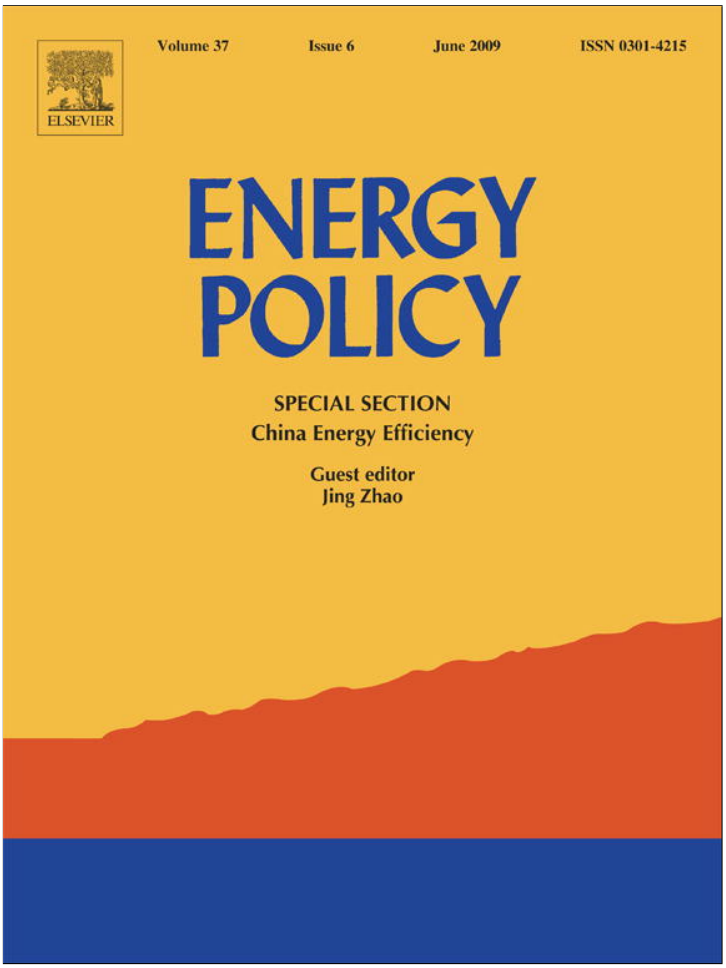

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Growth and oil price: A study of causal relationships in small Pacific Island countries

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ABSTRACT

This paper investigates the nexus between economic growth and oil price in small Pacific Island countries (PICs). Except Papua New Guinea, none of the 14 PICs has fossil any fuel resources. Consequently, the other 13 PICs are totally dependent on oil imports for their economic activities. Since PICs have limited foreign exchange earning capacities, as they have a very narrow range of exports and are highly dependent on foreign aid, high oil prices in recent months have seriously tested their economic resilience. This paper applies the ARDL bounds testing methodology to four selected PICs, Samoa, Solomon Islands, Tonga and Vanuatu, which have consistent and reliable time series of data, with a view to assess the impact of oil price on economic growth. The findings are that oil price, gross domestic product and international reserve are cointegrated in all the four PICs. Further, both in the long and short runs, we observe that there is a uni-directional relationship as causality linkage runs only from oil price and international reserves to economic growth. The paper makes some policy recommendations.

1. Introduction

Among the 14 Pacific Island countries (PICs), only Papua New Guinea (PNG) is a producer and net exporter of oil and refined fossil fuels. The ongoing commodity price boom, including increases in crude oil price, since the beginning of 2007 has been a big boon to PNG. For the last 2 years, it has contributed to improvement in PNG's terms of trade and rise in its export earnings. On the other hand, smaller PICs with no petroleum resources have been hit hard by surges in worldwide oil prices since early 2007 (Australian Agency for International Development, 2008; United Nations Economic and Social Commission for Asia and Pacific (UN ESCAP), 2008; Asian Development Bank (ADB), 2008). Being totally import dependent for all fuel and other energy needs, trade balances of all PICs, except that of PNG, have deteriorated considerably during recent years.

The PICs are also dependent on imports of wheat flour and rice, since they do not grow any wheat and rice production is totally absent in all PICs, except in Fiji, where it meets less than 10% of total consumption. Besides surge in oil price, which touched US$ 140 per barrel in mid July 2008, rapid rise in the prices of food grains, due to increased demand in their use as feed for bio-fuels in the US and Brazil, has further led to inflationary pressures in PICs.

