992	-8.032 [0]^A	1998
In $petrol_t$	-4.815[4]^B	1999	-4.740[0]^B	2009	-4.465[4]^B	2000	-4.535[0]^B	2003

Table 4 (continued)

Variables	Innovational Outlier				Additive Outlier			
	Level		1st difference		Level		1st difference	
	IO Stat	TB	IO Stat	TB	AO Stat	TB	AO Stat	TB
Trend specification: Intercept & trend Break specification: Intercept only								
In y_t	-3.594[0]	1993	-8.332[0]^{A}	2006	-4.017[1]	1990	-8.686[0]^{A}	2005
In k_t	-17.98[0]^{A}	1997	-9.251[0]^{A}	1994	-2.864[8]	1995	-6.588[0]^{A}	1996
In $petrol_t$	-4.613[4]^{C}	2001	-5.747[1]^{A}	2006	-4.530 [4]	1999	-5.001 [0]^{B}	2003
Trend specification: Intercept & trend Break specification: Intercept & trend								
In y_t	-3.423[0]	2008	-8.907[0]^{A}	1993	-4.193[0]	1990	-10.03[0]^{A}	1991
In k_t	-15.49[0]^{A}	1998	-7.590[0]^{A}	1995	-6.923 [0]^{A}	2005	-5.730[0]^{A}	2005
In $petrol_t$	-5.512[4]^{B}	1995	-5.979[1]^{A}	2007	-4.928[4]^{C}	1995	-5.068 [0]^{C}	2004
Trend specification: Intercept & trend Break specification: Trend								
In y_t	-3.494[0]	2006	-9.229[0]^{A}	1993	-4.376[0]^{B}	1985	-9.920[0]^{A}	1990
In k_t	-13.92[0]^{A}	2006	-7.727 [0]^{A}	2013	-7.444[0]^{A}	2008	-6.391[0]^{A}	2013
In $petrol_t$	-4.859[4]^{B}	1993	-4.588[0]^{B}	2003	-4.111[4]^{C}	1986	-4.788 [0]^{B}	2002

Notes: Break selection is based on the Dickey-Fuller t statistic and critical values are based on Vogelsang (1993) Lag length used is indicated in parenthesis and is automatically determined by Schwarz Criterion (SC). A, B and C indicate stationarity after controlling for structural breaks at the 1, 5 and 10 per cent levels, respectively.
Source: Authors' estimation using Eviews 9.

Lag length selection

Following the unit root test results, we carry out the lag-length tests based on a number of information criteria. As noted (Table 5), the maximum lag-length of 2 is indicated by the criteria at 5 % significance-level.

Table 5

Lag length selection

Lag	LL	LR	FPE	AIC	SC	HQ
0	139.2	NA	1.1 x 10^{-8}	-9.784	-9.203	-9.617
1	180.8	60.87	9.5 x 10^{-10}	-12.30	-11.28	-12.00
2	196.3	19.00^{A}	6.3 x 10^{-10A}	-12.79^{A}	-11.34^{A}	-12.37^{A}
3	203.5	7.256	8.6 x 10^{-10}	-12.66	-10.77	-12.11
4	210.5	5.363	1.3 x 10^{-9}	-12.50	-10.18	-11.83

Notes: A – significance at 5 % level. LL: log likelihood, LR: sequential modified LR test statistic, FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion. A indicates lag order selected by the various selection criteria.
Source: Authors' estimation in Eviews 9.

Bounds Test

With output per capita as the dependent-variable, the presence of a long run equilibrium relationship (cointegration) is confirmed by the ARDL-bounds test at the 1 % level. With this, we can now estimate the equilibrium and short run dynamic effects within a maximum lag of 2.

Table 6

Bounds Test of ARDL (2,0,0)

Test Statistic	Value
F-statistic	6.9075^{A}

Critical Value Bounds

Significance	Lower Bound	Upper Bound
10 %	3.17	4.14
5 %	3.79	4.85
2.5 %	4.41	5.52
1 %	5.15	6.36

Notes: Critical bounds automatically determined by Eviews 9. A indicates significance at 1 % level.
Source: Authors' estimation in Eviews 9.

