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Estimating quarterly GDP Data for the South Pacific Island Nations

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Abstract

Time series analyses generally rely on having a relatively high frequency of consistent and reliable data to work with. However for many of the South Pacific Island Nations (SPINS), data on major macroeconomic series, like GDP, are typically available only annually from the early 1980s. This paper empirically estimates quarterly GDP data from annual series using the approach of Abeysinghe and Rajaguru (2004), following the basic framework of Chow and Lin (1971), Fernandez (1981) and Litterman (1983). We link the available annual GDP series for a select group of SPINS with GDP-related series (predictor variables) that are available quarterly. We deem that our quarterly estimates of GDP are more consistent and reliable compared to estimates obtained through less sophisticated methods of univariate interpolation.

JEL codes: C82; E00

Keywords: Quarterly GDP; disaggregation of time series; South Pacific Island Nations.

1 Introduction

Empirical studies assessing the economic performance of South Pacific Island Nations (SPINS) have often produced mixed results.[1] A primary reason for this is related to the lack of consistent, reliable and comparable data for these countries, which prevents a comprehensive analysis of these countries' economic growth experiences and business cycles. During the Pacific Island Forum Economic Ministers Meeting (FEMM, 2000) and the regional Heads of Statistics and Planning Meeting (Secretariat of the Pacific Community, 2003, 2005, 2007) there was consensus that the issue of the non-availability of reliable, timely and quality economic and social statistics was a major constraint to policy making and planning in the region. Moreover, time series analyses suffer from low power and accuracy because of the use of a relatively short span of time series data for major economic indicators, like GDP. Haug (2002), however, shows that disaggregation of data (or, equivalently, higher frequency of observation or less temporal aggregation) can add power to tests (e.g., tests for cointegration), even if the span is kept fixed.

This paper seeks to address one of the shortcomings of data for selected SPINS by deriving quarterly estimates of real GDP for Fiji, Papua New Guinea (PNG), Samoa, the Solomon Islands, Tonga and Vanuatu. We use the basic methodology of Chow and Lin (1971) for estimating quarterly GDP figures from GDP-related quarterly series and annual GDP. This basic method has been modified through the years by Fernandez (1981) and Litterman (1983) to deal with the nonstationary characteristics of the data, and recently applied by Abeysinghe and Rajaguru (2004) to derive quarterly estimates of GDP for China and the ASEAN4 countries (Indonesia, Malaysia, the Philippines and Thailand). Others, like Hall and McDermott (2007) for New Zealand, have also applied the Chow-Lin-based approach to disaggregating data.[2]

The remainder of this paper is organised as follows. Section 2 provides an overview of the basic methodology for estimating quarterly series from related series. Section 3

[1] See for instance Briguglio, 1995; Armstrong et al., 1998; Easterly and Kraay, 2000; and Armstrong and Read, 2002, among many others.

[2] Alternative methods for disaggregation have been suggested by Moauro and Savio (2005), among others, using the Kalman filter. However, in practice, the Chow-Lin-based methodology is the most widely used.

describes the application of the methodology to derive quarterly real GDP estimates for SPINS, following the approach of Abeysinghe and Rajaguru (2004). Sections 4 and 5 detail the steps taken to convert the derived nominal quarterly series to real quarterly series and to ascertain the quality of the derived real quarterly series. Section 6 presents some concluding remarks.

2 Disaggregating time series

Chow and Lin (1971) provide a systematic method of estimating monthly time series data from quarterly data. Essentially, the Chow-Lin method identifies a relationship between the quarterly series of a variable, say GDP, and the monthly series of related variables (e.g., components of GDP like exports) to derive monthly estimates for GDP. With some modifications, the Chow-Lin method can be applied to the estimation of quarterly series from annual series.

We assume that the T observations in the quarterly series of GDP, y_q, are related to the T observations on quarterly GDP-related variables, X_q, based on a regression of the form

$$y_q = X_q \beta_q + \hat{u}_q \tag{1}$$

where y_q is $(T \times 1)$ and X_q is $(T \times k)$. The error term follows a stationary first-order autoregression $u_{q,t} = \rho_q u_{q,t-1} + e_{q,t}$ for $t = 1, \ldots T$, with $e_{q,t}$ having zero mean and a covariance matrix of $\sigma_e^2 I_T$.

The Chow and Lin (1971) equation that disaggregates n annual GDP estimates to $4n = T$ quarterly estimates is expressed as:

$$\hat{y}_q = X_q \hat{\beta}_a + V_q C'(C V_q C')^{-1} \hat{u}_a \tag{2}$$

Where β_a is estimated as:

$$\hat{\beta}_a = \left[X_q' C' \left(C V_q C' \right)^{-1} C X_q \right]^{-1} X_q' C' \left(C V_q C' \right)^{-1} y_a \tag{3}$$

and

$$C = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & \cdots & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & \cdots & . & . & . & . \\ . & . & . & . & . & . & . & . & \cdots & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & . & . & . & . & \cdots & 1 & 1 & 1 & 1 \end{bmatrix} \quad (4)$$

The ($4n \times 1$) vector of disaggregated quarterly GDP estimates is represented by $\hat{y}_q$. X_q is a ($4n \times k$) matrix, ignoring the constant term for now, of k predictor (GDP-related) variables and $\hat{\beta}_a$ is a ($k \times 1$) vector of generalised least squares (GLS) estimates derived from annual data. V_q is the covariance matrix ($4n \times 4n$) of the quarterly errors, $u_{q,t}$, and $\hat{u}_a = y_a - X_a\hat{\beta}_a$ is a ($n \times 1$) vector of residuals from an annual regression of GDP on predictor variables ($X_a = CX_q$). C is an ($n \times 4n$) averaging matrix if multiplied by 0.25 or an aggregation matrix as presented in equation (4), and y_a represents the observed $n \times 1$ vector of annual GDP figures.

