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Rise in Oil Price and Economic Growth in Pacific Island An Empirical Study

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Abstract

None of the 14 Pacific Island countries (PICs), except Papua New Guinea has any fossil fuel resources. Consequently, all the 13 PICs are totally dependent on oil imports for their economic activities. Recent surges in oil prices have had serious economic repercussions on economic growth. This paper applies panel analysis procedures to five major PICs, namely Fiji, Samoa, Solomon islands, Tonga and Vanuatu with a view to assessing the impact of oil price on economic growth. The findings are that oil price, economic growth and international reserve are cointegrated. The study findings are that although in the long run there is no long run causality relationship between these variables, in the short run the causality linkage runs from oil prices and international reserve to economic growth. The paper concludes with a brief discussion on policy options.

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Introduction

During an eight-year period (2000-2007), oil prices increased three-fold. From early January 2008, there were further increases in oil price, which reached the record level in mid 2008 at US$145 per barrel. 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 commodity price boom, since the beginning of the decade with oil price rising along with gold price doubling and copper prices increasing four fold, has been a big boon to PNG, in terms of improvement in terms of trade as well as resultant rise in its export earnings (Australian Agency for International Development 2008). On the other hand, the smaller PICs with no petroleum resources have been hit hard by surges in worldwide oil prices (United Nations Economic Commission for Asia and Pacific 2008, Asian Development Bank 2008). Being totally import dependent for all fuel and other energy needs, their trade balances have deteriorated considerably during recent years.

Aside from rise in oil price, increases in the prices of food grains due to higher demand in their use as feedstuff for bio-fuels, have also contributed to inflationary pressures in PICs. The latter are totally dependent on imports of wheat flour and rice as well, since they do not grow any wheat or rice, with the exception of Fiji, where rice production meets around 10% of total consumption.

While PNG, which has been running trade surpluses with substantial build-up in its foreign exchange reserves can thus, 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 decline in foreign exchange earnings from their limited export bases, consisting of traditional commodities, such as sugar in the case of Fiji, logs and oil palm in the case of Solomon Islands, and fruits and vegetables such as squash in the case of Samoa and Tonga, beef and kava in the case of Vanuatu, mounting trade deficits of PICs have to be financed by stagnant foreign exchange reserves. The result has been that despite heavy reliance on tourism and foreign aid inflows, PICs have been struggling with earmarking greater resources for critical growth enhancing investments, such as machinery and equipment.

It is apparent that there is a connection between oil price and economic growth, as documented by several studies both in developed and developing countries. Except for an empirical study on Fiji by Prasad *et al*. (2007), there are no studies on smaller PICs.

Accordingly, this paper is motivated to study other PICs, which are totally dependent on oil imports. Further, Prasad *et al*. (2007) employed a bi-variate model, using two variables, namely real gross domestic product (RGDP) and oil price in US dollars per barrel. Our present investigation attempts to use a multivariate model with a view to avoiding any likely omitted variable bias. Severe data limitations in regard to availability of reliable time series on a consistent basis for the smaller PICs, other than Fiji, do not allow us to undertake individual country studies.

As all small PICs share many commonalities in terms of limited resource and export bases, we propose a panel data analysis for five PICs, namely Fiji, Samoa, the Solomon Islands, Tonga and Vanuatu in respect of which we have consistent time series of data (World Bank 2007, Asian Development Bank 2007) from early 1980s, for conducting the empirical investigation. The paper is organized on the following lines: the second section provides a brief literature survey followed by the third section presenting an overview of the economic growth in the five 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 some 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 impacts on RGDP, domestic price level, balance of payments and fiscal position are exercised through several pathways (Asian Development Bank 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 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). In their study on selected OECD countries, Jimenez-Rodriguez and Sanchez (2005) found that an increase in oil price has a larger impact on RGDP than a fall in oil price; and among oil-importing countries, an increase in oil price has a negative impact on RGDP except for Japan, while for the oil-exporting countries the UK is negatively affected by an increase in oil price but Norway's RGDP 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.