While PNG, which has been running trade surpluses and hence with substantial build-up in its foreign exchange reserves, can afford food imports at higher prices to meet rising domestic food needs, the ability of smaller PICs to bear imports at higher costs is increasingly constrained by the availability of international reserves. With stagnation of and decline in earnings from their traditional exports, such as sugar in the case of Fiji, logs and oil palm in the case of Solomon Islands, fruits and vegetables such as squash in the case of Samoa and Tonga, and beef and kava in the case of Vanuatu, mounting trade deficits have to be financed with limited reserves, leaving less foreign exchange to be spent on critical growth enhancing investments, such as capital machinery and transport equipment and a host of intermediate goods.

It is obvious there is a nexus between oil price and growth, as documented by several studies both in developed and developing countries. Except for a specifically focused empirical study on Fiji by Prasad et al. (2007), there are no studies on smaller PICs. Accordingly, the present study is motivated in taking up a study of other PICs. However, severe data constraints restrict the scope of our study to only four countries, Samoa, Solomon Islands, Tonga and Vanuatu, in respect of which we have consistent time series of data (World Bank, 2007; Asian Development Bank (ADB), 2007) for conducting the empirical investigation.

The paper is organised on the following lines: the second section gives a brief literature survey followed by the third section

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presenting an overview of the economic growth in the selected four PICs. The fourth section discusses the methodology adopted for the study, while the fifth section reports the results. The sixth and final section is a summary, listing the conclusions with policy implications.

2. A brief literature survey

Rise in international oil prices has adverse effects on developing countries, which have no oil or any alternate energy resources. The impact on real gross domestic product (RGDP), rise in inflation and deterioration in the balance of payments and the fiscal position are exercised through several pathways (Asian Development Bank (ADB), 2005). Increases in oil price affect the economy through their effects on both demand and supply sides. The demand side effects are mainly through consumption and investment components of aggregate demand. A rise in oil price gets translated into higher prices for consumption goods, because of consequential rise in their transportation costs.

Further, rise in energy prices discourages investment in production processes and increase in production costs would lead to a lower level of output. Thus, higher oil prices squeeze aggregate supply, since rising intermediate input costs erode producers' profits. Consequently, producers cut back on output. Lower profits may then eat into investment spending and cause potential output to fall over a protracted period (Asian Development Bank (ADB), 2005).

Empirical studies have shown that effects of oil price rises on economic growth have been negative. These studies include Mork (1989), Lee et al. (1995), Hamilton (1983, 1996, 2003), Rasche and Tatom (1981), Darby (1982), Burbidge and Harrison (1984), Gisser and Goodwin (1986), Jimenez- Rodriguez and Sanchez (2005). In their study on selected OECD countries, Jimenez- Rodriguez and Sanchez (2005) found that an increase in oil price had a larger impact on gross domestic product (GDP) than a fall in oil price; and among oil-importing countries, an increase in oil price has a negative impact on GDP except for Japan, while for the oil-exporting countries, the UK is negatively affected by an increase in oil price, but Norway's GDP increases from an increase in oil price.

Kim and Willett (2000), who investigated the relationship between oil prices and economic growth for various panels of OECD countries, observed a negative relationship between oil price and economic growth. Glasure and Lee (2002) in their study on Korea came to the same conclusion that there existed a negative relationship between oil price and economic growth.

Recently, a number of papers examined the nature and role of oil price in Fiji and other Asian countries. These include: Narayan and Smyth (2007) and Narayan et al. (2008b) on impact of oil shocks on energy consumption; Narayan and Singh (2007) on nexus between electricity consumption and GDP for Fiji; Narayan et al. (2008a) on the relationship between oil price and exchange rate for Fiji; and Narayan and Narayan (2007) on the volatility of oil price. In the specific dealing exclusively with Fiji, Prasad et al. (2007) examined the nexus between oil price and real GDP in Fiji and concluded that an increase in oil price had a positive, albeit inelastic impact on real GDP. The authors argued that although the result was inconsistent with the findings in regard to developed countries, it was consistent with the results for some emerging economies studied by IMF (2000). Prasad et al. (2007) pointed out that such a result is not surprising, since Fiji's output since the mid 1980s has been around 50% less than the potential output level and actual output has not reached a threshold level at which oil prices can negatively impact output.

3. An overview of selected PICs

The PICs are the most vulnerable economies in the world to rapid rise in oil prices (Levanti, 2008). The primary reason is that PICs are fossil fuel intensive economies, despite the fact that their manufacturing activities are negligible. In his study, Levanti (2008) observes that for each US dollar of GDP that Australia produces, 0.055 l of oil-based fuels are consumed, which is observed to be less than half of all PICs except Vanuatu and Cook Islands. Two key reasons are identified: the services sector in Australia, which dominates the economy, is a low user of oil-based fuels; and only a very small proportion of electricity generation is from diesel generators (Levanti, 2008; pp. 218–219).