Fernandez (1981) and Litterman (1983), however, point out that this method is appropriate only when the error process is covariance stationary, and propose alternatives that correct for this shortcoming in the Chow-Lin method. Fernandez suggests that if the series have unit roots, i.e., they are integrated of order 1, denoted $I(1)$, the series need to be transformed first (by taking first differences) to yield series that are stationary. Fernandez assumes that $\rho_q = 1$, which implies a regression based on first differences. Litterman on the other hand generalises the Fernandez approach by pre-filtering the data in order to remove serial correlation in the errors. That is, autocorrelation is also incorporated in the estimation procedure. Since economic series are usually characterised as integrated processes, it is imperative to examine cointegrating relationships first between the variable of interest and its related variables, and then apply the Chow-Lin procedure with serial correlation adjustment as needed, instead of first-differencing. If cointegration is present, it implies a process in first differences with an error-correction term added in the model. This implies that a specification in first differences alone is misspecified when there is cointegration.

Following the basic methodology of Chow and Lin (1971) and the extensions proposed by Fernandez (1981) and Litterman (1983), Abeysinghe and Rajaguru (2004) derive quarterly real GDP estimates for China and several ASEAN countries. In a similar way, we adopt this methodology to derive the quarterly GDP estimates for

selected SPINS. Based on Litterman's extensions to the basic Chow-Lin method, we assume that $u_{q,t} = \rho_q u_{q,t-1} + e_{q,t}$ with $e_t \sim iid\ (0, \sigma_e^2)$ and substitute V_q with $(D'H'HD)^{-1}$:

$$D = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 & 0 \\ -1 & 1 & 0 & \cdots & 0 & 0 \\ 0 & -1 & 1 & \cdots & 0 & 0 \\ . & . & . & \cdots & . & . \\ 0 & 0 & 0 & \cdots & -1 & 1 \end{bmatrix}_{4n \times 4n} \quad \text{and} \quad H = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 & 0 \\ -\rho_q & 1 & 0 & \cdots & 0 & 0 \\ 0 & -\rho_q & 1 & \cdots & 0 & 0 \\ . & . & . & \cdots & . & . \\ 0 & 0 & 0 & \cdots & -\rho_q & 1 \end{bmatrix}_{4n \times 4n} \tag{5}$$

The calculation of ρ_q from the annual ρ_a is based on the relation:[3]

$$\rho_a = \frac{\rho_q^{10} + 4\rho_q^9 + 10\rho_q^8 + 20\rho_q^7 + 31\rho_q^6 + 40\rho_q^5 + 44\rho_q^4 + 40\rho_q^3 + 32\rho_q^2 + 24\rho_q + 10}{2\rho_q^6 + 8\rho_q^5 + 20\rho_q^4 + 40\rho_q^3 + 62\rho_q^2 + 80\rho_q + 44} \tag{6}$$

By setting H = I, we get the Fernandez (1981) case which involves first-differencing the series. When D = I, the model becomes the Chow-Lin case with AR(1) errors, and it is then preferable to equate the first element of H to $\sqrt{1-\rho^2}$. Finally, by setting D=H=I, we arrive at the basic Chow-Lin case with white noise errors.

3 Estimating quarterly GDP series for the SPINS

In deriving quarterly GDP estimates for the SPINS, we initially test for unit roots of each series and also for cointegration between the annual GDP variable and associated annual predictor variables. Marcellino (1999) proves that the integration and cointegration properties are invariant across different levels of aggregation of time series. This means that if the annual series have a unit root, so will the quarterly series. It also means that if two annual series are cointegrated, so will the quarterly series be cointegrated. Note that the Chow-Lin decomposition generally works well with annual GDP regressed on two or more quarterly predictor variables in order to derive robust and efficient quarterly estimates. The computer software EViews 6.1 is used for all unit root and cointegration tests. Gauss 8.1 is used for all transformations of annual to quarterly data.

[3] A real solution for ρ_q requires $\hat{\rho}_a > 0.166$. See Abeysinghe and Rajaguru (2004) for details.

