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This article examines the export-led growth and import-led growth hypotheses for a panel of Pacific island countries—namely, Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu—for the period 1982–2004. The modelling is performed using a panel unit root, panel co-integration and panel Granger causality approach. We find bi-directional Granger causality for the panel of Pacific island countries between exports and economic growth, imports and economic growth, and exports and imports. The results suggest that the poor growth performance of many Pacific island countries reflects their poor export performance; however, if the supply-side constraints on exports are removed, there could be a virtuous cycle between economic growth and exports.

Vinod Mishra is a Lecturer at the Department of Economics, Monash University;

Susan Sunila Sharma is a Ph.D student, School of Accounting, Economics and Finance, Deakin University

Russell Smyth is a Professor in the Department of Economics, Monash University.

The role of exports as an engine of economic growth has been the subject of many empirical studies. The direction of causation and the magnitude of the effects have been the subjects of debate in the development and growth literature for several decades (for example, Keesing 1967; Krueger 1985). The main question that arises in this debate is whether countries should promote their export sector, as opposed to pursuing an inward-oriented trade strategy as a vehicle for promoting economic growth. The export-led growth hypothesis states that causality flows from exports to economic growth. Another hypothesis is that the causality flows from economic growth to exports—that is, growth-led exports. A third hypothesis is import-led growth, which argues that economic growth is caused by imports.

The objective of this article is to examine the export-led growth, growth-led exports and import-led growth hypotheses for a panel of Pacific island countries—namely, Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. The article makes three contributions to the literature. First, while there are many studies of the export-led
growth and growth-led exports hypotheses for Asian countries, there are few such studies for the Pacific island countries.

The Pacific island countries make an interesting case study for examination of the export-led growth and import-led growth hypotheses. In the past decade, the Pacific island countries have adopted trade liberalisation strategies as a means of promoting economic growth and many are signatories to regional and international trade agreements, which have the objective of promoting economic development. These agreements include the Pacific Island Countries Trade Agreement (PICTA) and the Pacific Agreement on Closer Economic Relations (PACER), which includes Australia and New Zealand (Narsey 2004). The Pacific island countries are also negotiating a trade agreement with the European Union, known as the Economic Partnership Agreement (EPA).

Economic growth and export performance among the Pacific island countries have, however, been uneven and several commentators have expressed doubts about the perceived benefits of trade liberalisation (Rao, Sharma, Singh and Lata 2008). Narsey (2004) has argued that the Pacific island countries have not analysed the long-term viability of industries affected by PICTA or examined the costs of compliance with PACER. Prasad (2002) has suggested that many of the benefits of trade liberalisation have not flowed through to higher growth because of institutional constraints such as poor infrastructure, poor governance and uncertain land rights. Tapuiaga and Chand (2004) have emphasised the costs of restructuring industries that result from trade liberalisation, as resources are redeployed from less to more productive sectors.

The second contribution this article makes is that we add to the small number of papers that have used a panel framework. Most studies on the export-led growth hypothesis are for single countries. There are only two extant studies, of which we are aware, that employ a panel framework (Dawson and Hubbard 2004; Hsiao and Hsiao 2006). One possible reason for conflicting results from tests of the export-led growth and growth-led exports hypotheses with single-country studies is that, for many countries, we have only annual data with a maximum span of 40–45 years and often less. The power of traditional unit root tests, such as the Augmented Dickey-Fuller (ADF) test, and traditional co-integration tests, such as the Johansen (1988) test, can be distorted when the span of data is short (for example, Campbell and Perron 1991). Some studies use monthly or quarterly data to increase the number of observations, but this practice is questionable because with standard co-integration tests what matters is the time frame, rather than the number of observations (for example, Perron 1991).

Employing a panel-based co-integration and Granger causality approach has several advantages compared with focusing on a single country. First, panel data provide additional measurement precision by matching responses from one period with those from another. Second, panel data allow observation of changes in individual behaviour over time, as well as monitoring the behaviour of cohorts over time. Third, panel data are generally more accurate than cross-sectional data. A disadvantage of using panel data is that panel conditioning can bias responses, in that panel members become atypical as a result of being on the panel (this is also known as the ‘testing’ effect).

Another disadvantage is panel selection bias, which occurs when respondents are not representative of the underlying population—for example, they exclude the very rich, very poor or those who are transitory (Lohse, Bellman and Johnson 1999). A third disadvantage of employing
panel data is that the findings can be overgeneralised without sufficient regard for the heterogeneous nature of the panel in terms of development and size.

The third contribution of this article is that we expand on the conventional export-led growth model by including a third variable—namely, imports. Most empirical studies have examined the export-led growth and growth-led exports hypotheses without considering the role of imports. There are relatively few studies that have controlled for imports and considered the import-led growth hypothesis (Awokuse 2008; Thangavelu and Rajaguru 2004; Mahadevan and Suardi 2008). Failure to control for imports potentially results in a spurious relationship between exports and economic growth because export growth is typically associated with rapid import growth. If, therefore, imports are not included there is a problem of omitted variables bias, such that the relationship found to exist between exports and economic growth could in fact be between imports and economic growth.