In PICs, although expenditure on fuel accounts for smaller proportion of consumer spending than food, rise in fuel prices translates itself into increases in transportation costs of island countries' staples, cassava and other root crops, and fruits and vegetables from remote islands to marketing centres in urban areas, ultimately resulting in rise in their retail prices. In addition to fishing activities, tourist operators' services, which involve trips around islands and other land transportation and boat rides, are also fuel intensive. Furthermore, electricity generation in PICs is mostly by diesel generators and hydroelectric projects are very few and found only in Fiji and Vanuatu. Table 1 presents data on fuel imports as percentages of total imports and GDP for each of the four selected PICs.

Transport costs of fuel are very high as it has been calculated that imported fuels, mostly sourced from Singapore, land at a premium of more than 50% compared to Singapore price. The huge transport margins are attributed to non-competitive conditions for importing and distributing fuel mainly because of the smallness of PIC markets. Further, most PICs except Samoa, have to face double handling in fuel procurement through Fiji, because of insufficient storage and port facilities. Samoa adopts a competitive tender procedure and imports fuel directly from Singapore (Morris, 2006; Sanghi and Bartmanovich, 2007).

Aside from rapid rise in oil prices in recent years, volatility observed during last few years have seriously tested the ability of PICs to withstand the pressures on their foreign exchange reserves (Table 2). It is apparent that the PICs should have sufficient international reserves to pay not only for fuel imports, but also for other critical imports, including capital goods, which are essential for undertaking growth enhancement investments as well as for maintenance of current assets.

Table 1
Selected Pacific Island countries (PICs): imports of fuel as percent of total imports and GDP.

Countries	2001	2002	2003	2004	2005	2006
Samoa						
% of total imports	12.5	13.0	13.5	14.3	15.4	15.8
% of GDP	7.1	6.6	6.4	7.9	8.7	9.7
Solomon Islands						
% of total imports	21.3	21.0	21.0	37.8	42.5	39.5
% of GDP	5.3	4.9	4.9	8.5	13.9	15.5
Tonga						
% of total imports	15.8	13.2	19.2	19.8	23.1	NA
% of GDP	8.5	7.9	10.4	10.5	12.8	NA
Vanuatu						
% of total imports	14.7	11.8	14.7	13.3	11.4	11.9
% of GDP	5.4	4.5	5.4	5.1	4.6	NA

Source: Asian Development Bank (2007).

Table 2
Selected Pacific Island countries (PICs): growth rates, annual changes in oil price.

	Annual growth rate (%)	Annual change in oil price (%)	International reserves (% of GDP)
Samoa			
1981–1990 (Ave.)	1.1	−0.8	17.0
1991–1995 (Ave.)	1.1	2.1	28.5
1996–2000 (Ave.)	3.7	23.0	38.8
2001	6.5	−18.1	22.0
2002	1.0	−12.9	22.2
2003	3.5	54.9	25.2
2004	3.3	−1.1	24.9
2005	6.0	17.7	21.1
2006	1.8	59.6	18.6
2007	3.0	10.0	NA
Solomon Islands			
1981–1990 (Ave.)	6.8	−0.8	20.8
1991–1995 (Ave.)	5.1	2.1	11.7
1996–2000 (Ave.)	−2.4	23.0	8.9
2001	−8.2	−18.1	5.6
2002	−2.7	−12.9	6.4
2003	6.5	54.9	15.3
2004	8.0	−1.1	28.9
2005	5.0	17.7	30.6
2006	6.2	59.6	29.5
2007	5.4	10.0	NA
Tonga			
1981–1990 (Ave.)	1.8	−0.8	29.0
1991–1995 (Ave.)	3.6	2.1	20.5
1996–2000 (Ave.)	1.8	23.0	15.8
2001	1.8	−18.1	16.5
2002	3.2	−12.9	15.9
2003	2.7	54.9	22.7
2004	1.4	−1.1	27.7
2005	2.3	17.7	20.2
2006	1.3	59.6	19.0
2007	−3.5	10.0	NA
Vanuatu			
1981–1990 (Ave.)	2.9	−0.8	17.2
1991–1995 (Ave.)	7.5	2.1	20.4
1996–2000 (Ave.)	3.2	23.0	14.9
2001	−2.7	−18.1	14.3
2002	−4.9	−12.9	13.9
2003	2.4	54.9	13.9
2004	5.5	−1.1	17.1
2005	6.8	17.7	16.9
2006	5.5	59.6	18.2
2007	4.7	10.0	19.0

Source: Asian Development Bank (ADB) (2007).

