

Fueling Vulnerability

The Economic and Strategic Costs of Oil Dependence in the Pacific

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Technical Appendix

The main limitation is statistical power: Annual samples are short, several countries have fewer than 30 observations, and tourism-controlled samples are shorter again. Structural breaks and country-specific shocks also matter in small economies. The estimates are therefore best read as conditional historical relationships rather than structural causal effects. Results near conventional thresholds are treated cautiously, which is why the figures use broad evidence categories, benchmark checks, and clearly marked exceptions.

METHOD AND DATA

The baseline follows Sheridan, Tumbarello, and Wu ([IMF 2012](#)). For the error correction model (ECM) countries, the long-run relationship links log real GDP to log real GDP in the principal partner: Australia for most economies, the United States for the Compact of Free Association states, and New Zealand for Samoa. Palau is paired with the United States but is estimated separately because its GDP series is better characterized as stationary around a deterministic trend and structural break. The short-run equations relate domestic GDP growth to partner growth, changes in the real oil price and selected country-specific controls. The real oil price is the World Bank crude oil average of Brent, Dubai, and West Texas Intermediate, divided by the U.S. consumer price index. Fiji also controls for real sugar prices; Papua New Guinea and the Solomon Islands include the World Bank non-energy commodity price index. Tourism receipts are used as short-run robustness controls for Fiji, Vanuatu, and Tonga.

Long run equation:

$$\ln Y_{i,t} = \alpha_i + \beta_i \ln Y_{p(i),t} + u_{i,t}$$

Where $\ln Y_{i,t}$ is the log of real GDP in year t for each PIC (i), $Y_{p(i),t}$ is the log of real GDP in year t of economy i relevant major partner economy p , α_i is the long run intercept, β_i is the long run elasticity, and $u_{i,t}$ is the long-run residual term.

The error correction term is expressed as

$$\widehat{ECT}_{i,t-1} = \ln Y_{i,t-1} - \hat{\alpha}_i - \hat{\beta}_i \ln Y_{p(i),t-1}$$

Short run equation:

$$\Delta \ln Y_{i,t} = c_i + \alpha_i \widehat{ECT}_{i,t-1} + \delta_i \Delta \ln Y_{p(i),t} + \gamma_i \Delta \ln Oil_price_t + \theta_i' \Delta X_{i,t} + \varepsilon_{i,t}$$

Where c_i is the short-run intercept, α_i is the speed of adjustment, δ_i is the short-run anchor elasticity, γ_i is the oil price elasticity, θ_i is a vector of coefficients on the additional controls $X_{i,t}$ and $\varepsilon_{i,t}$ is the residual term.

The data is annual, generally 1980–2024, from the IMF World Economic Outlook and World Bank sources. Naoero (Nauru) is excluded from the headline analysis because comparable GDP data is not available before 2004; Niue and the Cook Islands are also omitted because the common annual GDP series is too limited. Long-run evidence is assessed using Engle-Granger residual tests and finite-sample ARDL bounds tests, supplemented by Gregory-Hansen structural-break tests; Phillips-Ouliaris and Johansen results are used as additional cross-checks. Because these tests have different assumptions and limited power in short annual samples, Figure 1 reports broad evidence categories rather than a single pass/fail cointegration label. Short-run inference uses Newey-West (HAC) standard errors. The baseline oil measure is the World Bank Pink Sheet crude average; Brent and Dubai are used separately as benchmark checks.

PARTNER-COUNTRY RELATIONSHIPS

Figure 1 reports the bilateral long-run elasticity from the parsimonious partner-only regression where that coefficient is comparable, and it separately classifies the strength of evidence for a persistent relationship. “Strong evidence” means that the relationship is supported across more than one reasonable long-run test and is not dependent on a single break treatment. “Moderate evidence” means that evidence appears under some admissible specifications or structural-break treatments but is not uniform across tests. Palau is also placed in this group because it is estimated in a separate stationary-break framework. “Limited evidence” means that the main tests do not provide a stable long-run relationship. These categories are deliberately broader than any one p-value.

The baseline adjustment coefficients are negative for all ECM countries, which is consistent with error correction, but their precision varies and they are not used to define the Figure 1 categories.

Table A1: Long-Run Relationship with Principal Partner and Figure 1 Classification

Scenario	Description	LR elasticity (β_L)	α_L	Cointegration EG ECM-t	Evidence	n
Fiji	Australia	0.74***	-0.31**	10% no	Moderate	44
Papua New Guinea	Australia	1.14***	-0.13**	None no	Moderate	44
Solomon Islands	Australia	0.85***	-0.06	None no	Limited	44
Vanuatu	Australia	0.85***	-0.20***	10% no	Moderate	44
Kiribati	Australia	0.65***	-0.12	None no	Limited	44
Tuvalu	Australia	0.69***	-0.30***	None no	Moderate	24
Marshall Islands	United States	0.68***	-0.36***	None no	Moderate	27
Federated States of Micronesia	United States	0.16***	-0.58***	5% 5%	Strong	29
Palau*	United States	n/a	—	—	Moderate	24
Tonga	New Zealand	0.70***	-0.21***	5% 1%	Strong	44
Samoa	New Zealand	0.98***	-0.40***	10% 5%	Strong	44