In the only study available on PICs, Prasad, *et al.* (2007), focusing on Fiji, note that an increase in oil price had a positive, *albeit* inelastic impact on RGDP. The authors of the Fiji study argue 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). Specifically, in the case of Fiji, Prasad *et al.* (2007) point out that Fiji's output since the mid 1980s has been 50 percent 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

In a succinct study on economic vulnerability of island countries, Levantis (2008) describes the PICs as the most vulnerable economies in the world to rapid rise in oil prices. The primary reason is PICs are fossil fuel intensive economies, despite the fact that their manufacturing activities are negligible. Levantis (2008) observes that for each US dollar of GDP that Australia produces, 0.055 litres of oil based fuels are consumed, which is less than half of the consumption by all PICs, except Vanuatu and Cook Islands. Two key factors 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 Australia's electricity generation is from diesel generators (Levantis 2008: 218-219).

Table 1: Selected PICs: Imports of Fuel as percent of Total Imports and GDP

Countries		2001	2002	2003	2004	2005	2006
Fiji							
	% of Total Imports	21.9	22.1	20.3	23.5	28.8	32.7
	% of GDP	13.4	12.5	12.5	14.7	18.5	21.9
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

NA= not available

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' staple, the root crops and other local foods 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 that are highly fuel intensive, tourism related enterprises, which involve trips around islands and other land transportation and boat rides, are also fuel intensive. Electricity generation is mostly by diesel generators. Hydroelectric projects are few, which are confined only to Fiji and Vanuatu. Table 1 presents data on fuel imports as percentages of total imports and GDP for each of the five selected PICs.

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

Table 2: Selected PICs: Growth Rates, Annual Changes in Oil Price

	Annual Growth Rate (%)	**Annual Change in Oil Price (%)**	**International Reserves (% of GDP)**
Fiji			
1981-1990 (Average)	1.5	-0.8	12.5
1991-1995 (Average)	2.6	2.1	16.5
1996-2000(Average)	2.2	23.0	20.0
2001	2.0	-18.1	20.5
2002	3.2	-12.9	18.0
2003	1.0	54.9	17.0
2004	5.3	-1.1	16.4
2005	0.7	17.7	9.5
2006	3.6	59.6	16.5
2007	-4.4	10.0	17.5
Samoa			
1981-1990 (Average)	1.1	-0.8	17.0
1991-1995 (Average)	1.1	2.1	28.5
1996-2000(Average)	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	17.2

Solomon Islands			
1981-1990 (Average)	6.8	-0.8	20.8
1991-1995 (Average)	5.1	2.1	11.7
1996-2000(Average)	-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	32.1

Table 2 (continued)

Tonga			
1981-1990 (Average)	1.8	-0.8	29.0
1991-1995 (Average)	3.6	2.1	20.5
1996-2000(Average)	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	18.0
Vanuatu			
1981-1990 (Average)	2.9	-0.8	17.2
1991-1995 (Average)	7.5	2.1	20.4
1996-2000(Average)	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 (2007), UNESCAP (2008)

Aside from rapid rise in oil prices in recent years, volatility in oil price observed during last few years has seriously tested the ability of PICs to pay for oil as well as 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 imports of essential fuel imports, but also for other critical imports, which are essential for growth enhancement investments, including machinery and equipment as well as maintenance of current assets. In the absence of sufficient foreign exchange reserves, which are increasingly used up for oil imports, the economic growth of PICs has come to be adversely affected.

4. Modeling Methodology and Results

Data Description

In the context of inadequate database in PICs, our modeling strategy for panel analysis has been constrained to be simple and the number of variables minimum, Since all the five PICs under study are oil-dependent, affecting 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, 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 written as

$$RGDP = f(OP, IRE)$$

where $RGDP$ = real GDP in index numbers,
OP = oil price (US$/per barrel)
IRE = international reserves as percent of GDP

The panel data analysis covers a 16-year period (1982-2007). While data series on real GDP and foreign exchange reserves are drawn from Asian Development Bank (2007) and United Nations Economic and Social Commission for Asia and Pacific (2008), data series on oil price in United States (US) dollar per barrel are sourced from International Energy Annual (www.iea.doc.gov). For undertaking empirical investigation, we transform the variables into logs and estimate the long run relationship in the linear form, as below;

$$\log RGDP_t = \beta_0 + \beta_1 \log OP_t + \beta_2 \log IRE_t + \varepsilon_t \quad (1)$$