The Pacific island countries context

Overall, the economic performance of the Pacific island countries in the past two decades has been disappointing. None of the Pacific island countries realised a real gross domestic product (GDP) per capita growth rate of 2 per cent for the period 1985–2006. Several reasons can be advanced for this poor economic growth—these include poor economic policies, political instability, unfavourable commodity prices, bad weather (Fairbairn 2002) and unstable exchange rates (Narayan and Narayan 2007, 2009; Narayan, Narayan, Prasad and Prasad 2009). Narayan and Prasad (2007) used a computable general equilibrium model to show that the coups had an adverse effect on export performance in Fiji. Civil unrest has also had a negative impact on the export performance of Papua New Guinea and Solomon Islands. For many Pacific island countries, such as Fiji and Vanuatu, tourism is a major export and this has also been affected by political instability (Narayan 2004a; Narayan, Narayan, Prasad and Prasad In press).

Countries adversely affected by poor commodity prices include Fiji (garments and sugar), Solomon Islands (logs) and Vanuatu (beef). Pacific island country exports are vulnerable to external shocks. For example, the East Asian financial crisis (1997–99) led to a collapse of demand in the major Asian export markets of Solomon Islands for logs and Vanuatu for beef and timber (Fairbairn 2002). A study by Yari (2003) found that after the East Asian financial crisis, Vanuatu had the most volatile export earnings in the South Pacific. Instability of export earnings—measured as the average percentage deviation of export earnings from the exponential trend level—for 1998–2000 for Vanuatu was 21.5 per cent, which was higher than Nauru (20 per cent), Papua New Guinea (18 per cent), Solomon Islands (17 per cent) and Fiji (14 per cent).

For most Pacific island countries, the agricultural sector, including fishing, has traditionally provided the major economic activity. Agricultural production in the Pacific island countries has, however, been seriously affected by adverse weather and natural disasters, which has had a negative effect on export performance. For example, Cyclone Ron in 1998 caused widespread damage that particularly affected the northern islands of Tonga, with heavy rain generating serious losses in food crops for export. Similarly, in 1997, drought had a catastrophic effect on Papua New Guinea’s coffee, cocoa and coconut production—the mainstays of the agricultural-based economy in that country and major sources
of export earnings. For example, the coffee crop in Papua New Guinea was slashed by up to 50 per cent in 1997 and GDP declined 4.6 per cent (AusAID 2000).

Despite moves to liberalise trade in the past decade, many Pacific island countries have not been in a position to benefit as export sectors are facing decline. This is particularly true in Fiji where export performance has been weak in recent times, with exports declining by 6.8 per cent in 2005 and 11.3 per cent in 2006. Part of the decline in exports reflects a sharp fall in garment exports after expiration of the Multi-Fibre Agreement, and, in part, it is due to the poor performance of sugar. The impact on the balance of payments of falling exports has been exacerbated in many Pacific island countries by strongly rising imports. The Pacific island countries are highly dependent on imported petroleum for their commercial energy requirements. Petroleum imports account for more than 90 per cent of overall energy requirements, making the Pacific island countries extremely vulnerable to rising oil prices. In Fiji, imports increased 13.2 per cent in 2006, despite a tightening of monetary policy. Imports in Tonga also increased in 2005 and 2006, while the country experienced poor export performance.

While increasing oil prices have had an adverse effect on the balance of payments of most Pacific island countries, higher oil, copper and gold prices have aided Papua New Guinea, which is both an oil producer and refiner. There was a mineral boom in Papua New Guinea in the early 1990s when a number of new mines, such as the large Kutubu and Porgera mining projects, began production (Faal 2007). Over a long period, however, revenue windfalls from mineral booms in Papua New Guinea were not well managed. Papua New Guinea’s economic performance has been better in the past few years due to strong mineral prices coupled with a stable political environment and better allocation of revenue from the mineral windfall, including investment in education, health and infrastructure (ADB 2007).

**Hypotheses**

The export-led growth hypothesis states that Granger causality runs from exports to GDP. There are several possible reasons why Granger causality might run from exports to GDP (Ahmad 2001). At the most obvious level, exports increase GDP because exports are a component of GDP. At a more subtle level, countries with a high export-to-GDP ratio are more open to outside influences and generate externalities, such as incentives to innovate. These efficiency gains increase GDP through increasing total factor productivity (TFP) in the Solow-Swan growth accounting framework.

The competing growth-led exports hypothesis is captured in variants of ‘handmaiden’ theories of trade (Kravis 1970) or the argument that growth mechanisms that are ‘internally generated’ best explain the growth of exports (Jung and Marshall 1985). To illustrate this argument, assume that there is growth in TFP due to technological improvements that are independent of trade. In this scenario, it is plausible that the comparative cost structure of such an economy would evolve in a manner that is consistent with growing exports (Ahmad 2001:148).

Increased imports also have the potential to play a complementary role in promoting economic growth. The transfer of technology from industrialised to developing countries via imports could serve as an important source of economic growth. Endogenous growth models assume that imports stimulate long-run economic growth because they offer domestic firms access to foreign knowledge (Grossman
and Helpman 1991; Coe and Helpman 1995). Imports could therefore be sources of technology-intensive intermediate factors of production (Lawrence and Weinstein 1999). To the extent that imports act as a conduit for technology transfer, they can play a bigger role than exports in promoting economic growth (Awokuse 2008).