ARDL Diagnostic tests results

Importantly, prior to estimating the long-run results, we examine the diagnostic tests that provide indication of the level of dynamic stability and acceptability of the model. In this regard, the results need to satisfy up to some probability, the conditions of residual homoscedasticity, non-existence of residual correlation, un-biasness and residual normality. The respective diagnostic tests applied include: Breush-Godfrey-Lagrange multiplier test of residual auto-correlation, Ramsey's RESET test using the square of the fitted values for the correct functional form, Arch test of residual heteroscedasticity and the Anderson-Darling test of residual normality. From the initial lag estimates (Table 7 and Table 8), which precede the long-run and short-run results, we note that at the 1 percent level of significance: the error terms are normally distributed with no significant departures from normality; there is no serial correlation of disturbances; the absence of biasness; and the residuals are homoscedastic. Furthermore, based on the lag-estimate diagnostic tests, the ensuing CUSUM and CUSUMSQ plot are presented in Figure 1 A and B for the estimated model. The respective figures indicate that the parameters in the model are dynamically stable.

Table 7

Diagnostic test results

Test Type		Test Statistic	P-Value
Serial Correlation:	F_{2}^{sc}	$F(1,25) = 0.280^{A}$	0.601
Functional Form:	F^{ff}	$F(1,25) = 1.586^{A}$	0.125
Heteroscedasticity:	F^{hc}	$F(1,29) = 0.705^{A}$	0.408
Normality:	A_{RN}^{2}	$A^{2} = 0.203^{A}$	0.866

Notes: The null hypothesis is the presence of the various types of tests. A, B & C. Denotes rejection at the 1 %, 5 % and 10 % levels, respectively.
Source: Authors' estimation in Eviews 9.

Table 8

ARDL (2,0,0) lag estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dependent variable: ln y_t				
In y_{t-1}	0.219^{A}	0.06817	3.2140	0.004
In y_{t-2}	0.108^{C}	0.05789	1.8724	0.072
In k_t	0.190^{A}	0.00911	20.866	<0.001
In $petrol_t$	0.056^{A}	0.01521	3.6965	0.001
T_B	0.026^{A}	0.00791	3.3088	0.003
Constant	3.576^{A}	0.27915	12.812	<0.001

Model Statistics

$R^2 = 0.9590$, $\bar{R}^2 = 0.9511$, $\sigma_R = 0.0289$, SSR = 0.0218, $\bar{x}_y = 8.584449$, $\hat{\sigma}_y = 0.130751$

LL = 71.2922, F-stat = 121.4758^{A}, AIC = -4.0808, SC = -3.8059, HQC = -3.9897, DW = 2.0906

Notes: A, B and C denotes statistical significance at the 1 %, 5 % and 10 % levels.
Source: Authors' estimation in Eviews 9.