4. Data and methodology

In the context of inadequate database in PICs, our modeling strategy has to remain simple. While data series on real GDP and foreign exchange reserves are drawn from Asian Development Bank (ADB) (2007) and United Nations Economic and Social Commission for Asia and Pacific (UN ESCAP) (2008), data series on oil price in United States (US) dollar per barrel are sourced from International Energy Annual (www.iea.doc.gov). Since all the four PICs under study are dependent on oil imports for all economic activities, ranging from subsistence agriculture and fishing to tourism, it is hypothesized that rise in oil price has a negative impact on growth. However, adequate international reserves, aided by rise in export earnings from both commodities and services, including tourism, besides foreign aid, and remittance inflows, would lessen the negative impact of rise in oil price on growth. Accordingly, it is postulated that international reserves and growth are positively associated.

The above relationships are symbolized in the following model:

$$LRGDP = f(LOILPRICE, LIR, TREND) \quad (1)$$

where $LRGDP$ = real GDP (in local currency) in natural log; $LOILPRICE$ = oil price (US$/per barrel) in natural log; and; LIR = international reserves (as percent of GDP) in natural log. $TREND$ = time trend variable, which to capture secular trend in macroeconomic variables during the period of study.[1]

We apply the model to each of the four countries (Samoa: 1982–2007; Solomon Islands: 1980–2007; Tonga: 1981–2007; and Vanuatu: 1980–2007). For estimating a long-run oil price and growth model, we resort to the autoregressive distributed lag (ARDL) procedure, developed by Pesaran et al. (2001). The ARDL bounds testing model is a general dynamic specification, which applies lags of the dependent variable and the lagged and contemporaneous values of the explanatory variables, through which the short-run impacts can be directly estimated, and the long-run relationship can be indirectly estimated.

The conventional cointegration procedures proposed by both the Engle and Granger (1987) residual-based procedure and the Johansen (1988) and Johansen and Juselius (1990) maximum likelihood approach require a testing of unit root to ensure that all series are integrated of order one. Same order of integration is necessary because in the presence of a mixture of $I(0)$ and $I(1)$ regressors, Harris (1995) shows that both trace and maximum eigenvalue tests from the Johansen procedure will be difficult to interpret and generate nuisance parameters. Besides, Rahbek and Mosconi (1999) also demonstrate how $I(0)$ regressors in a Johansen-type framework can to generate spurious cointegrating relations with other variables in the model.[2]

Bound test with ARDL framework has several advantages: (i) it allows testing for the existence of a cointegrating relationship between variables in levels irrespective of whether the underlying regressors are $I(0)$ or $I(1)$ (Pesaran and Shin, 1999; Pesaran et al., 2001); (ii) it is considered more appropriate than the Johansen–Juselius multivariate approach for testing the long-run relationship amongst variables when the data are of a small sample size (Mah, 1995; Tang and Nair, 2002)[3]; (iii) Pesaran and Shin (1999) show that estimators of the short-run parameters are consistent and the estimators of long-run parameters are super-consistent in small sample sizes. Therefore, ARDL model has become increasingly popular in recent years and we begin the empirical analysis with this procedure.[4]

[1] Narayan and Smyth (2006) have extensively discussed on the inclusion of time trend variable in the estimation.

[2] Hassler (1996) provides extensive discussion on the problems of stationary variables in cointegrating regressions.

[3] Some previous studies have used ARDL model to relatively small sample sizes with as few as 20 observations in their research. For example, Pattichis (1999) apply the ARDL model to estimate an import demand function for Cyprus from 1975 to 1994 (20 observations). Tang (2001) applies the ARDL framework to study inflation in Malaysia for the period of 1973–1997 (25 observations) while Tang and Nair (2002) apply the ARDL technique to estimate an import demand function for Malaysia from 1970 to 1998 (29 observations).