Literature review

A large number of studies have tested the export-led growth hypothesis on single countries (for example, Blumenthal 1972; Nandi and Biswas 1991; Ahmad, Harnhirun and Yang 1997; Marin 1992; Shan and Sun 1998). Giles and Williams (2000) provide an extensive review of many of these studies. Here, we briefly review some of the more well-known studies. Blumenthal (1972) used ordinary least squares to test the export-led growth hypothesis for Japan using annual and quarterly data for the period 1953–67. He found that there was an insignificant statistical relationship between exports and economic growth. Nandi and Biswas (1991) tested the export-led growth hypothesis for India using annual time series data for the period 1960–85. They used bi-variate Sims and vector autoregressive lag (VARL) modelling approaches and found support for the export-led growth hypothesis. Ahmad, Harnhirun and Yang (1997) tested the same hypothesis for five Asian countries using annual times series data for the period 1976–88. They found support for the growth-led exports hypothesis for Malaysia, the Philippines, Singapore and Indonesia, but no causal relationship between exports and growth for Thailand. Marin (1992) used quarterly data for the first quarter 1960 to the second quarter 1987 for Germany, the United Kingdom, the United States and Japan to test the export-led growth hypothesis and found support for it for Germany, the United States and the United Kingdom, but for Japan he found bi-directional causality between exports and economic growth. Shan and Sun (1998) examined the causal relationship between exports and growth using Granger causality for Hong Kong, Korea and Taiwan for the first quarter 1978 to the third quarter 1996. They found that Granger causality ran from exports to economic growth only for Taiwan, while they found evidence of bi-directional Granger causality for Korea and Hong Kong.

There are some studies that have considered the import-led growth hypothesis (among others, Awokuse 2008; Thangavelu and Rajaguru 2004; Mahadevan and Suardi 2008). Awokuse (2008) examined the relationship between trade and economic growth in Argentina, Colombia and Peru. He found mixed support for the export-led growth, import-led growth and growth-led exports hypotheses. Thangavelu and Rajaguru (2004) examined the relationship between trade and labour productivity for nine rapidly developing Asian countries in a time series framework using a vector error-correction model. Their results suggest that imports are more important than exports in promoting productivity growth, with Granger causality running from imports to productivity growth in India, Indonesia, Malaysia, the Philippines, Singapore and Taiwan. Mahadevan and Suardi (2008) examined the export-led growth and import-led growth hypotheses for Japan and Korea and found that economic growth and trade were independent in Korea, while Japan's economic growth was import but not export led.

There are only two single-country studies of the export-led growth and import-led growth hypotheses for the Pacific island countries, of which we are aware, and both focus on Fiji and Papua New Guinea. Ram (2003) examined the export-led growth and import-led growth hypotheses for Fiji.

There are few studies on the export-led growth hypothesis that employ a panel framework. Hsiao and Hsiao (2006) studied the causal relationship between exports and economic growth using time series data from 1986 to 2004 for eight Southeast Asian economies. They found out that bi-directional Granger causality existed between economic growth and exports. Dawson and Hubbard (2004) tested the export-led growth hypothesis for 14 Central and Eastern European countries using annual data for the period 1994–99 and found strong evidence in support of it.

Data and empirical specification

In this article, we use a multivariate model to test the export-led growth and import-led growth hypotheses. The model consists of three variables: real GDP (Y), real exports of goods and services (E) and real imports of goods and services (I). The data, which consist of annual observations for the period 1982–2004, are all in constant 2000 US dollars and have been extracted from the World Development Indicators (World Bank 2009). The panel consists of five Pacific island countries: Fiji, Papua New Guinea, Solomon Islands, Tonga and Vanuatu. These are the five Pacific island countries for which consistent data are available for this time frame. While there are data for some countries up to 2007, for other countries, the data on imports and exports end in 2004. All data were converted into natural logs before undertaking the analysis.

The multivariate model can be written as follows (Equations 1, 2, 3).

\[
\ln Y_t = \alpha_{i0} + \alpha_{i1} \ln E_t + \alpha_{i2} \ln I_t + e_{it} \\
\ln E_t = \alpha_{i0} + \alpha_{i1} \ln Y_t + \alpha_{i2} \ln I_t + e_{it} \\
\ln I_t = \alpha_{i0} + \alpha_{i1} \ln E_t + \alpha_{i2} \ln Y_t + e_{it}
\]

Econometric techniques

Panel unit root tests

While several panel unit root tests have been proposed, we start with the panel unit root tests suggested by Im, Pesaran and Shin (2003) and Maddala and Wu (1999). The \( t \)-bar test proposed by Im, Pesaran and Shin (2003) has the advantage that it does not assume that all countries converge towards the equilibrium value at the same speed under the growth-led exports hypothesis. There are two stages in constructing the \( t \)-bar test statistic. The first is to calculate the average of the individual ADF \( t \)-statistics for each of the countries in the sample. The second is to calculate the standardised \( t \)-bar statistic (Equation 4).

\[
t - bar = \sqrt{N}(t_{\alpha} - \kappa) / \sqrt{v_t}
\]

In Equation 4, \( N \) is the size of the panel, \( t_{\alpha} \) is the average of the individual ADF \( t \)-statistic for each of the countries with and without a trend, and \( \kappa \) and \( \nu \) are, respectively, estimates of the mean and variance of each \( t_{\alpha} \). Im, Pesaran and Shin
(2003) provided Monte Carlo simulations of $\kappa_i$ and $v_i$ and tabulated exact critical values for various combinations of $N$ and $T$. A problem with the $t$-bar test is that if there is cross-sectional dependence in the disturbances, the test is no longer applicable. Im, Pesaran and Shin (2003) suggested that, in the presence of cross-sectional dependence, the data could be adjusted by demeaning and that the standardised demeaned $t$-bar statistic converged to the standard normal in the limit. Strauss and Yigit (2003), however, show that demeaning across the panel does not usually eliminate cross-sectional dependence. We therefore also employ the cross-sectionally augmented version of the IPS test statistic (CIPS) proposed by Pesaran (2007). The CIPS has the advantage that it explicitly allows for cross-sectional dependence by suitably truncating the IPS $t$-bar statistic.