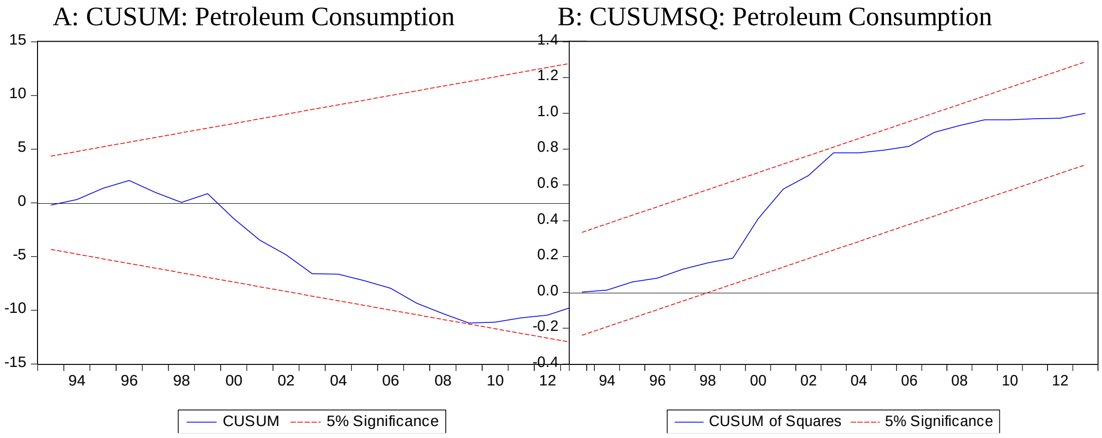

Figure 1. CUSUM & CUSUMSQ Plot

Short and long-run

The disequilibrium and long-run estimates are presented in Table 9, Panel A and B, respectively. We note that the cointegrating elasticity coefficient exceeds the short-run elasticity coefficient which provides greater credibility of the overall results. In the case where the short-run elasticity coefficients exceed the long-run coefficients, it is likely that the model suffers from omitted variable biasness or misspecification. As noted in Table 9 (Panel B), the short-run capital- and the energy-per capita($\Delta \ln pet_t = 0.056$) share are positive and statistically significant within the conventional (1-10 percent) levels of significance. From the long-run results (Table 9, Panel A), we note that the elasticity of output with respect to petrol consumption is 0.084($\ln pet_t = 0.084$), which implies that a one per cent increase in petrol consumption, holding all others things constant, on average contributes about 0.08 % to the long-run growth of Fiji. This is finding is similar to Mishra, Smyth and Sharma (2009) who find in a panel study of Pacific island economies, the long run effect of energy consumption to be 0.08 and is within our 95 % confidence interval limits (0.04 – 0.11). The low elasticity of output might suggest that petroleum consumption acts as an integral part of production and is not easily substitutable with other energy sources. This answers one of the key aims of our paper. Energy-substitution policies may not be very easy for Fiji and petrol is still a key driver of economic growth despite its harmful effects on the environment. Given that Fiji's carbon footprint is relatively low, petroleum consumption is still crucial to growth. This finding is consistent with Narayan and Singh (2006). Furthermore, the long-run share of capital is 0.2827 ($\ln k_t = 0.2827$), whereas the short-run share is 0.1900 ($\Delta \ln k_t = 0.1900$). We also note that the error correction term (ECT_{t-1}), which measures the speed of adjustment to the long-run equilibrium given the previous periods shock, is negative, statistically significant at 1 percent level (ECT_{t-1}= -0.6725), and indicates a relatively fast speed of convergence. In other words, about 67.25 % of any disequilibrium caused by shocks from the previous period is corrected in the current period.

Table 9

Short-run dynamic and long-run level estimate

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Panel A: Long-run				
In k_t	0.283^A	0.01464	19.306	<0.001
In $petrol_t$	0.084^A	0.02169	3.8525	0.001
T_B	0.039^A	0.01125	3.4606	0.002
Constant	5.318^A	0.15496	34.318	<0.001
Panel B: Short-run				
ΔIn y_{t-1}	-0.108^C	0.05789	-1.8724	0.072
ΔIn k_t	0.190^A	0.00911	20.866	<0.001
ΔIn $petrol_t$	0.056^A	0.01521	3.6965	0.001
ΔT_B	0.026^A	0.00791	3.3088	0.003
ECT_{t-1}	-0.673^A	0.04023	-16.717	<0.001

Notes: A, B and C denotes statistical significance at the 1 %, 5 % and 10 % levels.
Source: Authors' estimation in Eviews 9.

Moreover, as noted from the short-run results (see Table 9: Panel B), the coefficient of lag-one output per capita ($\Delta \ln y_{t-1} = -0.108386$) is negative and statistically significant at the 1% level implying that the previous period short-run policy outcome specific to growth has a negative effect on current period output. On the other hand, the coefficient of the structural break ($T_B = 0.0262$) is positive and statistically significant implying that the events marked by the structural break periods had positive impact on output per capita.