3.1 Determining the predictor variables

The derivation of quarterly real GDP estimates involves finding relevant real predictor variables. However, there were much fewer available data on real variables than on nominal variables. For instance, we considered the use of real predictor variables such as industrial production, employment and the building materials index. However, only a few SPINS have quarterly data going back to 1980: Fiji (only an industrial production index), PNG (only the employment index) and the Solomon Islands (only a production index). Other countries, like Tonga, only have data on the manufacturing index, but it is available on an infrequent basis and for a short span only. PNG's building survey data has not been updated in the last two decades, and Vanuatu does not have an adequate real measure of any GDP-related variable for the period required. Samoa was the only country that started compiling quarterly GDP but the series is too short for any robust time-series regression analysis. We explored various sources of data, including a respective country's National Statistical Office, Central Bank and Finance Department, all of which have websites. However, our main data sources are the International Financial Statistics (IFS) database, the World Economic Outlook (WEO) database and the United Nations Statistics Division (UNSD) National Accounts Aggregates database.

Based on the aforementioned reasons, we use related nominal predictor variables in connection with nominal GDP instead of real predictor variables in connection with real GDP. However, while it is desirable to have more than two predictor variables for the Chow-Lin procedure to generate GDP estimates, in the case of the SPINS even the availability of nominal variables has been sparse. To ascertain the suitability of GDP-related variables for the data disaggregation procedure, we estimate the basic regression equation below, for each country, with annual data:

$$y_t = \beta + \beta_1 X_{1t} + \beta_2 X_{2t} + u_t, \tag{7}$$

where y_t is the natural log of nominal GDP at time *t* for all countries, X_{1t} is the natural log of money supply (M1 or M2) at time *t,* and X_{2t} is the natural log of exports or net-exports at time *t*.

Before deciding on money supply (X_{1t}) and exports or net-exports (X_{2t}) as predictor variables for the data disaggregation procedure, we carefully considered several other GDP-related variables. We investigated the availability of suitable nominal quarterly variables, including imports and exports, price indices, exchange rates and monetary aggregates. Other associated data on balance of payments and government finance data are mainly available only on an annual frequency. We specify all variables in natural logarithms except for net-exports that show negative values and are therefore modelled in levels along with all other variables in the regression. After several data diagnoses and GLS regressions, we chose exports and the money supply as predictor variables.[4] In general, estimation of equation (7) for each country shows that money, exports and net-exports are suitable GDP-predictor variables.

3.2 Tests for Unit Roots

We first examine the statistical properties of the annual data through standard unit root tests. All the series are tested for unit roots based on a model with a constant and deterministic time trend in the test regression. The unit root tests ascertain the order of integration for nominal GDP and the GDP-related nominal series that we use (i.e., exports, money supply and net-exports). More specifically, our unit root tests show that nominal GDP is *I*(1) for all the countries, using the Augmented Dickey-Fuller (ADF) test and Akaike's (1973) information criterion (AIC) to select the lag augmentations. Exports are *I*(1) for all countries except for the Solomon Islands which shows *I*(2). Therefore, we used the first difference for exports, which is I(1) and represents the growth rate of exports. Money, M1, is *I*(1) for all countries, except for Vanuatu and Fiji for which it is *I*(0). We use M2 and net-exports instead for Vanuatu because both are *I*(1) and highly correlated with nominal GDP, unlike exports and M1. For Fiji, we use M2 (instead of M1) which is *I*(1). The tests for real annual GDP show for all countries that *I*(1) best describes the time series behaviour over the sample period. While the test results meet our expectations, we acknowledge that the small sample size may adversely affect the test power.

[4] We test for unit roots and cointegration and run appropriate regressions to ascertain the goodness of fit of the model (R^2) relating GDP with the chosen predictor variables. We also examine whether there is strong correlation among GDP and the predictor variables, and check for correct signs of coefficients of the variables to ensure that the relationship makes economic sense.

3.3 Tests for Cointegration

Johansen (1988) and Johansen and Juselius (1990) propose two maximum-likelihood based tests for cointegration: a likelihood ratio trace-test and a maximum eigen-value (λ-max) test. If each series follows a unit root process and GDP and the related series are cointegrated, we set D = I in equation (5). Cointegration leads to super-consistent parameter estimates of least squares regressions (Sims et al., 1990). We next obtain the residuals from $\hat{u}_a = y_a - X_a\hat{\beta}_a$ and regress $\hat{u}_{a,t} = \rho_a \hat{u}_{a,t-1} + e_{a,t}$ to obtain the estimated value of ρ_a, denoted $\hat{\rho}_a$, which is used to calculate $\hat{\rho}_q$ from equation (6) in order to be plugged into the *H* matrix.

Cointegration test results often depend critically on the number of lagged differences included in the regression equation. The reason for the augmentation of the lagged differences is to ensure that the errors are white noise. We use AIC in order to determine the appropriate lag length of the vector autoregressive (VAR) model for the cointegration tests. Considering the short span of time series data available (1980 to 2006), the maximum lag for the lag selection is set at 4. Once the optimal lag length was established, cointegration among the series was tested based on the Johansen cointegration tests. Cointegration among the variables means that annual GDP can be represented as a vector error-correction model. We allow for deterministic time trends in the underlying time series but not in the cointegrating vectors. The cointegration tests show evidence of long-run cointegrating relationships among nominal GDP and the corresponding predictor variables in all countries except for Fiji.[5] The result for Fiji is inconsistent with what one expects. A predictor variable should move together with the variable it is supposed to be related with and therefore the two should be cointegrated.[6]

In cases where a cointegrating relationship is not evident, we follow Fernandez (1981) and Litterman's (1983) suggestions and estimate the residuals based on the first-

[5] The trace and the maximum eigen-value tests lead to the same results except for Tonga where cointegration is found for the trace test only. We used critical values based on MacKinnon et al. (1999).