Maddala and Wu (1999) criticised the working-paper version of the Im, Pesaran and Shin (2003) test on the basis that, in many real-world applications, cross-correlations were unlikely to take the simple form proposed by Im, Pesaran and Shin and that they could not be effectively eliminated by demeaning the data. Maddala and Wu (1999) proposed a panel unit root test developed from Fisher (1932). The test essentially combines the $p$-values of the test statistic for a unit root in each residual cross-sectional unit. The test is non-parametric and has a chi-square distribution with $2N$ degrees of freedom, where $N$ is the number of cross-sectional units or countries. Using the additive property of the chi-squared variable, the test statistic can be derived (Equation 5).

$$\lambda = -2 \sum_{i=1}^{N} \log_{e} \pi_i$$

Here, $\pi_i$ is the $p$-value of the test statistic for unit $i$. The Maddala and Wu (1999) test has the advantage over the Im, Pesaran and Shin (2003) test in that it does not depend on different lag lengths in the individual ADF regressions. Maddala and Wu (1999) performed Monte Carlo simulations showing their test was superior to the Im, Pesaran and Shin (2003) test. Baltagi and Kao (2000) also reported that Fisher (1932) types of tests such as those of Maddala and Wu (1999) were superior to the Im, Pesaran and Shin (2003) test in terms of size-adjusted power.

Panel co-integration tests

If real imports, real exports and real GDP contain a panel unit root, the issue arises of whether there exists a long-run equilibrium relationship between the variables. We first test for panel co-integration using Pedroni’s (2004) test, which allows for heterogeneity in the intercepts and slopes of the co-integrating equation. Pedroni (2004) provides seven statistics for the test of the null of no co-integration in heterogeneous panels. As the Pedroni (2004) test is well known, we do not go into detail. One group of tests is termed ‘within dimension’ (panel tests) and the other group of tests is ‘between dimension’ (group tests). The ‘within dimension’ tests take into account common time factors and allow for heterogeneity across countries. The ‘between dimension’ tests are ‘group mean co-integration tests’ and allow for heterogeneity of parameters across countries. The seven Pedroni (2004) panel co-integration test statistics that we employ are as follows.

Within dimension (panel tests)

a. panel v-statistic
b. panel Phillips-Perron type rho-statistics
c. panel Phillips-Perron type t-statistic
d. panel ADF type t-statistic.
Between dimension (group tests)
e. group Phillips-Perron type rho-statistics
f. group Phillips-Perron type t-statistic
g. group ADF type t-statistic.

We also implement the panel co-integration test of Larsson, Lyhagen and Lothgren (2001), which allows for multiple co-integration relations. The Larsson, Lyhagen and Lothgren (2001) likelihood-based panel test for co-integration rank in heterogeneous panel models is based on the average of individual rank trace statistics. The key statistic, 

\[ \gamma_{r}^{T}(H(r)|H(3)) \]

is the average of the N individual trace statistics (Larsson, Lyhagen and Lothgren 2001). Neither the Pedroni (2004) nor the Larsson, Lyhagen and Lothgren (2001) tests allow for the existence of structural breaks in the co-integrating vector. In the presence of structural breaks, both will have low power to reject the null. We therefore also employ the Westerlund (2006) panel co-integration, which accommodates multiple structural breaks in the co-integrating vector.

The index \( j = 1, \ldots, M_i + 1 \) denotes structural breaks. At most, \( M_i \) breaks or \( M_i + 1 \) regimes can be accommodated that are located at dates \( T_{i0}, \ldots, T_{iM_i} \), where \( T_{i0} = 1 \) and \( T_{iM_i+1} = T \). A fixed fraction, \( \lambda_{ij} \in (0,1) \), of \( T \) such that \( T_{ij} = [\lambda_{ij}T] \) and \( \lambda_{ij-1} < \lambda_{ij} \) for \( j = 1, \ldots, M_i \), specifies the location of the breaks. Westerlund (2006) uses the Bai and Perron (2003) technique to determine the structural breaks endogenously, which globally minimises the sum of squared residuals to obtain the location of breaks:

\[ \hat{T}_i = \arg \min_{T_i} \sum_{j=1}^{M_i+1} \sum_{t=t_{j+1}}^{T_i} (y_{it} - z_{it}^j \hat{\gamma}_j - x_{it}^j \hat{\beta}_j)^2, \]

in which \( \hat{\gamma}_j \) and \( \hat{\beta}_j \) are the estimates of the co-integration parameters based on the partition \( T_i = (T_{i1}, \ldots, T_{iM_i})' \); \( T_i = (T_{i1}, \ldots, T_{iM_i})' \) is a vector of estimate break points and \( i \) is the trimming parameter such that \( \lambda_{ij} - \lambda_{ij-1} > t \). The minimum length of each segment is set equal to 0.15\( T \) to ensure that the break-date estimator works efficiently and we also follow the advice of Bai and Perron (2003) and use the Schwartz Bayesian criterion. The maximum number of allowable breaks is set equal to 5.