[4] The empirical procedure is on the lines adopted by various recent studies. These include (i) Ghatak and Siddiki (2001) on India's exchange rate; (ii) Atkins and Coe (2002) on Fisher effect in the US and Canada; (iii) Bahmani-Oskooee and Ng (2002) on Hong Kong's money demand; (iv) Vita and Abbott (2002) on savings and investment in the US; (v) Bahmani-Oskooee and Goswami (2003) on *J*-curve in Taiwan; (vi) Pattichi and Kanaan (2004) on Balassa–Samuelson Hypothesis; (vii) Tang (2004) on Japan's money demand; (viii) Liu and Shu (2004) on stock market and consumption in selected Asian economies; (ix) Nieh and Wang (2005) on Taiwan's exchange rate determination; (x) Narayan and Smyth (2005) on Brunei's import demand function; (x) Choong et al. (2005) on foreign direct investment,

There are two steps involved in estimating the long-run relationship between oil price, international reserves and economic growth. The first step is to examine the presence of a long-run relationship among all variables in the equation. Once the long-run relationship is confirmed in the model, the long-run coefficients are estimated using the associated ARDL model. To examine for cointegration in Eq. (1) by the bounds test proposed by Pesaran et al., the following model is constructed for each country:

$$\Delta LRGDP_t = \beta_0 + \beta_1 LRGDP_{t-1} + \beta_2 LOILPRICE_{t-1} + \beta_3 LIR_{t-1} + \beta_4 TREND + \sum_{i=1}^{p} \beta_{5i} \Delta LRGDP_{t-i} + \sum_{i=0}^{p} \beta_{6i} \Delta LOILPRICE_{t-i} + \sum_{i=0}^{p} \beta_{7i} \Delta LIR_{t-i} + \varepsilon_t \quad (2)$$

$$\Delta LOILPRICE_t = \alpha_0 + \alpha_1 LRGDP_{t-1} + \alpha_2 LOILPRICE_{t-1} + \alpha_3 LIR_{t-1} + \alpha_4 TREND + \sum_{i=0}^{p} \alpha_{5i} \Delta LRGDP_{t-i} + \sum_{i=1}^{p} \alpha_{6i} \Delta LOILPRICE_{t-i} + \sum_{i=0}^{p} \alpha_{7i} \Delta LIR_{t-i} + u_t \quad (3)$$

$$\Delta LIR_t = \delta_0 + \delta_1 LRGDP_{t-1} + \delta_2 LOILPRICE_{t-1} + \delta_3 LIR_{t-1} + \delta_4 TREND + \sum_{i=0}^{p} \delta_{5i} \Delta LRGDP_{t-i} + \sum_{i=0}^{p} \delta_{6i} \Delta LOILPRICE_{t-i} + \sum_{i=1}^{p} \delta_{7i} \Delta LIR_{t-i} + v_t \quad (4)$$

where ε_t, u_t and v_t are the random disturbance terms. The null hypothesis of testing the long-run relationship in Eq. (2) is $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ and the alternative hypothesis is at least one is not equal to zero. Similarly, the null hypothesis of testing the long-run relationship in Eq. (3) is $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ and the alternative hypothesis is at least one is not equal to zero. The same procedure is adopted for testing the long-run relationship in Eq. (4), where it is tested whether $\delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$.

If the computed *F*-statistics are above the upper bound critical value provided by Pesaran et al. (2001) and Narayan (2005),[5] we reject the null hypothesis of no cointegration and conclude that there is a long-run equilibrium relationship among variables. On the other hand, if the calculated *F*-statistic is lower than the lower bound value, we cannot reject the null hypothesis of no long-run equilibrium relationship among variables. However, if the calculated *F*-statistic lies within the upper bound value and lower bound value, then the results are inconclusive.

If cointegration is confirmed, we derive the long-run coefficients from the cointegration vector from the ARDL model. The short-run causal relationships between variables are estimated by the associated vector error correction model (VECM) framework.

5. Empirical results

As a first step for undertaking the empirical examination, we conduct unit root tests of the three variables in logs for each country, although such tests are not required for the ARDL bounds testing procedure. If the variables are integrated of the same order, the Granger causality test results would be unbiased. The results of unit root tests in regard to time series of real GDP (*LRGDP*), oil price (*LOILPRICE*) and international reserve (*LIR*) are given in Table 3. The results of ADF unit root tests show that all the series have unit roots.[6] However, the presence of a unit root is rejected at first difference. Hence, these variables are integrated of *I*(1) process. According to Maddala and Kim (1998), the results from ADF test may not be necessarily conclusive because ADF tests are generally known to have low power. Therefore, we used the unit root test suggested by Ng and Perron (2001) in the modified Phillips–Perron framework (MZ test). The results of these tests confirmed the ADF test findings.

The results of the ARDL bounds in regard to each of the four countries are reported in Table 4.[7] In the equations with *LRGDP* as dependent variable, we note that the computed *F*-statistics for these countries are above the upper bound critical values provided by Pesaran et al. (2001) and Narayan (2005). Hence, we have strong evidence to reject the null hypothesis of no cointegration at 1% significance level between oil price, international reserve and economic growth for all the four countries under study. On the other hand, the calculated *F*-statistics in regard to the other two equations with *LOILPRICE* and *LIR* as dependent variables in all the four PICs, are found lower than the lower bound critical values. Hence, we do not reject the null hypothesis of no cointegration.