Panel Unit Root and Stationary Tests

We adopt the Maddala and Wu (1999), Hadri (2000), Levin *et al*. (2002) and Im *et al.* (2003) panel unit root and stationarity tests in this study[1]. The null hypothesis of these

[1] Recent advances in panel data analysis have focused attention on unit root and cointegration properties of variables observed over a relatively long span of time across a large number of cross section units of countries. Accordingly, these panel techniques have increased the statistical power of unit root tests over the single-equation methods that were based on a limited time series dimension. These techniques enable the researchers to exploit the benefits from cross-sectional information to obtain much more definitive evidence regarding stationarity.

tests is that the panel series, which are duly transformed into their logs, has unit root (non-stationary) except for the HADRI test. The HADRI test is similar to the KPSS type unit root test, with a null hypothesis of stationarity in the panel. As the application of these techniques is becoming increasing available in the economic literature, details are not presented in this paper but rather the interested reader could refer to the original articles. The results portrayed in Table 3 clearly shows that the series of the variables (logRGDP, logOP, logIRE) are of an *I(1)* process where the pooled data are stationary in their first differences.

Table 3: Panel Unit Root and Stationarity Tests Results

	Test Statistics					
	LLC	**IPS**	**MW (ADF)**	**MW (PP)**	**HADRI**	**Conclusion**
A: Level						
Model Specification: Individual Effects						
logRGDP	1.703	3.672	-1.664	2.193	7.617	-
	(0.955)	(0.999)	(0.998)	(0.994)	(0.000)	
logOP	2.222	3.631	1.603	1.320	2.284	-
	(0.986)	(0.999)	(0.998)	(0.999)	(0.011)	
Logier	-0.857	-1.264	13.941	15.403	3.490	-
	(0.195)	(0.103)	(0.175)	(0.118)	(0.000)	
Model Specification: Individual Effects and Individual Linear Trends						
logRGDP	-0.719	-0.152	6.552	10.807	4.044	-
	(0.235)	(0.439)	(0.766)	(0.372)	(0.000)	
logOP	1.511	0.696	10.071	1.799	8.779	-
	(0.934)	(0.757)	(0.434)	(0.997)	(0.000)	
logIRE	2.202	0.869	9.250	8.236	9.299	-
	(0.986)	(0.807)	(0.508)	(0.605)	(0.000)	
B: First Differences						
Model Specification: Individual Effects						
ΔlogRGDP	-4.692	-5.617	30.688	66.999	-0.050	*I(1)*
	(0.000)	(0.000)	(0.001)	(0.000)	(0.520)	
ΔlogOP	-2.552	-3.660	31.060	65.693	0.694	*I(1)*
	(0.005)	(0.000)	(0.001)	(0.000)	(0.243)	
ΔlogIRE	-6.014	-4.895	50.092	70.893	0.726	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.233)	
Model Specification: Individual Effects and Individual Linear Trends						
ΔlogRGDP	-3.768	-4.555	22.481	80.000	1.275	*I(1)*
	(0.000)	(0.000)	(0.012)	(0.000)	(0.101)	
ΔlogOP	-4.082	-6.485	80.691	95.600	-0.399	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.655)	
ΔlogIRE	-8.478	-7.793	62.474	66.964	0.561	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.287)	

Notes: IPS, LLC and HADRI indicated the Im *et al.* (2003), Levin et al. (2002) and Hadri (2000) panel unit root and stationary tests. MW (Fisher-ADF) and MW (Fisher-PP) denotes Maddala and Wu (1999) Fisher-ADF and Fisher-PP panel unit root test. The IPS, LLC, MW (Fisher-ADF) and MW (Fisher-PP) examine the null hypothesis of non-stationary while HADRI tests the stationary null hypothesis. The three variables were grouped into one panel of N=26, T=5. The parenthesized values are the probability of rejection. Probabilities for the MW (Fisher-ADF) and MW (Fisher-PP) tests are computed using an asymptotic χ^2 distribution, while the other tests follow the asymptotic normal distribution. All variables are transformed into logarithm form prior to estimation.