The null hypothesis that all countries in the panel are co-integrated is \( H_0 : \phi_i = 0 \) for all \( i = 1, \ldots, N \), versus \( H_1 : \phi_i \neq 0 \) for \( i = 1, \ldots, N \), and \( \phi_i = 0 \) for \( i = N, +1, \ldots, N \). In this, the alternative hypothesis permits \( \phi_i \) to differ across cross-sectional units. The panel LM test statistic is in Equation 9.

\[ Z(M) = \sum_{i=1}^{N} \sum_{j=1}^{M_i+1} \sum_{t=T_{i0}+1}^{T_i} (T_{ij} - T_{i(j-1)} - 2)^2 \hat{\omega}_{ih1}^2 S_{it}^2 \]

In Equation 9, \( \hat{\omega}_{ih1}^2 = \hat{\omega}_{ih1}^2 - \hat{\omega}_{ih21}^2 \hat{\omega}_{i22}^2 \hat{\omega}_{ih21}^2 \) and \( S_{it} = \sum_{k=T_{i0}+1}^{t} \hat{e}_{ik}^* \), where \( \hat{e}_{ik}^* \) is any competent estimation of \( e_{it} \). To estimate \( e_{it} \), we use fully modified OLS (FMOLS) (Phillips and Hansen 1990), where the test statistic is written as a function of breaks.

**Panel Granger causality**

Next, we examine the direction of causality between the variables in a panel context. Engle and Granger (1987) show that if two
non-stationary variables are co-integrated, a VAR in first differences will be miss-specified. If we find a long-run equilibrium relationship between real exports, real imports and real GDP when testing for Granger causality, we specify a model with a dynamic error-correction representation. The VAR model is augmented with a one-period lagged error correction term (ECT) that is obtained from the co-integrated model. The Granger causality test is as follows (Equations 10, 11, 12).

\[ \Delta \ln Y_{it} = \theta_{1t} + \sum_p \theta_{1Tp} \Delta \ln Y_{it-p} + \sum_p \theta_{2Tp} \Delta \ln E_{it-p} + \sum_p \theta_{3Tp} \Delta \ln I_{it-p} + \psi_{1T} ECT_{t-1} \]  

\[ \Delta \ln E_{it} = \theta_{2t} + \sum_p \theta_{2Tp} \Delta \ln E_{it-p} + \sum_p \theta_{3Tp} \Delta \ln I_{it-p} + \psi_{2T} ECT_{t-1} \]  

\[ \Delta \ln I_{it} = \theta_{3t} + \sum_p \theta_{3Tp} \Delta \ln I_{it-p} + \sum_p \theta_{3Tp} \Delta \ln Y_{it-p} + \psi_{3T} ECT_{t-1} \]  

All variables are as defined previously, \( \Delta \) denotes the first difference of the variable and \( p \) denotes the lag length. The significance of the first-differentiated variables reveals the direction of short-run Granger causality, while the \( t \)-statistics on the one-period lagged error-correction term indicate long-run Granger causality. The pooled mean group estimator (PMGE), proposed by Pesaran, Shin and Smith (1999), is used to estimate Equations 10–12. Short-run causality is tested based on \( H_0 : \theta_{1Tp} = 0 \) for all \( i \) and \( k \) and \( H_0 : \theta_{3Tp} = 0 \) for all \( i \) and \( k \) in Equation 10. For Equations 11 and 12, the null hypothesis is similar to Equation 10. For long-run causality, the null hypothesis is \( \psi_{jt} = 0 \), where \( j = 1, 2, 3 \). The Schwarz information criterion, used to select the optimal lag length, suggests that the optimal lag length for each country is 2.

### Empirical findings

To ascertain whether cross-sectional dependence is a problem in this panel, we estimate individual ADF(p) regressions (without cross-section augmentation) for lag lengths \( p = 1, 2, 3 \) and 4 and compute pair-wise cross-section correlation coefficients of the residuals from these regressions (namely, \( \hat{\rho}_{ij} \)). The simple average of these correlation coefficients across all pairs, \( \bar{\hat{\rho}} \), together with the associated cross-section dependence (CD) test statistics proposed by Pesaran (2004), is presented (Table 1). There is evidence of cross-sectional dependence in each variable at all lags.

The results from the panel unit root tests are reported (Table 2). The panel unit root tests applied to the levels indicate that the unit root null hypothesis cannot be rejected for any of the three variables. When the panel unit root tests are applied to the first differences for each variable, however, the unit root null is rejected in each instance. This result implies that each of the three variables is integrated of order one or I(1).

Given that each variable is I(1), we proceed to test for panel co-integration using Pedroni’s (2004) test. The results for Pedroni’s (2004) seven statistics are reported (Table 3). The null hypothesis is that there is no co-integration. We find that the p-values are all greater than 0.10, implying that the null hypothesis cannot be rejected at the 10...
Table 1  Cross-section correlation of the errors in the ADF(p) regression for GDP, exports and imports in the panel of Pacific island countries

<table>
<thead>
<tr>
<th></th>
<th>1982–2004 (T = 23, N = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P = 1</td>
</tr>
<tr>
<td>Log (GDP)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\rho}$</td>
<td>0.57</td>
</tr>
<tr>
<td>CD</td>
<td>7.81***</td>
</tr>
<tr>
<td>Log (Exports)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\rho}$</td>
<td>0.16</td>
</tr>
<tr>
<td>CD</td>
<td>2.18**</td>
</tr>
<tr>
<td>Log (Imports)</td>
<td></td>
</tr>
<tr>
<td>$\bar{\rho}$</td>
<td>0.30</td>
</tr>
<tr>
<td>CD</td>
<td>4.17***</td>
</tr>
</tbody>
</table>

* statistical significance at 10 per cent
** statistical significance at 5 per cent
*** statistical significance at 1 per cent

Notes: The CD test statistic is proposed in Pesaran (2004) for testing for cross-sectional dependence in panels. The null hypothesis is that output innovations are cross-sectionally independent. The CD statistic follows a $N(0, 1)$ distribution and the 10 per cent, 5 per cent and 1 per cent critical values are 1.64, 1.96 and 2.57 respectively.