[6] Abeysinghe and Rajaguru (2004) found much less evidence for cointegration in their data and hence used growth rates instead.

differenced series, i.e., $\hat{\varepsilon}_{a,t} = \Delta y_a - \Delta X_a \hat{\beta}_a$, and then regress $\hat{\varepsilon}_{a,t}$ on its lagged value, i.e., $\hat{\varepsilon}_{a,t} = \rho_a \hat{\varepsilon}_{a,t-1} + v_t$, to obtain $\hat{\rho}_a$. Since the GDP series we use are in natural logs, the first-differenced series are the growth rates of GDP.

3.4 Deriving GDP estimates for the SPINS

The Johansen cointegration tests support cointegration among the variables of interest for the SPINS. We therefore set D = I in equation (5) and estimated the quarterly nominal GDP series from the corresponding annual series and the quarterly series of the predictors according to equation (6). For PNG, we find that $\hat{\rho}_a = 0.4285$ and $\hat{\rho}_q = 0.5841$; for Samoa we find $\hat{\rho}_a = 0.3587$ and $\hat{\rho}_q = 0.4712$; for the Solomon Islands we find $\hat{\rho}_a = 0.6775$ and $\hat{\rho}_q = 0.8229$; for Tonga, we find $\hat{\rho}_a = 0.6674$ and $\hat{\rho}_q = 0.8157$; and for Vanuatu, we find $\hat{\rho}_a = 0.5277$ and $\hat{\rho}_q = 0.6991$.

Since no cointegration among the variables of interest is evident for Fiji, the quarterly nominal GDP is estimated from the first-differenced series (annual nominal GDP and quarterly predictor variables specified all as growth rates) following equation (5) . We tested for no correlation at lag 1 using the Breusch-Godfrey serial correlation LM-test and the test statistic was insignificant, indicating no autocorrelation in the regression residuals so that we set $\rho_q = 0$ for Fiji. The resulting quarterly nominal GDP series for the SPINS are presented in Table 1.

4 Implicit GDP Deflators

After deriving quarterly nominal GDP estimates, the series are adjusted to arrive at quarterly real GDP estimates, using the derived GDP deflator. Since the GDP deflators were available only annually from the IFS, WEO and UNSD databases, we also had to derive quarterly estimates for this variable using the modified Chow-Lin method. Identifying predictor variables also meant finding co-movement among related variables. After numerous checks for relevant predictor variables, the consumer price index (CPI) and money supply, M1, were chosen as predictors for all the countries, except for Fiji, where M2 was selected, and Vanuatu where the

exchange rate was used in place of money.[7] Our unit root tests based on the ADF and AIC, and allowing for a constant and deterministic time trend in the series, show that the GDP deflators for all countries are *I*(1). The CPIs for Fiji and Samoa are *I*(1) while the others are *I*(2). The natural logarithms of money, M1, for all countries are *I*(1), except for Fiji and Vanuatu. For Fiji, we used instead M2's growth rate that is *I*(1). For Vanuatu, we used instead of M1 the exchange rate that is *I*(1). The predictor variables that were *I*(2) were transformed to *I*(1) by first-differencing[8] for the Johansen cointegration test (using up to 4 lags), and also for the modified Chow-Lin procedure. All annual deflator and predictor variables were cointegrated, allowing for deterministic time trends in the underlying time series but not in the cointegrating vectors, when testing for cointegration. Similarly to estimating quarterly nominal GDP, we set D = I in equation (5) and estimated the quarterly deflator series according to equation (6). In determining the annual and quarterly correlation coefficient at lag 1, we find for Fiji, $\hat{\rho}_a = 0.4905$ and $\hat{\rho}_q = 0.6603$; for PNG, $\hat{\rho}_a = 0.8185$ and $\hat{\rho}_q = 0.9105$; for Samoa, $\hat{\rho}_a = 0.7363$ and $\hat{\rho}_q = 0.8619$; for the Solomon Islands, $\hat{\rho}_a = 0.9124$ and $\hat{\rho}_q = 0.9593$; for Tonga, $\hat{\rho}_a = 0.7289$ and $\hat{\rho}_q = 0.8572$; and for Vanuatu, we find $\hat{\rho}_a = 0.8435$ and $\hat{\rho}_q = 0.9241$.

5 Quality of the Disaggregated GDP series

After deriving quarterly nominal GDP estimates, the series are adjusted to arrive at quarterly real GDP estimates, using the derived GDP price deflator. In order to ensure that the quarterly real GDP estimates we have derived for the SPINS are consistent and reliable, we tested for unit roots, which generally shows that our disaggregated real GDP estimates for all countries are *I*(1).[9] This is consistent with our results for annual data. We also computed annual real GDP series from the quarterly real series we have just derived with the modified Chow-Lin procedure and compared these with published annual real GDP from the IFS and WEO in order to ensure accuracy and consistency of our results. Where the published annual real GDP data were not of the required base year (year 2000), the series were re-based.