Panel Cointegration

We proceed to examine whether there exists any long run equilibrium relationship between the variables under investigation. Towards this purpose, we resort to Pedroni (1999, 2001, 2004) and Kao (1999) panel cointegration tests. Pedroni considers seven different statistics, four of which are based on pooling the residuals of the regression along the within-dimension (panel test) of the panel and the other three are based on pooling the residuals of the regression along the between-dimension (group test) of the panel. The within-dimension tests take into account common time factors and allow for heterogeneity across countries. The between-dimension tests are the group mean cointegration tests, which allow for heterogeneity of parameters across countries. Meanwhile, Kao (1999) proposed DF and ADF-type tests for ε_{it} where the null is specified as no cointegration. In this study, we only report the ADF-type test. The details of these tests are discussed in Appendix 1.

Table 4: Panel Cointegration Results

A: Pedroni Residual Cointegration test	
Panel cointegration statistics (within-dimension)	
Panel v-statistic	-3.883 (0.003)
Panel PP type ρ-statistic	-0.375 (0.371)
Panel PP type *t*-statistic	-2.361 (0.024)
Panel ADF type *t*-statistic	-2.907 (0.005)
Group mean panel cointegration statistics (between-dimension)	
Group PP type ρ -statistic	2.580 (0.014)
Group PP type *t* –statistic	-5.142 (0.000)
Group ADF type *t*- statistic	-2.622 (0.018)
B: Kao Residual Cointegration test	
ADF	-2.136 (0.016)

Notes: The number of lag truncations used in the calculation of the seven Pedroni statistics is 3 while Kao ADF statistic is 3. Probability values are in parenthesis.

As reported in Panel A Table 4, we find strong evidence to reject the null hypothesis of no cointegration for all cases except the panel PP type ρ-statistic. According to Pedroni (2004), the panel PP type ρ-test tends to under-reject the null. Similarly, the ADF-type statistics from Kao (1999) also suggesting that that the three-dimension model for the selected PICs is in fact cointegrated (see Panel B). Thus, we find log RGDP, log OP and log IRE are cointegrated in the multi-country panel setting of the five PICs for the sample period.

Panel Fully Modified OLS (FMOLS) Estimates

To obtain the long run estimates of the cointegrating relationship, we adopt the panel group mean Fully Modified OLS (FMOLS) following the work by Pedroni (2000). The FMOLS procedure accommodates the heterogeneity that is typically present both in the transitional serial correlation dynamics and in the long run cointegrating relationships. The FMOLS estimator is described in Appendix 1.

Table 5: Fully Modified OLS (FMOLS) Estimates: Dependent Variable logRGDP

Countries	logOP	logIRE
Fiji	-0.180 (–12.800)*	0.280 (9.620)*
Samoa	-0.350 (-2.890)*	0.090 (6.970)*
Solomon Islands	-0.290 (-2.600)*	0.360 (1.070)
Tonga	-0.680 (-3.670)*	1.240 (0.760)
Vanuatu	-0.410 (-2.930)*	0.540 (3.560)*

Notes: The values in parentheses are the t-statistics. Asterisk (*) shows significance at 5 percent level. All variables are transformed into logarithm form prior to estimation.

The long run estimates for each of the five PICs and for the panel of PICs are reported in Table 5. We observe that the panel results clearly show that log IRE is positive and statistically significant while log OP is postulated as negatively influencing the logRGDP. These were consistent with the theoretical hypothesis that rise in oil price has a negative impact on growth while international reserves behaves positively towards growth.

The estimated long run estimated panel equation by FMOLS is given below,

$$\log RGDP = -0.160 \log OP + 0.560 \log IRE$$

(-4.860) (5.130)

Since the regression exercises were undertaken with variables in logs, the values of the estimated coefficients denote elasticity magnitudes: one percent rise in OP leads to decline in output by 0.16 percent and one percent rise in IRE leads to an increase in RGDP by 0.56 percent.