Table 2  Panel unit root tests

<table>
<thead>
<tr>
<th></th>
<th>$\ln Y$</th>
<th>$\ln E$</th>
<th>$\ln I$</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPS</td>
<td>0.94</td>
<td>−1.23</td>
<td>0.87</td>
</tr>
<tr>
<td>MW(ADF)</td>
<td>5.34</td>
<td>17.11</td>
<td>8.76</td>
</tr>
<tr>
<td>MW(PP)</td>
<td>5.31</td>
<td>5.77</td>
<td>8.54</td>
</tr>
<tr>
<td>CIPS</td>
<td>−2.71</td>
<td>−2.54</td>
<td>−2.85</td>
</tr>
<tr>
<td>Δ $\ln Y$</td>
<td>Δ $\ln E$</td>
<td>Δ $\ln I$</td>
<td></td>
</tr>
<tr>
<td>IPS</td>
<td>−5.32***</td>
<td>−5.10***</td>
<td>−7.00***</td>
</tr>
<tr>
<td>MW(ADF)</td>
<td>44.40***</td>
<td>42.45***</td>
<td>59.48***</td>
</tr>
<tr>
<td>MW(PP)</td>
<td>45.11***</td>
<td>42.29***</td>
<td>62.10***</td>
</tr>
<tr>
<td>CIPS</td>
<td>−4.16***</td>
<td>−3.61***</td>
<td>−3.99***</td>
</tr>
</tbody>
</table>

*** statistical significance at 1 per cent

Notes: MW(ADF) and MW(PP) are the Maddala and Wu (1999) tests. The IPS test is the Im, Pesaran and Shin (2003) test. CIPS is the Pesaran (2007) test. All unit root tests were performed with individual trends and intercepts for each series.
per cent level. None of the seven test statistics supports co-integration; thus, we conclude that there is no panel co-integration among the three variables.

The individual country-by-country and panel test results for the Larsson, Lyhagen and Lothgren (2001) test are reported (Table 4). The country-by-country results indicate the presence of a co-integrated vector equal to 1 (Fiji, Papua New Guinea, Tonga and Vanuatu) or 3 (Solomon Islands). For the panel, there are three co-integrating vectors. Pedroni’s (2004) and Larsson, Lyhagen and Lothgren’s (2001) co-integration tests differ on the number of co-integrating vectors. Studies by Gutierrez (2003), Karaman Örsal (2007) and Wagner and Hlouskova (2006) compare the performance of the Pedroni (2004) and Larsson, Lyhagen and Lothgren (2001) co-integration tests using Monte Carlo simulation, and all three studies indicate that Pedroni’s (2004) test outperforms Larsson, Lyhagen and Lothgren’s (2001) test. We therefore proceed on the basis that the variables are not panel co-integrated.

### Table 3  Pedroni test for panel co-integration

<table>
<thead>
<tr>
<th>Tests</th>
<th>Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel v-statistic</td>
<td>–0.3307</td>
<td>0.3777</td>
</tr>
<tr>
<td>Panel rho-statistic</td>
<td>–0.0089</td>
<td>0.3989</td>
</tr>
<tr>
<td>Panel PP-statistic</td>
<td>–0.6043</td>
<td>0.3324</td>
</tr>
<tr>
<td>Panel ADF-statistic</td>
<td>–0.7152</td>
<td>0.3089</td>
</tr>
<tr>
<td>Group rho-statistic</td>
<td>0.6785</td>
<td>0.3169</td>
</tr>
<tr>
<td>Group PP-statistic</td>
<td>0.0791</td>
<td>0.3977</td>
</tr>
<tr>
<td>Group ADF-statistic</td>
<td>–0.7999</td>
<td>0.2897</td>
</tr>
</tbody>
</table>

**Notes:** The panel co-integration tests were performed with common time dummies. The test statistic is distributed $N(0, 1)$ under the null hypothesis of no co-integration.

### Table 4  Larsson, Lyhagen and Lothgren panel co-integration test

| Country                | $LR_p(H(r)|H(3))$ | Rank($r$) |
|------------------------|-------------------|-----------|
| Fiji                   | $r = 0$           | $r = 1$   | $r = 2$   |
|                        | 28.45*            | 10.62     | 0.89      | 1          |
| Papua New Guinea       | 45.04***          | 9.83      | 0.11      | 1          |
| Solomon Islands        | 29.45             | 14.78     | 6.50**    | 3          |
| Tonga                  | 28.58*            | 7.99      | 2.36      | 1          |
| Vanuatu                | 31.19**           | 9.16      | 1.33      | 1          |
| Panel tests            | $r = 0$           | $r = 1$   | $r = 2$   |
|                        | $7.91***$         | 3.02***   | 1.65**    | 3          |

* significance at 10 per cent
** significance at 5 per cent
*** significance at 1 per cent

**Notes:** For the individual trace statistics, MacKinnon, Haug and Michelis (1999) p-values are used. The panel trace statistics follow a normal distribution ($N(0, 1)$) under the null hypothesis of no co-integration (1 per cent, 5 per cent and 10 per cent critical values given as 2.33, 1.65 and 1.28 respectively).
The inability of the Pedroni (2004) test to find co-integration might reflect its inability to accommodate structural breaks. We therefore also employ the Westerlund (2006) panel co-integration test, which allows for multiple structural breaks. The Westerlund (2006) test statistic turns out to be –3.12. Given the 5 per cent level critical value of 2.16, we are unable to reject the null hypothesis of panel co-integration. In contrast with the results from Pedroni’s (2004) tests, therefore, the Westerlund (2006) test with structural break(s) suggests panel co-integration between real GDP, real exports and real imports for the five Pacific island countries. The Westerlund (2006) test suggests there is one break for each of the countries. The break dates are 1988 (Fiji), 1998 (Papua New Guinea), 1997 (Solomon Islands), 1997 (Tonga) and 1999 (Vanuatu). For Fiji, the break date coincides with the first military coups, which occurred in May and December 1987. The break dates in the other Pacific island countries coincide with the time of the East Asian financial crisis (1997–99).