[7] Including exchange rates resulted in cointegration among the variables for Vanuatu, whereas net-exports did not.
[8] In the case of the CPI, the logs of first differences (inflation rates) were used.
[9] According to Marcellino (1999), disaggregation should not affect the *I*(1) property of the series.

We show in Figure 1 how our quarterly GDP estimates (seasonally adjusted) compare with the published annual series from IFS and WEO. As can be seen, although the quarterly estimates appear more volatile than the annual series, they nonetheless still generally follow the annual trend, i.e., they show consistent behaviour with the annual GDP trend. Note too that the volatility of the quarterly estimates of the SPINS can be characterised by unforeseen events like the frequent occurrence of natural disasters that caused severe damage to the economies of the SPINS. For example, Samoa was affected by two major cyclone disasters in 1990, as well as Vanuatu in 2001. Furthermore, external and internal shocks relating to world commodity price volatility and political instability have also affected the economies of some of the SPINS. Moreover, it is worthwhile to note that our constructed quarterly series for Samoa follows a trend very similar to the quarterly series published by Samoa's Ministry of Finance from 1994 onwards.[10] When growth rates (year-on-year and quarter-to-quarter) are compared, there appear to be some minor differences (positive and negative growth rates) which can be attributed to differences in data compilation. Further, we note that the relative size of volatility of our quarterly estimates affects the growth rates.

6 Summary

This paper addresses the problem of lack of time-series data for many of the South Pacific Island Nations by applying the basic methodology of Chow and Lin (1971) for deriving quarterly GDP estimates from annual data. We take particular care in first identifying the extent and nature of the relationships among the annual nominal and real GDP variable on the one hand and associated annual predictor variables on the other hand. In relation to this, the choice of the appropriate set of variables to use for the decomposition procedure involved testing for cointegrating relationships among the relevant variables in order to determine co-movement among these variables. We validate the consistency and reliability of our quarterly GDP estimates by carefully examining the behaviour of the estimated quarterly series in relation to the published annual series.

[10] Unlike for the other countries, Samoa's quarterly GDP series was provided by the Ministry of Finance from 1994:Q1 to 2006:Q4, so that we could compare our estimates to those produced by the Ministry.

References

Abeysinghe, T. and Rajaguru, G. (2004). "Quarterly Real GDP Estimates for China and ASEAN4 with a Forecast Evaluation". *Journal of Forecasting*, 23, 432-447.

Akaike, H. (1973). "Information Theory and an Extension of the Maximum Likelihood Principle", in 2nd International Symposium on Information Theory, Petrov, B.N. and Csaki, F. (eds), *Akademiai Kiado*, 267-281.

Armstrong, H., de Kervenoael, R.J., Li, X. and Read, R. (1998). "A Comparison of the Economic Performance of Different Micro-states, and Between Micro-states and Larger Countries". *World Development*, 26, 639-656.

Armstrong, H. and Read, R. (2002). "The Phantom of Liberty?: Economic Growth and the Vulnerability of Small States". *Journal of International Development*, 14, 435-458.

Briguglio, L. (1995). "Small Island Developing States and Their Economic Vulnerabilities". *World Development,* 23, 1615-1632.

Chow, G. C. and Lin, A. (1971). "Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series". *Review of Economics and Statistics*, 53, 372-375

Easterly, W. and Kraay, A. (2000). "Small States, Small Problems? Income, Growth and Volatility in Small States". *World Development,* 28, 2013-2027.

Fernandez, R.B. (1981). "A Methodological Note on the Estimation of Time Series. *Review of Economics and Statistics*", 63, 471-476.

FEMM. (2000). Forum Economic Ministers Meeting, 25-16 July, 2000. Record of Meeting Decisions. Alofi, Niue.

Hall, V. and McDermott, J. (2007). "A Quarterly Post-World War II Real GDP Series for New Zealand". Motu Working Paper 07-13, Motu Economic and Public Policy Research.

Haug, A. A. (2002). "Temporal Aggregation and the Power of Cointegration Tests: A Monte Carlo Study." *Oxford Bulletin of Economics and Statistics*, 64, 399-412

International Monetary Fund (2007). International Financial Statistics: Available at: http://ifs.apdi.net/imf/imfbrowser.aspx?branch=ROOT

International Monetary Fund (2006). World Economic Outlook Database: Available at: http://www.imf.org/external/pubs/ft/weo/2006/02/data/index.aspx

Johansen, J. (1988). "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, 12, 231-254.

Johansen, S and K. Juselius (1990).Maximum Likelihood Estimation and Inference on Cointegration – With Applications to the Demand for Money, *Oxford Bulletin of Economics and Statistics*, 52, 169-210.

Johansen, S. (1992). "Determination of Cointegration Rank in the Presence of a Linear Trend", *Oxford Bulletin of Economics and Statistics*, 54, 383-397.