Turning to the country specific evidence, the results also indicate a positive and significant relationship between log IRE and log RGDP for all the countries except for Solomon Islands and Tonga. In both cases, the coefficient of log IRE is not significant, although the sign is positive. In this sense the international reserves would not be able to lessen the negative impact of rise in oil price on growth. The signs of the coefficients of log OP in all estimated country equations with log RGDP are consistent with *a priori* expectations and are also statistically significant. The results confirm that in all the island countries under study, an increase in oil price leads to decline in output. The elasticity estimates range from –0.18 (Fiji) to -0.68 (Tonga).

Granger Causality Tests

To test for panel causality, we estimate a panel based vector error correction model (VECM) with a dynamic error correction term based on Holtz-Eakin *et al*. (1988, 1989). The three-dimensional empirical model are represented as follows

$$\Delta\log RGDP_{it} = \pi_{1j} + \sum_{p=1}^{m}\pi_{11ip}\Delta\log RGDP_{it-p} + \sum_{p=1}^{m}\pi_{12ip}\Delta\log OP_{it-p} + \sum_{p=1}^{m}\pi_{13ip}\Delta\log IRE_{it-p} + \mu_{1i}ECT_{it-1} + \zeta_{1it} \tag{2a}$$

$$\Delta\log OP_{it} = \pi_{2j} + \sum_{p=1}^{m}\pi_{21ip}\Delta\log OP_{it-p} + \sum_{p=1}^{m}\pi_{22ip}\Delta\log RGDP_{it-p} + \sum_{p=1}^{m}\pi_{23ip}\Delta IRE_{it-p} + \mu_{2i}ECT_{it-1} + \zeta_{2it} \tag{2b}$$

$$\Delta\log IRE_{it} = \pi_{3j} + \sum_{p=1}^{m}\pi_{31ip}\Delta\log IRE_{it-p} + \sum_{p=1}^{m}\pi_{32ip}\Delta\log RGDP_{it-p} + \sum_{p=1}^{m}\pi_{33ip}\Delta OP_{it-p} + \mu_{3i}ECT_{it-1} + \zeta_{3it} \tag{2c}$$

where Δ is the lag operator, p denotes the lag length. All variables are as previously defined in Equation 1. By using the specification in Equation 2, one could test causality direction. For example, to test log OP does not Granger cause log RGDP we consider $H_0 : \pi_{12ip} = 0$ for all i and p while $\mu_{1i} = 0$ as in Equation (2a)[2]. The rejection implies that log OP $\longrightarrow$ log RGDP. Similar analogous restrictions and testing procedure can be applied in testing the hypothesis that log RGDP does not Granger cause movement in log OP where the null hypothesis H_0: $\pi_{22ip} = 0$ for all i and p while $\mu_{2i} = 0$ in Equation (2b).

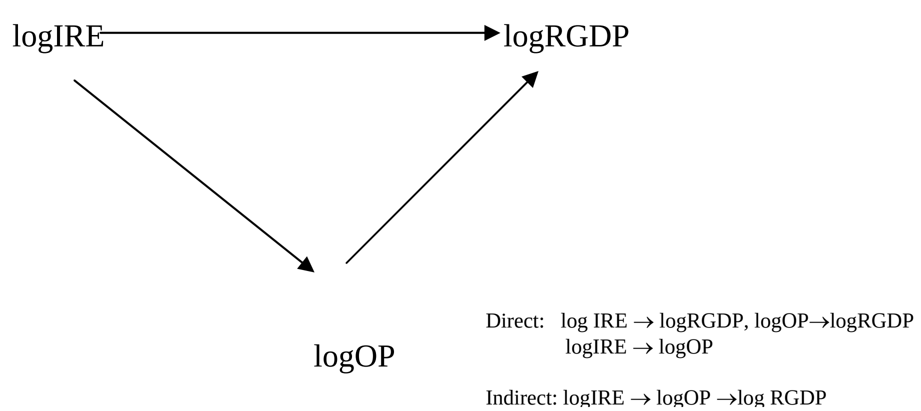
[2] The F-test or Wald χ^2 of the explanatory variables (in first differences) indicates the short run causal effects ($\pi_{12ip} = 0$ for all i and p) while the long run causal (μ_{1i} =0) relationship is implied through the significance of the lagged ECT which contains the long run information.