A co-integrating equation was estimated for each country (using FMOLS) for each segment (separated by the presence of breaks) (Equation 13).

$$\beta_1 \ln(GDP_i) + \beta_2 \ln(Export_i) + \beta_3 \ln(Import_i) + u_i = 0 \quad (13)$$

As there is only one break present in the data, we obtain two segments (of different size for each country, given that break dates are allowed to be different across countries). The co-integrating vector for both the segments is presented (Table 5).

The panel Granger causality results are reported (Table 6). There is short-run Granger causality running from real exports to real imports and from real income to exports. We find bi-directional Granger causality running between economic growth and real exports, between economic growth and real imports, and between real imports and real exports in the long run. Bi-directional Granger causality between exports and economic growth reflects the fact that exports represent a sizeable proportion of GDP in four of the five countries. In 2007, exports constituted 49 per cent of GDP in Fiji (down from 65 per cent in 2000); in 2007, exports constituted 90 per cent of GDP in Papua New Guinea (up from 66 per cent in 2000); in 2004, exports constituted 49 per cent of GDP in Solomon Islands (up from 38 per cent in 2000); while in 2006, exports were 44 per cent of GDP in Vanuatu, which was the same as the 2000 figure. The only country in the sample in which the ratio of exports to GDP is low is Tonga, where

<table>
<thead>
<tr>
<th>Country</th>
<th>Before break</th>
<th>After break</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiji</td>
<td>$\beta_1$ = 2.13</td>
<td>$\beta_1$ = 1.01</td>
</tr>
<tr>
<td></td>
<td>$\beta_2$ = -21.75</td>
<td>$\beta_2$ = 0.41</td>
</tr>
<tr>
<td></td>
<td>$\beta_3$ = -0.03</td>
<td>$\beta_3$ = 0.00</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>$\beta_1$ = 0.08</td>
<td>$\beta_1$ = 0.24</td>
</tr>
<tr>
<td></td>
<td>$\beta_2$ = 20.13</td>
<td>$\beta_2$ = 17.34</td>
</tr>
<tr>
<td></td>
<td>$\beta_3$ = 0.05</td>
<td>$\beta_3$ = 0.04</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>$\beta_1$ = 0.15</td>
<td>$\beta_1$ = 0.38</td>
</tr>
<tr>
<td></td>
<td>$\beta_2$ = 15.99</td>
<td>$\beta_2$ = 12.73</td>
</tr>
<tr>
<td></td>
<td>$\beta_3$ = 0.07</td>
<td>$\beta_3$ = -0.07</td>
</tr>
<tr>
<td>Tonga</td>
<td>$\beta_1$ = 1.11</td>
<td>$\beta_1$ = 0.81</td>
</tr>
<tr>
<td></td>
<td>$\beta_2$ = -5.41</td>
<td>$\beta_2$ = 1.27</td>
</tr>
<tr>
<td></td>
<td>$\beta_3$ = 0.04</td>
<td>$\beta_3$ = 0.02</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>$\beta_1$ = 0.04</td>
<td>$\beta_1$ = -1.28</td>
</tr>
<tr>
<td></td>
<td>$\beta_2$ = 17.68</td>
<td>$\beta_2$ = 41.69</td>
</tr>
<tr>
<td></td>
<td>$\beta_3$ = 0.05</td>
<td>$\beta_3$ = 0.33</td>
</tr>
</tbody>
</table>
the figure is 15–16 per cent (World Bank 2009). Exports are a major source of not only foreign exchange, but employment in the Pacific island countries (Narayan and Narayan 2004). For example, in Fiji, the sugar industry employs more than 25 per cent of the country’s total workforce (Narayan 2004b), while in Solomon Islands fisheries and logging are responsible for just more than 25 per cent of the country’s workforce (DCET 2001). It is not surprising therefore that export performance is closely linked to economic development in the Pacific island countries.

The Pacific island countries have pursued export-oriented strategies but export sectors have under-performed, reflecting economic and political instability (Ram, Prasad and Duncan 2005). With the possible exception of Fiji, export concentration remains a major problem in the Pacific island countries. The Pacific island countries, as a whole, export a narrow range of primary agricultural products such as coconut oil, copra, fish and fruits. Fiji has had some success in export diversification and exports crude petroleum, gold, pearls and textiles in addition to agricultural products. Reliance on a narrow agricultural export base is questionable because of volatility and unpredictability in global agricultural markets. Increasing openness, associated with globalisation, has the effect of linking trade with economy-wide shocks (Mahadevan 2007). Our results suggest that poor export performance in the Pacific island countries can be expected to have an adverse effect on economic growth and poor economic growth will have adverse feedback effects on export performance.