Johansen, J. (1995). A Statistical Analysis of Cointegration for I(2) Variables. *Econometric Theory*, 11, 25-59

Litterman R.B. (1983). A Random Walk, Markov model for the Distribution of Time Series. *Journal of Business and Economic Statistics*, 1, 169-173.

MacKinnon, J. G., Haug, A. A. and Michelis, L. (1999). "Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration". *Journal of Applied Econometrics*, 14, 563-577.

Marcellino, M. (1999). "Some Consequences of Temporal Aggregation in Empirical Analysis". *Journal of Business and Economic Statistics*, 17,129-136.

Moauro, F. and Savio, G. (2005). "Temporal disaggregation using multivariate structural time series models". *Econometrics Journal*, 8, 214–234.

Ng, S. and Perron, P. (2001). "Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power", *Econometrica*, 69, 1519-1554.

Schwarz, G. (1978). "Estimating the Dimension of a Model", *The Annals of Statistics*, 6, 461-464.

Secretariat of the Pacific Community. (2003). Thirteenth Regional Meeting of Heads of Statistics, Regional Meeting of Heads of Statistics 13 List of Meeting Papers, Noumea. SPC / STATS 13 Working Paper 6. Available at: http://www.spc.int/statsen/English/News_and_Events/Stats13/REPORT.htm

Secretariat of the Pacific Community. (2005). Regional Meeting of Heads of Planning and Heads of Statistics, Planners and Statisticians Meeting, Noumea. Available at: http://www.spc.int/statsen/English/News_and_Events/RMHPS2005/RMHPS2005.htm

Secretariat of the Pacific Community. (2007). Regional Meeting of Heads of Planning and Heads of Statistics, Noumea. Available at: http://www.spc.int/sdp/index.php?option=com_content&task=view&id=25&Itemid=1

Sims, C.A., Stock, J.H. and Watson, M.W. (1990). "Inference in Linear Time Series Models with Some Unit Roots". *Econometrica*, 58, 161–82.

United Nations Statistics Division (2007). National Accounts Main Aggregates Database. Available at: http://unstats.un.org/unsd/snaama/dnllist.asp

Table 1

Disaggregated Quarterly Real and Nominal GDP for the SPINs

Quarter/	Real GDP (base year 2000) in millions of local currency						Nominal GDP in millions of local currency					
Year	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU
Q1 1980	2,047	2,132	532	821	86	17,178	881	796	112	111	31	7,090
Q2 1980	1,976	8,255	648	819	144	18,569	905	2,846	145	107	66	7,182
Q3 1980	2,005	5,788	743	1,202	136	20,406	937	1,931	166	173	56	7,609
Q4 1980	2,549	5,911	522	1,269	138	19,351	1,187	1,941	144	191	53	7,638
Q1 1981	2,295	5,972	590	1,122	126	21,348	1,044	1,973	160	171	46	8,605
Q2 1981	2,340	5,684	551	1,100	178	19,442	1,047	1,899	151	173	79	9,018
Q3 1981	2,303	4,925	602	1,027	129	19,082	1,044	1,646	158	162	44	8,861
Q4 1981	2,347	5,350	482	895	119	18,984	1,086	1,836	132	147	35	9,161
Q1 1982	2,303	4,101	449	1,027	205	18,923	1,100	1,398	117	177	89	9,422
Q2 1982	2,279	5,030	560	999	151	19,541	1,111	1,727	134	174	51	9,286
Q3 1982	2,261	7,304	544	954	162	20,124	1,123	2,493	129	171	58	9,755
Q4 1982	2,215	5,512	652	1,059	163	21,547	1,119	1,977	140	201	60	10,827
Q1 1983	2,253	5,939	642	974	177	20,301	1,152	2,171	150	181	68	9,671
Q2 1983	2,231	5,862	547	1,071	144	21,646	1,152	2,205	144	202	48	10,638
Q3 1983	2,229	5,567	470	1,147	197	19,904	1,159	2,134	143	225	84	10,377
Q4 1983	2,124	5,487	556	1,004	207	20,685	1,111	2,118	176	198	94	10,903
Q1 1984	2,124	5,827	577	1,159	177	20,060	1,121	2,224	178	236	70	11,333
Q2 1984	2,321	5,366	490	1,060	178	22,456	1,235	2,017	159	221	70	12,487
Q3 1984	2,370	5,543	573	957	188	23,809	1,261	2,089	188	210	78	13,963
Q4 1984	2,705	5,747	585	1,050	191	21,678	1,460	2,169	196	229	76	12,735
Q1 1985	2,311	6,511	562	1,014	186	22,726	1,295	2,426	191	228	72	13,175
Q2 1985	2,394	5,481	537	1,058	201	21,529	1,371	2,064	179	249	81	13,316
Q3 1985	2,304	5,011	633	929	203	23,088	1,334	1,901	200	214	81	13,237
Q4 1985	2,175	6,246	590	1,077	199	21,848	1,272	2,392	193	254	85	11,653
Q1 1986	2,251	6,369	630	1,106	199	24,277	1,323	2,435	209	261	92	13,494
Q2 1986	2,327	6,498	677	965	199	20,929	1,386	2,485	222	236	97	11,678
Q3 1986	2,496	7,119	590	1,037	208	21,677	1,500	2,670	195	254	107	11,728
Q4 1986	2,642	4,517	561	984	201	20,704	1,608	1,683	181	247	104	13,020