Table 6: Panel Granger Causality Results

Dependent Variables	ΔlogRGDP	ΔlogOP	ΔlogIRE	ECT	
	χ^2-statistics (p-value)			Coefficient	t-ratio
ΔlogRGDP	-	9.260 (0.026)	9.887 (0.024)	0.009	0.655
ΔlogOP	3.414 (0.332)	-	9.440 (0.025)	0.021	1.467
ΔlogIRE	3.714 (0.294)	0.549 (0.907)	-	-0.045	-6.084

Notes: Parenthesized values are the probability of rejection of Granger non-causality. Δ is the first different operator. Estimations are based on the pooled data for 1982-2007 and 5 Pacific Island Countries (N=5, T=26) with three lags. Asterisk (*) shows significance at 5 percent level. All variables are transformed into logarithm form prior to estimation.

Figure 1: Causality Direction



Note: logIRE → logRGDP implies one-way causality.

The empirical results presented in Table 6 show that the coefficient of the error correction term (ECT) is not statistically significant in the equation with log RGDP as dependent variable, indicating the absence of a long run causality relationship running from log OP and log IRE to log RGDP. However, we note the existence of a significant short run causal relationship running from log OP and log IRE to log RGDP, since the estimated coefficients of both the explanatory variables are statistically significant. The directions of causal relationship are illustrated in Figure 1. Indirect causality between log IRE and log RGDP operates through log OP. log IRE appears to be the initial receiver of any exogenous shocks that disturb the equilibrium of the panel system.

V. Summary and Conclusions

The objective of the paper was to examine the connection between oil price and economic growth in five selected PICs. The choice of the five countries, namely Samoa, Solomon Islands, Tonga and Vanuatu was dictated by availability of reliable time series of data on macroeconomic variables. Unlike Papua New Guinea, the largest country with oil resources amongst all PICs, the five countries under study are dependent on imported fuel, as they have no fossil fuel energy resources, An earlier study on Fiji by Prasad *et al.* (2007), which employed a bi-variate model, concluded that there was a positive association between oil price and growth. The reasoning behind the finding was that Fiji's output since the mid 1980s was around 50% less than the potential output level and that the actual output had not reached a threshold level at which oil prices could negatively impact output.

Our study employed a tri-variate model including one more variable, namely international reserves besides oil price and output, since the capacity of PICs to withstand the pressures of surge in oil price would be far greater than otherwise, to keep up high rate of investment in critical areas for maintaining economic growth.

Adopting a panel cointegration procedure for empirical investigation, which covered a 16-year period (1982-2007), the study found that while oil price negatively affected growth, international reserves positively influenced growth for the panel as a whole as well as in each of the five countries. Although no long-run Granger causality relationship could be established between oil price and growth, the study finding is that in the short run, the causality linkage ran from oil price and international reserves to output.

The policy conclusions are clear. In the short-run, surges in oil price are beyond the control of small island nations and hence the scope for short-term measures is minimal. Towards reducing the immediate impact of increases in oil price, measures including reducing import duties and value added taxes, are appropriate. Although they would be politically correct, popular and easy, fiscal impacts of such measures are serious and they have to be faced sooner or later. Fall in revenue consequent to reduction in duties and taxes would affect budgetary position, giving rise to deficits or forcing governments to cut down essential expenditures, including maintenance of existing public assets including infrastructures.

Governments in PICs have to seriously examine alternate long-term policy measures that adjust for high oil prices. Governments are already aware of good international practices towards ensuring efficient use of energy, such as use of energy lights, reduction and control on the use of energy in government buildings and public places. Time has now come to put them into practice without any delay. By adopting them, they can set an example to commercial firms in the private sector and households.