Note: * $p < .1$, ** $p < .05$, *** $p < .01$. The Engle-Granger column reports the strongest rejection level from the residual test. Stars on the LR elasticity are based on OLS standard errors from the static cointegrating regression. Under cointegration these standard errors are not asymptotically valid, so they are indicative of the precision of the estimate rather than a formal test; the cointegration column carries the inference on whether a long-run relationship exists. The cointegration column reports the strongest level at which each test rejects the null of no cointegration, or “None”/“no” where it does not. Both tests have non-standard distributions, so conventional t critical values do not apply: Engle-Granger residual ADF against MacKinnon critical values (-3.90 / -3.34 / -3.04); ECM t-test against Banerjee-Dolado-Mestre critical values (-3.79 / -3.21 / -2.91). *Palau’s log GDP tests stationary in levels and is estimated as a stationary dynamic model with a deterministic break, so no cointegrating vector and no long-run elasticity is identified for it. Limited evidence means the tests do not confirm a long-run relationship at conventional levels; it does not mean that no relationship exists.

OIL PRICE ESTIMATES AND BENCHMARK CHECKS

Figure 2 translates the estimated oil coefficient into the GDP response to a 50 percent increase in the real oil price. Because oil enters in log changes, the plotted effect is $100 \times \text{coefficient} \times \ln(1.5)$. For Fiji and Vanuatu, the preferred short-run specification includes tourism receipts; for the other ECM countries, the parsimonious specification is retained. Palau uses its separate stationary-break model. Tourism data begins substantially later than the GDP series, so tourism is kept out of the long-run relationship and enters only the shorter short-run equation.

Each country is shown once in Figure 2. The chart gives priority to a statistically significant negative two-year total; if that is absent, it uses a significant same-year effect and then a significant following-year effect. Countries without a statistically

significant negative response are shown using the two-year point estimate in gray. Two benchmark-dependent results are explicitly flagged (Tonga and Tuvalu).

Table A2: Oil Price Effects Shown in Figure 2

Country	GDP effect (%)	Timing shown	Specification/benchmark	Statistical evidence
Fiji	-2.4***	Two-year total	Tourism-adjusted	Negative result broadly consistent across benchmarks
Papua New Guinea	-3.8**	Two-year total	Baseline	Negative result broadly consistent across benchmarks
Solomon Islands	-2.4**	Following year	Baseline	Lagged negative result across benchmarks
Vanuatu	+1.5	Two-year point estimate	Tourism-adjusted	No significant negative effect
Kiribati	-1.8	Two-year point estimate	Baseline	No significant negative effect
Tuvalu	-3.3*	Two-year total	Dubai	Significant under Dubai; weaker in other benchmarks
Marshall Islands	-0.4	Two-year point estimate	Baseline	No significant negative effect
Federated States of Micronesia	+0.6	Two-year point estimate	Baseline	No significant negative effect
Palau	-4.0***	Same year	Baseline (stationary model)	Same-year negative result across benchmarks
Tonga	-2.6*	Two-year total	Dubai	Delayed negative result in baseline and Dubai
Samoa	-0.1	Two-year point estimate	Baseline	No significant negative effect

Note: * $p < .1$, ** $p < .05$, *** $p < .01$. Values are percentage-point GDP responses to a 50 percent real oil price increase and are rounded to one decimal place. Significance is assessed with Newey-West (HAC) standard errors.

Most benchmark differences occur in estimates near conventional significance thresholds, so the article emphasizes the broad pattern rather than small changes in p-values.

SELECTED ROBUSTNESS CHECKS AND LIMITATIONS

Tourism controls leave the broad oil results intact but matter for some individual estimates. In Fiji, controlling for tourism strengthens the negative response. In Vanuatu, the earlier positive response is no longer statistically significant. Papua New Guinea has a clear post-2014 shift associated with the start of liquefied natural gas exports. A post-2014 level-shift dummy changes the oil coefficient only modestly, from about -0.062 to -0.055, and the oil effect remains significant at 5 percent. The error-correction coefficient remains negative but becomes less precise, suggesting that the oil result is more stable than the exact speed of long-run adjustment. For Kiribati, adding tuna stock measures does not generate robust long-run evidence, and the oil coefficient remains negative but statistically insignificant. These models are used as short-run robustness checks rather than to re-estimate the long-run relationship.

CHINA COMPARISON AND INTERPRETATION

The baseline long-run regression is re-estimated with Chinese GDP in place of the principal partner for the ECM-eligible countries. China does not establish a baseline long-run relationship where the principal partner fails. In several countries both pass the same weak-threshold test, so this should not be read as evidence that China is insignificant; rather, the bilateral GDP tests do not show China replacing the more established partner as the long-run macroeconomic reference point. Palau is excluded because it is not treated as a conventional cointegrated pair.