Bi-directional Granger causality between imports and economic growth is a reflection that imports also represent a high proportion of GDP in the Pacific island countries. Based on the latest figures available, in 2007, imports as a percentage of GDP were 64 per cent in Fiji and 68 per cent in Papua New Guinea; in 2006, the comparable figures in Tonga and Vanuatu were 61 per cent and 58 per cent, respectively; and in 2001, imports were 41 per cent of GDP in Solomon Islands (World Bank 2009). The Pacific island countries rely on export receipts to finance imports of almost all investment goods used in capital formation.

Imports of energy, machinery, transport equipment and manufactured goods have been major sources of economic development in Pacific island countries (Narayan and Narayan 2004). In 2007,

Table 6  Panel Granger causality results

<table>
<thead>
<tr>
<th></th>
<th>ΔY</th>
<th>ΔE</th>
<th>ΔI</th>
<th>ECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔY</td>
<td>-</td>
<td>2.1744</td>
<td>0.7351</td>
<td>-0.1865***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.1193)</td>
<td>(0.4822)</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>ΔE</td>
<td>1.7905</td>
<td>-</td>
<td>0.5139</td>
<td>-0.0942**</td>
</tr>
<tr>
<td></td>
<td>(0.1725)</td>
<td></td>
<td>(0.5998)</td>
<td>(0.0350)</td>
</tr>
<tr>
<td>ΔI</td>
<td>0.2304</td>
<td>8.6534***</td>
<td>-</td>
<td>-0.0349***</td>
</tr>
<tr>
<td></td>
<td>(0.7947)</td>
<td></td>
<td>(0.0004)</td>
<td>(0.0002)</td>
</tr>
</tbody>
</table>

*** rejection of the null hypothesis at 1 per cent
** rejection of the null hypothesis at 5 per cent
Note: The p-values are given in parentheses.
manufactured goods as a percentage of merchandise imports were 48 per cent in Fiji and 56 per cent in Vanuatu, while the comparable figure for Papua New Guinea in 2004 was 65 per cent (World Bank 2009). Manufactured goods and machinery represent sources of technological progress embodied in imported inputs, which are important sources of economic growth. In this sense, the results are consistent with the view that developing economies with limited technological endowment could benefit from access to foreign technology from industrialised countries via imports (Grossman and Helpman 1991; Coe and Helpman 1995).

Imports are also an important source of economic growth where the export base is narrow. For example, the PNG economy is highly dependent on imports for manufactured goods. Its industrial sector, exclusive of mining, accounts for only 9 per cent of GDP and contributes little to exports. Small-scale industries produce beer, soap, concrete products, clothing, paper products, matches, ice-cream, canned meat, fruit juices, furniture, plywood and paint. The small domestic market, relatively high wages and high transport costs are constraints to domestic industrial development. Overall, our results suggest that import openness is very important in promoting economic growth in the Pacific island countries as it complements the role of exports by serving as a supply of intermediate inputs. In this sense, the results provide evidence in support of the introduction of measures to liberalise trade in Pacific island countries.

It has been argued that in the newly industrialising countries of Asia, a very high level of foreign direct investment (FDI) is a further channel through which manufactured imports act as a conduit for export-led growth (for example, Thangavelu and Rajaguru 2004). With the exception of Hong Kong and Singapore, however—where in 2007 FDI as a percentage of GDP was 14 per cent and 26 per cent, respectively—FDI as a percentage of GDP was similar in the Pacific island countries to the newly industrialising countries of Asia. Among the Asian countries, the relevant figure in 2007 was South Korea (0), Indonesia (2 per cent), Malaysia (5 per cent), the Philippines (2 per cent), Thailand (4 per cent) and China (4 per cent). The corresponding figures for the Pacific island countries in the same year were Fiji (8 per cent), Tonga (11 per cent), Vanuatu (7 per cent) and Solomon Islands (8 per cent) (World Bank 2009).

Bi-directional Granger causality between exports and imports is consistent with the findings of Narayan and Narayan (2004), who find that exports and imports are co-integrated in Fiji and Papua New Guinea. A high level of intra-industry trade is associated with exports and imports moving together (Bernard and Jensen 2004). A high level of intra-industry trade has been used to explain bi-directional Granger causality between exports and imports in similar studies for Asian countries, such as Malaysia (Mahadevan 2007). This is, however, unlikely to be the explanation in the Pacific island countries, in which intra-industry trade is low. The results likely reflect the fact that revenue raised from exports is an important means of financing imports and that technologies embodied in imported inputs are used in export industries.

**Conclusion**

This article has tested the export-led growth and import-led growth hypotheses for a panel of Pacific island countries for the period 1982–2004. The analysis includes imports as well as exports to overcome the omitted variable bias that has plagued many studies on this topic, and it is one of the few studies to employ a panel framework. The
relative importance of exports and imports in contributing to economic growth in the Pacific island countries has increased in light of growing trade deficits for the Pacific island countries, which naturally begs the question: is economic development export or import driven? Our results suggest that in the long run there is bi-directional causality between economic development and exports and imports.

With respect to the export-led growth hypothesis, our results can be explained on the basis that poor economic performance in the Pacific island countries has been associated with poor export performance. In terms of policy implications, our results suggest that if supply-side constraints hampering exports can be removed, and export performance improved, there could be a virtuous cycle of higher exports and improved economic growth. A proviso to this conclusion is that one of the disadvantages of employing panel data is that the findings can be over-generalised without sufficient regard to the heterogeneous nature of the panel in terms of the development and size of particular Pacific island countries. This disadvantage has to be borne in mind when interpreting the results.

References


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