Public utilities in PICs are heavily subsidized by governments, as 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. Similar adjustments have 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 luxury cars and heavy and small utility vehicles would be appropriate, as the incidence of taxes falls on the wealthy. By the same token, mass transport system has to be encouraged with appropriate incentives. Private sector, which operates bus and other transport have to be encouraged further with carefully designed incentive system, which would include reduction in import duties and other concessions in procurement of buses and trucks.

In regard to electricity generation, all PICs, except Fiji and Vanuatu, presently rely mainly on diesel generators. Alternate energy resources including solar, hydro and wind power as well bio-gas need 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.

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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Appendix 1

Cointegration and Fully Modified OLS

Pedroni panel cointegration test

There are in all seven panel cointegration tests. Detailed description of the formulae for the seven panel cointegration statistics, are given in Pedroni (1999: 660-661).

A. Within-dimension (panel tests):

a) Panel ν-Statistic
b) Panel Phillip-Perron (PP) type ρ-Statistics
c) Panel Phillips-Perron (PP) t-Statistic (non-parametric)
d) Panel Augmented Dickey Fuller (ADF) t-Statistic (parametric)

B. Between-dimension (group tests):

e) Group Phillip-Perron (PP) type ρ-Statistics
f) Group Phillips-Perron (PP) t-Statistic (non-parametric)
g) Group Augmented Dickey Fuller (ADF) t-Statistic (parametric)

These seven statistics are based on the estimated panel cointegration regression residuals of the likely cointegrating vector

$$\log RGDP_{i,t} = \alpha_i + \phi_i t + \beta_1 \log OP_{i,t} + \beta_2 \log IRE_{i,t} + \varepsilon_{i,t} \qquad \text{(A.1)}$$

varying across countries, thus permitting full heterogeneity (β_i), fixed effects (α_i) and individual specific deterministic trends ($\phi_i t$) across individual members of the panel. Pedroni (1999) shows that under appropriate standardization based on the moments of vector of Brownian motion function, each of these statistics converges weakly to a standard normal distribution when both the T and N of the panel grow large. The standardized distributions for the above mentioned seven panel and group statistics can be expressed in the form of

$$\frac{e_{N,T} - \mu\sqrt{N}}{\sqrt{\nu}} \Rightarrow N(0,1) \qquad \text{(A.2)}$$

where e_{NT} is the respective panel/group cointegration statistic and μ and ν are the expected mean and variance of the corresponding statistics. They are computed by Monte Carlo stochastic simulations and tabulated in Pedroni (1999, Table 2).

Kao panel cointegration test

Unlike Pedroni test, Kao (1999) test specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. In this case, we specified the panel regression model as

$$y_{it} = x_{it}^{'}\beta + z_{it}^{'}\gamma + \varepsilon_{it} \qquad \text{(A.3)}$$

where y_{it} and x_{it} are I(1) and non cointegrated. For $z_{it} = \{\mu_i\}$ Kao (1999) proposed DF and ADF-type unit root tests for ε_{it} where the null is specified as no cointegration.

The DF-type test can be calculated from this regression of:

$$\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{it-1} + v_{it} \qquad \text{(A.4)}$$

while the augmented version of the pooled specification:

$$\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{it-1} + \sum_{j=1}^{p}\varphi_j \Delta\hat{\varepsilon}_{it-j} + v_{itp} \qquad \text{(A.5)}$$

where $\hat{\varepsilon}_{it} = \tilde{y}_{it} - \tilde{x}_{it}\hat{\beta}$ and $\tilde{y} = y_{it} - \bar{y}_i$. The OLS estimate of ρ and the t-statistics are given as

$$\hat{\rho} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{\varepsilon}_{it}\hat{\varepsilon}_{it-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{\varepsilon}_{it}^{2}} \text{ and } t_{\rho} = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{\varepsilon}_{it-1}^{2}}}{s_{\varepsilon}}.$$