We now proceed to estimate the long-run estimates for each country. The estimated equation with *LRGDP* as dependent variable for PICs is shown as follows:

Samoa:

$$LRGDP = \underset{(1.504)}{2.812} - \underset{(-2.043)}{0.443} LOILPRICE ** + \underset{(3.410)}{1.829} LIR *** + \underset{(4.548)}{0.129} TREND ***$$

Solomon Islands:

$$LRGDP = \underset{(5.299)}{11.271} *** - \underset{(-4.856)}{1.745} LOILPRICE ** + \underset{(3.982)}{0.209} LIR ** - \underset{(-5.806)}{0.064} TREND ***$$

Tonga:

$$LRGDP = \underset{(7.276)}{4.899} *** - \underset{(-4.367)}{0.045} LOILPRICE *** + \underset{(6.044)}{0.110} LIR *** + \underset{(7.391)}{0.024} TREND ***$$

Vanuatu:

$$LRGDP = \underset{(3.552)}{3.519} *** - \underset{(-4.253)}{0.987} LOILPRICE *** + \underset{(1.847)}{0.599} LIR * + \underset{(2.494)}{0.022} TREND **$$

Note: *, ** and *** indicate significance at 10%, 5% and 1% levels, respectively. Figures in parentheses representing calculated "*t*" values.

In all the four country equations, we observe that the estimated coefficients of oil price have the expected negative signs. Further, they are highly significant. The magnitudes of the estimated coefficients, which denote elasticities of output with respect to price of oil, range from −0.045 (Tonga) to −1.745

(*footnote continued*)
financial development and economic growth in Malaysia; (xi) Narayan and Narayan (2005a) on import demand function for Fiji; (xii) Narayan and Singh (2007) on the nexus between electricity consumption and economic growth for Fiji; and Narayan and Narayan (2008) on Fiji's money demand function for the period 1971–2002.

[5] Narayan and Narayan (2005b) and Narayan (2005) argue that the use of Pesaran et al. (2001) critical values for small sample study may produce misleading results because the critical values calculated are generally lower than those generated by Narayan who used similar GAUSS code used by Pesaran et al. (2001). Narayan (2005) has generated a new set of critical values ranging from 30 to 80 observations. Since the sample size in our study is small (that is, ranged from 26 to 28 observations for PICs) and as the critical values provided by Pesaran et al. (2001) are calculated on the basis of large sample sizes of 500 and 1000 observations and 2000 and 40,000 replications respectively, we use the critical values provided by both Pesaran et al. (2001) and Narayan (2005).

[6] The number of lags was determined using the Akaike Information Criterion (AIC).

[7] In choosing the lag length, we used the Akaike Information Criterion (AIC).

Table 3
The results of unit root tests.

Country/variable	ADF test		Ng and Perron MZ test	
	Level (constant with trend)	First difference (constant without trend)	Level (constant with trend)	First difference (constant without trend)
Samoa (1982–2007)				
LRGDP	−0.981 (0)	−4.495** (0)	−2.112 (0)	−11.840** (0)
LOILPRICE	−1.668 (0)	−5.777** (0)	−5.471 (0)	−11.482** (0)
LIR	−2.893 (0)	−3.653** (0)	−2.398 (1)	−9.285** (0)
Solomon Islands (1980–2007)				
LRGDP	−1.692 (1)	−3.864** (0)	−4.124 (1)	−10.586** (0)
LOILPRICE	−1.367 (0)	−6.137** (0)	−5.718 (0)	−12.607** (0)
LIR	−1.291 (0)	−4.257** (0)	−10.234 (1)	−11.469** (0)
Tonga (1981–2007)				
LRGDP	−2.678 (0)	−4.765** (0)	−9.401 (0)	−11.986** (0)
LOILPRICE	−1.560 (0)	−5.899** (0)	−5.175 (0)	−11.975** (0)
LIR	−2.578 (0)	−4.329** (0)	−6.304 (0)	−11.840** (0)
Vanuatu (1980–2007)				
LRGDP	−2.019 (0)	−3.893** (0)	−5.383 (0)	−12.270** (0)
LOILPRICE	−1.367 (0)	−6.137** (0)	−6.998 (0)	−12.607** (0)
LIR	−2.696 (0)	−3.082** (1)	−3.098 (0)	−9.285** (0)

Note: The ADF critical value at 5% level is –2.9640 and –3.5629 for constant without trend and constant with trend regressions, respectively. These critical values are based on Mckinnon. The optimal lag is selected on the basis of Akaike Information Criterion (AIC). The Ng and Perron critical value is based on Ng and Perron (2001) critical value and the optimal lag is selected based on Spectral GLS-detrended AR based on SIC. The null hypothesis of the test is: a series has a unit root. The figures in brackets denote number of lags. The double asterisk (**) denotes the rejection of the null hypothesis at the 5% level of significance.