Table 1 continued

Quarter/ Year	Real GDP (base year 2000) in millions of local currency						Nominal GDP in millions of local currency					
	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU
Q1 1987	2,585	6,357	579	967	220	22,013	1,613	2,234	191	252	122	13,417
Q2 1987	2,416	4,241	619	1,102	212	22,315	1,518	1,552	203	290	113	13,648
Q3 1987	2,167	6,693	630	1,218	198	20,447	1,405	2,565	212	333	107	13,435
Q4 1987	2,019	7,646	617	1,110	199	23,098	1,340	3,139	234	323	116	14,410
Q1 1988	2,265	7,683	637	1,033	197	21,454	1,542	3,510	250	327	126	14,911
Q2 1988	2,285	6,842	512	1,163	224	21,909	1,553	3,300	221	376	158	14,836
Q3 1988	2,306	5,185	606	1,068	188	21,340	1,560	2,590	245	336	135	15,442
Q4 1988	2,498	6,454	666	1,204	200	23,565	1,674	3,290	263	385	141	16,339
Q1 1989	2,563	6,780	605	1,153	222	21,263	1,669	3,269	242	371	160	15,187
Q2 1989	2,564	6,778	768	1,166	201	21,975	1,660	3,188	286	367	140	15,871
Q3 1989	2,746	6,610	569	1,198	199	22,659	1,781	3,117	225	383	143	17,335
Q4 1989	2,857	5,316	583	1,151	192	25,841	1,872	2,527	239	417	138	18,765
Q1 1990	2,648	5,557	560	1,124	179	25,384	1,808	2,681	234	461	130	18,508
Q2 1990	2,746	5,075	578	1,164	197	25,610	1,925	2,511	257	508	153	18,718
Q3 1990	2,983	5,965	594	1,255	196	26,540	2,105	2,962	256	565	158	18,409
Q4 1990	2,830	8,493	669	1,213	213	24,894	2,047	4,274	285	571	182	17,918
Q1 1991	2,910	3,426	669	1,314	205	26,118	2,154	1,801	295	616	179	18,989
Q2 1991	2,808	11,520	632	1,272	194	28,813	2,085	5,993	275	594	172	22,122
Q3 1991	2,599	7,335	547	1,246	201	26,006	1,962	3,889	256	587	184	21,126
Q4 1991	2,625	5,451	515	1,238	237	26,016	1,988	2,939	248	602	226	21,332
Q1 1992	2,580	5,924	640	1,311	184	27,736	1,954	3,257	317	659	164	23,086
Q2 1992	3,067	6,719	490	1,427	228	24,492	2,356	3,674	251	745	216	20,500
Q3 1992	2,944	7,454	628	1,465	242	28,463	2,379	4,075	306	803	233	23,179
Q4 1992	3,072	11,488	598	1,476	197	25,625	2,483	6,125	289	849	180	21,854
Q1 1993	2,955	8,662	588	1,409	232	27,629	2,414	4,594	270	812	218	24,162
Q2 1993	2,938	10,635	675	1,640	213	28,004	2,431	5,613	305	983	198	24,302
Q3 1993	3,128	10,046	621	1,447	203	27,708	2,585	5,305	307	910	179	23,961
Q4 1993	3,179	7,167	558	1,426	239	27,646	2,650	3,836	331	897	213	25,374