Ganger non-causality

We applied a maximum lag (l) of 3 in the Toda-Yamamoto approach to Granger non-causality based on the maximum lag in the cointegration test ($k = 2$) and the maximum order of integration from the unit root test results ($\delta_{max} = 1$), i.e. ($l = k + \delta_{max} \leq 3$).

In addition, we ensured dynamic stability of the VAR model by taking lags ($l = 3$) in which the inverse roots of the autoregressive polynomial is within the positive and negative unity i.e. $-1 \leq I_R \leq 1$.

Based on the causality assessment (see Table 10), the results support the growth hypothesis of energy consumption. This confirms a unidirectional causality from petrol consumption per capita to output per capita ($In\, pet \rightarrow ln\, y$) within conventional levels of significance.

Table 10

Toda-Yamamoto Granger Non-Causality results

Explanatory Variables		Dependent Variables					
		$\ln y_t$		In k_t		In $petrol_t$	
$\ln y_t$	→	-		4.126	[0.248]	0.542	[0.910]
In k_t	→	6.887^{c}	[0.076]	-		1.998	[0.573]
In $petrol_t$	→	11.481^{A}	[0.009]	3.533	[0.316]	-	

Notes: A, B and C denote statistical significance at the 1 %, 5 % and 10 % levels, respectively.
Source: Authors' estimation in Eviews 9.

This finding, although confirming that petrol is an engine of growth in Fiji similar to the causality results of Narayan and Singh (2006) poses complications in policies aimed at sustainability and the phasing out of non-renewable sources such as petrol similar to Wang et al. (2015). Additionally, a unidirectional causality from capital stock per capita to output per capita $(\ln k \rightarrow ln\, y)$ is also noted, supporting that investment Granger causes output per capita. In this regard, investment in infrastructure development and private investments such as in hotel and tourism services is likely to enhance economic growth in Fiji and similar small island economies.

Conclusions and policy discussions

In this paper, we explored the relationship between petrol consumption and real output (in per capita terms). We note the existence of a long-run cointegration using the ARDL Bounds approach and examined the causality directions using the Toda and Yamamoto (1995) procedure, respectively. The long-run and short-run impacts are examined through estimating the respective elasticity coefficients. The results support energy-lead growth hypothesis for Fiji which duly underscores Fiji's reliance on petroleum as a key source of energy for growth.

It is important to highlight that Fiji has potential in petroleum production. Fiji undertook its first petroleum exploration in the 1970s to mid-1980s. In these explorations, the wells proved the presence of source rocks and oil and gas. In terms of the source rocks and reefal reservoirs, Fiji's large offshore basins share resemblance with the petroleum producing Tertiary basins of Southeast Asia and Papua New Guinea (Rodd, 1993). The Petroleum (Exploration and Exploration) (Amendment) Act, 1995, provides the guidelines for prospective investors to explore and exploit petroleum resources in Fiji.[‡‡]

The study recognises that renewable sources of energy is ideal for green development and in this regard, where possible, prospects of wind systems, solar thermal, Hydro, among others should be considered as alternative sources of energy. Fiji has high potential for solar, hydro and geothermal energy and a medium potential for wind biomass energy and tidal energy (IRENA, 2012). However, the challenge faced by Fiji and other small island developing states is the high-cost of shifting to renewable resources (hydro-, solar- and wind power) given the high financial risks caused by huge investment costs and inadequate local expertise to maintain the technologies (Mala et al., 2007; Niles & Lloyd; 2013). Stauvermann and Kumar (2009) propose ethanol production from sugarcane as a substitute for petrol use, at least in the long run whilst procuring some positive spin-off for currently suffering sugarcane farmers and the industry. Nevertheless, given the results of Dornan (2014a, 2014b), it appears to be desirable that institutional reforms of Fiji's energy sector should take place to improve its labour productivity, profitability and fuel efficiency to boost economic growth.

[‡‡] http://www.paclii.org/fj/legis/consol_act_OK/paea439/.