Table 4
Bound test for cointegration analysis for selected PICs.

Country (period)	Dependent variable	*F*-statistics		
Samoa (1982–2007)	LRGDP	11.831***		
	LOILPRICE	2.559		
	LIR	0.656		
Solomon Islands (1980–2007)	LRGDP	17.366***		
	LOILPRICE	0.959		
	LIR	0.427		
Tonga (1981–2007)	LRGDP	16.436***		
	LOILPRICE	1.341		
	LIR	2.543		
Vanuatu (1980–2007)	LRGDP	8.909***		
	LOILPRICE	2.996		
	LIR	2.235		
	Pesaran et al. (2001)[a]		Narayan (2005)[b]	
Critical value	Lower bound value	Upper bound value	Lower bound value	Upper bound value
1%	4.30	5.23	5.666	6.988
5%	3.38	4.23	4.048	5.090
10%	2.97	3.74	3.378	4.274

Note: *, ** and *** indicate significance at 10%, 5% and 1% levels, respectively.
[a] Critical values are obtained from Pesaran et al. (2001), Table CI(iv) Case IV: unrestricted intercept and restricted trend.
[b] Critical values are obtained from Narayan (2005), Table case IV: unrestricted intercept and restricted trend.

(Solomon Islands). The *F*-statistics for these equations for all PICs are obviously lower than the lower bound critical values. Except in the case of Solomon Islands, real GDP is highly inelastic with respect to price.

The results also show that *IR* has a positive impact on economic growth, which provide evidence to support the notion that sufficient international reserves would reduce the adverse effect of rise in oil price on growth. Besides, the trend (time) variable is statistically significant in all PICs.

Having established the existence of a long-run relationship between growth, oil price, and international reserves for four PICs, we now proceed to investigate causality relationship, both in the long and short-runs, which must exist by definition in at least one direction (Engle and Granger, 1987). The causality relationships are reported in Table 5. The results (Wald test: *F*-statistics) show the null hypothesis that oil price does not Granger cause economic growth in the short run can be rejected in favour of oil price-led growth hypothesis for all PICs. However, the reverse causality, that is, economic growth Granger causes oil price, is not significant even at 10% significance level in these countries. This particular result stands in contrast to the conclusion reached by Prasad et al. (2007) in the case of Fiji.

Table 5
Granger causality results based on vector error correction model for selected PICs.

Country	Oil price-led growth		Growth-led oil price	
	Short run	ECT	Short run	ECT
Samoa	4.4053**	−0.3954** (−2.5773)	1.3701	−0.6570 (−0.5335)
Solomon Islands	8.2163***	−0.9760** (−5.7948)	0.5162	−0.7012 (−0.6154)
Tonga	4.7371**	−0.6938** (−2.7845)	0.0665	−0.9323 (−0.0983)
Vanuatu	3.9238**	−0.8508*** (−4.6149)	2.3943	−0.2875 (−0.2061)

Note: The Wald statistic which tests the joint significance of the lagged values of the independent variables is reported. This statistic is to be compared with *F*-statistics. Figures in parentheses representing *t*-statistics.
*, ** and *** indicate significance at 10%, 5% and 1% levels, respectively.

The error correction terms (ECTs) in the equations with $\Delta LRGDP$ as dependent variable in all the four PICs (Table 5) have negative signs and they are found significant. The magnitudes of the coefficients of ECTs in the equations $\Delta LRGDP$ as dependent variable denote the speed of adjustment in correcting any disequilibrium and they range from 0.3954 (Samoa) to 0.9760 (Solomon Islands). On the other hand, ECTs in equations with $\Delta LOILPRICE$ and ΔLIR as dependent variables are not significant. These results establish that causal linkage is uni-directional; that is, it runs only from oil price and international reserves to domestic output and not vice versa. Further, they confirm the result obtained from the bounds testing procedures, indicating that there is only one cointegration vector, which is the equation with real GDP as the dependent variable.