In this case, $s_{\varepsilon}^{2} = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=2}^{T}\left(\hat{\varepsilon}_{it} - \hat{\rho}\hat{\varepsilon}_{it-1}\right)^{2}$. Under the null of no cointegration, Kao (1999) shows that following the statistics:

$$DF_{\rho} = \frac{\sqrt{N}T(\hat{\rho}-1) + 3\sqrt{N}}{\sqrt{10.2}} \qquad \text{(A.6)}$$

$$DF_{t} = \sqrt{1.25}t_{p} + \sqrt{1.875N} \qquad \text{(A.7)}$$

$$DF_{\rho}^{*} = \frac{\sqrt{N}T(\hat{\rho}-1)\frac{3\sqrt{N}\hat{\sigma}_{v}}{\hat{\sigma}_{0v}^{2}}}{\sqrt{3 + \frac{36\hat{\sigma}_{v}^{4}}{5\hat{\sigma}_{0v}^{4}}}} \qquad \text{(A.8)}$$

$$DF_{t}^{*} = \frac{t_{\rho} + \frac{\sqrt{6N}\hat{\sigma}_{v}}{2\hat{\sigma}_{0v}}}{\sqrt{\frac{\hat{\sigma}_{0v}^{2}}{2\hat{\sigma}_{v}^{2}} + \frac{3\hat{\sigma}_{v}^{2}}{10\hat{\sigma}_{0v}^{2}}}} \qquad \text{(A.9)}$$

where $\hat{\sigma}_{v}^{2} = \hat{\Sigma}_{yy} - \hat{\Sigma}_{yx}\hat{\Sigma}_{xx}^{-1}$ and $\hat{\sigma}_{0v}^{2} = \hat{\Omega}_{yy} - \hat{\Omega}_{yx}\hat{\Omega}_{xx}^{-1}$. For ADF can be constructed as:

$$ADF = \frac{t_{ADF} + \frac{\sqrt{6N}\hat{\sigma}_{v}}{2\hat{\sigma}_{0v}}}{\sqrt{\frac{\hat{\sigma}_{0v}^{2}}{2\hat{\sigma}_{v}^{2}} + \frac{3\hat{\sigma}_{v}^{2}}{10\hat{\sigma}_{0v}^{2}}}} \tag{A.10}$$

where t_{ADF} is the t-statistics of ρ in equation A.5.

Fully Modified OLS Estimates

Following Pedroni (2000, 2001), we consider the following cointegrated system for panel data of

$$Y_{it} = \alpha_i + \beta_i X_{it} + \mu_{it} \tag{A.11}$$

$$X_{it} = X_{i,t-1} + e_{it} \tag{A.12}$$

where, $i = 1,2,...,N$ countries over the time period of $t = 1,2,...M$. In addition, $Z_{it} = (Y_{it}, X_{it})' \sim I(1)$ and $\zeta_{it} = (\mu_{it}, e_{it})' \sim I(0)$ with covariance matrix of $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i^{'}$, where Ω_0^i is the contemporaneous covariance, Γ_i is the weighted sum of autocovariances while $\Omega_i = L_i L_i'$ in which L_i is the lower triangular decomposition of Ω_i. For simplicity, we assume that Y = logRGDP while X [logOP and logIRE] of Equation 1 and A.1 in this study. The panel FMOLS estimator for coefficient β is given as:

$$\beta_{FM}^{*} = N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(X_{it} - \overline{X}_{it})^{2}\right)^{-1}\left(\sum_{t=1}^{T}(X_{it} - \overline{X}_{it})Y_{it}^{*} - T\hat{\gamma}_{i}\right) \tag{A.13}$$

where

$$Y_{it}^{*} = \left(Y_{it} - \overline{Y}\right) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\Delta X_{it} \text{ and } \hat{\gamma}_{i} = \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\left(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^{0}\right)$$

Likewise, the associated t-statistics for the estimator can be constructed as:

$$t_{\hat{\beta}_{FM}^{*}} = N^{-1/2}\sum_{i=1}^{N} t_{\hat{\beta}_{FM,i}^{*}} \text{ where } t_{\hat{\beta}_{FM,i}^{*}} = (\hat{\beta}_{FM,i}^{*} - \beta_{0})\left(\hat{\Omega}_{11i}^{-1}\sum_{t=1}^{T}(X_{it} - X_{i})^{2}\right)^{1/2}.$$

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