On transportation services, another aspect to consider is the growing demand for second-hand cars in Fiji which used to solely run on petrol, however, is slowly substituted by hybrid cars. To minimise emissions and congestions whilst ensuring productive and efficient use of transport services, focus needs to be on developing an improved public transportation services and infrastructure, and supporting the use of eco-friendly transports. In this regard, the import and use of hybrid cars are encouraging. However, it must be noted that carbon emission in Fiji is increasing (see Figure 2), and more than 90 % of the emissions are from the liquid fuel consumption (petroleum-derived fuels). Thus, greater efforts need to be put in place to control emissions in the country. Given the growing demand for transportation use and urbanization, possibilities of importing and promoting new hybrid vehicles, green infrastructure and fuel efficient public transportation are crucial. To aim for 100 % renewable energy, a mix of potential sources and measures such as solar, wind, biofuels and ensuring energy efficiency should be considered.

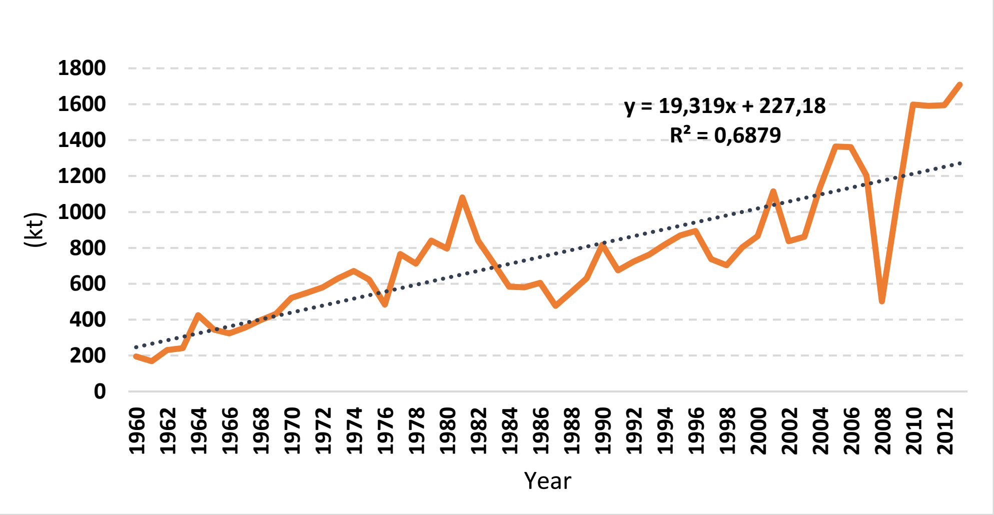

Figure 2. CO_2 emission for Fiji

Source: World Bank (2015).

While the results show that petroleum consumption is a plausible source of long-run growth, a sustainable and efficient use of use petrol dependent plants, machineries and transportations cannot be overlooked. Overtime, the countries in the small island developing states should plan to shift towards greater use of renewable energy and/or away from heavy reliance on petroleum as a major source of energy. In this regard, greater efforts from government and private sector in building capacity and driving renewable energy projects are essential. Additionally, the institutional capacity for green energy requires transparent incentive mechanisms, laws, and changes in organizational and internal processes, all of which needs to be considered in developing effective renewable energy plans. It must be highlighted that small island countries in the Pacific can leverage from countries like South Korea which has been successful in promoting green industries. Given that energy is a crucial ingredient of economic growth, using renewable energy whilst keeping pace with productive activities will provide greater (spillover) economic, social and environmental benefits to Fiji and other small island economies.