Various diagnostic tests – tests of normality, autocorrelation, heteroskedasticity in the error term and misspecification error – have been conducted to examine the validity and reliability of the short-run causal regressions for these PICs.[8] We do not reject the null hypotheses of no autocorrelation, the error terms being normally distributed and homoskedasticity. The RESET test indicates that the model is correctly specified. Moreover, the structure of the parameters have not diverged abnormally over the period of the analysis as the plot of the CUSUM and CUSUMSQ statistics are confined within the 5% critical bounds of parameter stability.

6. Summary and policy implications

This paper investigated the oil price and growth nexus in four smaller PICs, namely Samoa, Solomon Islands, Tonga and Vanuatu, which are dependent on oil imports, as they have no fossil fuel or any alternative energy resources. Imports of fuel have to be paid for in foreign exchange, availability of which is severely constrained by a narrow range of exports, uncertain tourism earnings, and volatility in aid and remittance inflows. Considering the data deficiencies in PICs, a simple three-variable model was formulated with a view to testing the relationship between growth and oil price. The three variables were real GDP, oil price in US dollars per barrel and international reserves as percentage of GDP. As the time series of relevant data are available only from the early 1980s for all the four selected PICs, the sample size for each PIC is less than 30. Hence, we resorted to ARDL bounds testing procedure for testing the existence of cointegration between the variables, which were in natural logs.

The ARDL bounds test results for each of the four countries showed that the three variables were cointegrated indicating the existence of a long-run relationship between them and there was only one cointegration vector, which was the equation with real GDP as dependent variable, the explanatory variables being oil price and international reserves. The estimated long-run regression equations with RGDP showed that the coefficients of oil price and international reserves, with negative and positive signs respectively were statistically significant. Since the model was estimated with variables in logs, the coefficients of oil price in each of the four countries' equations denote real GDP elasticities with respect to oil price. By further tests through error correction modeling, it was established the Granger causality relationship was unidirectional and the linkage ran only from oil price and international reserves to growth in all the four countries. The results thus confirm that rise in oil price negatively affects growth in all the four PICs.

6.1. Policy prescriptions

The policy implications are clear. Since oil prices are beyond the control of small island nations, the scope for short term measures is minimal. Therefore, the option is exploring ways and means to minimise the impact of oil price rise, by reducing import duties and value added taxes. These steps would be easy as well as popular. Although they would be politically correct, fiscal impact of such measures have to be carefully assessed and handled, as fall in revenue consequent to reduction in duties and taxes would affect budgetary position, giving rise to deficits or leading to effect cuts of essential expenditures, including maintenance of existing public assets, such as roads and postponing critical investment expenditures such as physical infrastructure.

While there would be short term problems in balancing expenditures and revenues of government, clear and firm long-term policy measures are needed, which cannot be postponed. These are the measures that adjust for high oil prices. These are listed below:

(i) Efficient use of energy use should be encouraged. Governments in PICs are already aware of good international practices such as use of energy lights, reduction and control on the use of energy in public buildings and public places. Governments should consider adopting them and by so doing they can set an example and educate the public.
(ii) Public utilities, as of now are heavily subsidized, since they are not allowed to raise electricity tariffs. Adjustments in tariffs have to be effected to meet the rise in costs of electricity generation and distribution by the electricity authorities in all PICs.
(iii) Adjustments have also to be effected in regard to the imports of vehicles, which may not be as unpopular as in the case of electricity tariffs. Levying heavy import duties on energy-inefficient, old model luxury cars and small utility vehicles

[8] We do not report the results of diagnostic checking to conserve space. However, the results are available upon request.

would be appropriate, as the incidence of taxes falls on the wealthy.

(iv) Vehicles, which are generally more energy efficient, should replace the older inefficient vehicles in the public sector and their use be encouraged by private sector as well. Appropriate incentives through fiscal measures should be designed to switch to energy efficient vehicles.

(v) By the same token, mass transport system should be encouraged with appropriate incentives. Private transport enterprises operating urban as well as rural bus services need to be encouraged further with a carefully designed incentive system, which would include reduction in import duties and other concessions in procurement of buses and trucks.

(vi) In regard to electricity generation, except Vanuatu, all the three among the four PICs rely only on diesel generators. Alternate energy resources including solar, hydro and wind power have to be investigated. Although initial capital costs are high for hydropower projects, in the long-run operating costs are low and predictable, as compared with high volatility in oil price.

(vii) Finally, PICs should resort to bulk fuel procurement programme. Presently, each PIC enters into a contract with suppliers of fuel, most of which is imported from Singapore. Instead, a common procurement programme through a competitive tendering process would help in obtaining larger reduction in fuel prices. The Pacific Islands Forum, an intergovernmental regional organisation is already working on the proposal. If the proposal materialises, pressures on international reserves would be reduced to a considerable extent.

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