Table 1 continued

Quarter/ Year	Real GDP (base year 2000) in millions of local currency						Nominal GDP in millions of local currency					
	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU
Q1 1994	3,158	9,401	597	1,568	204	26,115	2,620	5,061	459	984	174	24,116
Q2 1994	3,346	8,068	574	1,513	215	28,436	2,780	4,509	497	956	179	26,178
Q3 1994	3,201	10,345	588	1,575	256	27,777	2,646	5,911	514	1,068	219	25,284
Q4 1994	3,179	11,262	614	1,812	252	30,083	2,662	6,824	519	1,202	212	26,843
Q1 1995	3,331	9,256	563	1,821	245	29,670	2,779	5,847	443	1,203	200	25,584
Q2 1995	3,345	8,438	572	1,903	267	27,426	2,794	5,472	438	1,293	223	24,404
Q3 1995	3,333	4,860	676	1,537	240	32,646	2,792	3,393	524	1,103	200	27,948
Q4 1995	3,351	16,407	707	1,739	211	31,016	2,847	10,842	559	1,259	174	27,011
Q1 1996	3,428	12,085	713	1,964	250	29,431	2,951	8,020	554	1,483	224	26,298
Q2 1996	3,357	11,212	677	1,733	251	31,584	2,922	7,458	544	1,341	234	27,938
Q3 1996	3,443	8,833	689	1,704	221	31,092	3,020	6,025	565	1,347	203	27,149
Q4 1996	3,391	7,852	647	1,721	233	31,589	2,964	5,535	557	1,372	216	28,391
Q1 1997	3,405	9,061	685	1,706	258	34,674	3,019	6,777	607	1,379	245	31,135
Q2 1997	3,375	11,617	680	1,704	221	32,034	3,010	8,819	608	1,423	201	29,365
Q3 1997	3,524	9,376	602	1,823	218	31,921	3,123	7,102	568	1,503	196	29,217
Q4 1997	3,481	7,166	773	1,779	230	31,122	3,094	5,430	712	1,492	210	29,052
Q1 1998	3,454	8,735	729	1,669	230	34,698	3,133	6,772	684	1,437	210	32,872
Q2 1998	3,537	10,112	710	1,737	233	28,361	3,304	7,898	680	1,534	216	27,785
Q3 1998	3,409	10,462	679	1,978	260	36,221	3,300	8,386	634	1,720	250	34,338
Q4 1998	3,377	10,152	703	1,744	242	36,559	3,388	8,373	656	1,543	231	34,968
Q1 1999	3,337	7,699	643	1,570	234	33,988	3,401	6,289	623	1,387	224	33,347
Q2 1999	3,442	7,234	722	1,977	248	31,815	3,539	6,305	694	1,778	243	31,941
Q3 1999	3,491	10,872	721	1,811	255	32,724	3,592	10,017	722	1,622	254	32,643
Q4 1999	4,039	14,753	752	1,741	251	32,765	4,143	13,649	722	1,629	251	31,712
Q1 2000	3,945	11,739	743	1,824	249	33,435	3,937	11,393	724	1,736	249	32,665
Q2 2000	3,552	10,827	736	1,512	255	33,259	3,547	10,789	720	1,498	251	33,204
Q3 2000	3,342	8,495	766	1,396	283	32,629	3,347	8,519	773	1,429	287	32,746
Q4 2000	3,275	7,657	788	1,381	254	35,541	3,278	7,885	816	1,429	256	36,229

Table 1 continued

Quarter/ Year	Real GDP (base year 2000) in millions of local currency						Nominal GDP in millions of local currency					
	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU	FIJI	PNG	SAMOA	SOLOMON ISLANDS	TONGA	VANUATU
Q1 2001	3,455	11,070	872	1,314	269	36,099	3,522	11,546	888	1,362	273	36,893
Q2 2001	3,604	9,242	841	1,396	261	34,753	3,688	9,784	877	1,451	268	36,159
Q3 2001	3,747	9,326	802	1,395	256	26,802	3,857	10,050	826	1,449	265	28,365
Q4 2001	3,847	9,103	734	1,434	276	33,544	4,022	9,983	771	1,515	297	34,981
Q1 2002	3,794	4,848	730	1,391	285	30,947	3,943	5,594	782	1,492	316	33,000
Q2 2002	3,926	12,355	924	1,366	259	31,125	4,120	14,633	997	1,502	289	31,478
Q3 2002	3,789	11,462	804	1,392	238	29,401	4,007	13,992	874	1,610	268	31,061
Q4 2002	3,543	11,339	798	1,299	308	30,133	3,774	14,094	881	1,532	370	32,384
Q1 2003	4,088	11,503	837	1,456	254	28,298	4,441	14,724	913	1,739	302	30,679
Q2 2003	3,550	7,998	748	1,413	290	32,235	3,926	10,197	838	1,684	357	34,887
Q3 2003	3,737	9,927	929	1,369	286	33,105	4,138	12,531	1,061	1,639	362	36,354
Q4 2003	4,007	9,628	847	1,551	291	32,003	4,445	12,021	964	1,874	370	35,052
Q1 2004	3,509	10,765	877	1,405	261	34,068	3,875	13,126	1,037	1,773	330	36,966
Q2 2004	4,100	8,869	851	1,664	301	32,310	4,611	10,830	1,014	2,084	391	36,309
Q3 2004	4,091	10,375	890	1,828	300	33,227	4,669	12,803	1,075	2,332	395	37,144
Q4 2004	4,261	10,467	878	1,372	276	32,841	4,957	13,505	1,057	1,757	368	37,138
Q1 2005	3,998	10,508	891	1,604	327	35,498	4,735	14,263	1,075	2,134	456	39,851
Q2 2005	3,942	12,891	943	1,644	291	32,742	4,767	18,378	1,146	2,207	411	37,012
Q3 2005	3,989	5,711	867	1,685	270	37,849	4,874	8,551	1,082	2,352	384	42,792
Q4 2005	3,721	13,367	973	1,639	282	35,329	4,555	20,676	1,207	2,272	419	41,275
Q1 2006	4,105	9,564	907	1,614	260	34,889	4,937	14,957	1,127	2,308	394	41,431
Q2 2006	4,273	12,676	937	1,491	230	36,372	5,104	20,240	1,189	2,150	344	42,977
Q3 2006	4,108	10,981	965	1,625	324	37,405	4,959	17,579	1,214	2,383	505	42,411
Q4 2006	4,255	10,585	1,004	2,108	369	40,824	5,170	16,571	1,291	3,114	569	45,788

Figure 1

Comparison of Published Annual logs of Real GDP (Actual)

with Estimated Quarterly logs of Real GDP (Disaggregated Estimate)