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Потребление энергии и экономический рост на малых островах

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Нефть – основной источник энергии, используемой в транспорте и производстве электроэнергии для многих малых островных стран Тихого океана. Отмечая растущий спрос на услуги транспорта и инфраструктуры, мы исследуем долгосрочную связь между потреблением нефти и производством продукции на одного рабочего на Фиджи, небольшой островной экономике в Тихом океане. Мы используем производственную функцию Кобба-Дугласа и ограничения в рамках модели ARDL (авторегрессионной модели с распределёнными лагами) в период с 1980 по 2013 год. Результаты свидетельствуют, что увеличение потребления нефти на 1 % приводит к экономическому росту на 0,08 % в долгосрочной перспективе. Общие результаты подчеркивают необходимость эффективного использования энергии в целом с акцентом на возобновляемых источниках энергии, как важного источника экономического роста. Мы утверждаем, что энергия в любой форме (возобновляемой или невозобновляемой) является важным фактором экономического роста для малых островных стран Тихого океана. Кроме того, страна является импортером и дистрибьютором нефти на соседние острова. Из нефтепродуктов производят автомобильный бензин, реактивное топливо, керосин, мазут и получают сжиженный газ. Деятельность авиакомпаний, паромов, круизных лайнеров и других видов транспорта связана с туристической индустрией и во многом зависит от нефти. Кроме того, нефтепродукты используются для производства электроэнергии, а объемы использования во время «горячего и сухого сезона» увеличиваются для поддержки гидроэлектростанций. Рассматривая Фиджи, как ориентир, и нефть, как основной источник энергии, исследование изучает взаимосвязь между энергией и экономическим ростом, учитывая при этом капитал, трудовые ресурсы и структурные сдвиги. Целью исследования является также активизация процессов эффективного использования энергии и управления источниками энергии в Тихом океане; при этом главная цель – поддержка экономического роста и стимулирование политики постепенного отказа от невозобновляемых источников энергии.

Ключевые слова: потребление нефти, рост, авторегрессионная модель с распределёнными лагами (ARDL), фактор, структурный разрыв, Фиджи.

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Споживання енергії та економічне зростання на малих островах

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Нафта – основне джерело енергії, що використовується у транспорті та виробництві електроенергії для багатьох малих острівних країн Тихого океану. Відзначаючи зростаючий попит на послуги транспорту та інфраструктури, ми досліджуємо довгостроковий зв'язок між споживанням нафти та виробництвом продукції на одного робітника на Фіджі, невеликій острівній економіці в Тихому океані. Ми використовуємо виробничу функцію Кобба-Дугласа та обмеження в рамках моделі ARDL (авторегресійної моделі із розподіленими лагами) у період із 1980 до 2013 рік. Результати свідчать, що збільшення споживання нафти на 1 % призводить до економічного зростання на 0,08 % у довгостроковій перспективі. Загальні результати підкреслюють необхідність ефективного використання енергії в цілому зі зосередженням уваги на відновлюваних джерелах енергії, як важливого джерела економічного зростання. Ми стверджуємо, що енергія в будь-якій формі (поновлюваній або невідновлюваній) є невід'ємним чинником економічного зростання для малих острівних країн Тихого океану. Окрім того, країна є імпортером і дистриб'ютором нафти на сусідні острови. Із нафтопродуктів виробляють автомобільний бензин, реактивне паливо, гас, мазут та отримують зріджений газ. Діяльність авіакомпаній, поромів, круїзних лайнерів та інших видів транспорту пов'язана з туристичною індустрією та значною мірою залежить від нафти. Крім того, нафтопродукти використовуються для виробництва електроенергії, а обсяги використання під час «гарячого та сухого сезону» збільшуються для підтримки гідроелектростанцій. Розглядаючи Фіджі, як орієнтир, та нафту, як основне джерело енергії, дослідження вивчає взаємозв'язок між енергією та економічним зростанням, враховуючи при цьому капітал, трудові ресурси та структурні зсуви. Дослідження має на меті надати поштовх ефективному використанню енергії та управлінню джерелами енергії в Тихому океані; при цьому головна мета – сприяти економічному зростанню та стимулювати політику поступової відмови від невідновлюваних джерел енергії.

Ключові слова: споживання нафти, зростання, авторегресійна модель із розподіленими лагами (ARDL), фактор, структурний розрив, Фіджі.

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