

Common Trend and Common Currency: Australia and New Zealand

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Abstract

This note empirically examines the existence of common trend between the bilateral real exchange rates of Australia and New Zealand with two of their major trading partners, Japan and the United States, as base countries. Results from Johansen cointegration analysis show that New Zealand and Australia bilateral real exchange rates with Japan as the base country share a common stochastic trend, which can be interpreted in terms of an optimum currency area. This no longer holds should the United States be selected as the base country. This might shed light on the impact of comparative advantage in the regional trade among Australia, New Zealand, and Japan in a liberalized environment.

Key words: common trend; optimum currency area; generalized PPP

JEL classification: C32; F31

1. Introduction

New Zealand's most important bilateral economic relationship is with Australia. There has been a high degree of economic integration between New Zealand and Australia with free trade agreements as well as linked capital and labor markets. In 1965 New Zealand and Australia reached the free trade agreement, known as New Zealand Australia Free Trade Agreement (NAFTA). Trade between Australia and New Zealand grew substantially, particularly in manufactured goods. Between 1965 and 1982 the total exports of New Zealand to Australia increased from NZ\$99 million to NZ\$532 million in constant 1977 values, while imports from Australia rose from NZ\$371 million to NZ\$705 million (Rayner and Lattimore, 1991).

In 1973 the United Kingdom joined the European Community (EC), and, as a consequence, New Zealand tried to alter the composition of its exports and to diversify export markets. Australia and New Zealand began to take a renewed interest in each other and new levels of free trade arrangements led to an Australia New Zealand Closer Economic Relations Trade Agreement (CER) in 1983, proposing the

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elimination of export incentives in trade with Australia by 1987, tariffs by 1990, and import licensing by 1995 (Wooding, 1987). Australia and New Zealand were approaching the free trade area, and since 1988 Australia has been the top trade partner and primary market for New Zealand. In order to enhance the free trade economic relation between Australia and New Zealand, Lloyd (1994) emphasizes the two countries should remove all impediments and harmonize major policies that impinge on trade and competition across the Tasman. In 2002 Australia was the first major trade partner for New Zealand and approximately 20 percent of total exports of New Zealand went to Australia. As of March 2003, the stock of foreign direct investment (FDI) in New Zealand from Australia alone accounted for about 38 percent of total stock of FDI in New Zealand.

When the fundamental variables are sufficiently interrelated and their economies are highly integrated with each other, even though bilateral real exchange rates might be non-stationary, they can share common stochastic trends and in turn have the long-run cointegrating relationship (Enders and Hurn, 1994) which is known as generalized purchasing power parity (G-PPP) theory. The high degree of interrelation between Australia and New Zealand can be seen by the following examples. The productivities in tradable and non-tradable sectors of Australia and New Zealand exhibit a very similar trend in which the magnitude of their fluctuations is almost identical (Figure 1). The bilateral real exchange rate between the two countries shown in Figures 2 and 3 appears possibly non-stationary; the strong positive correlations between the real exchange rate and both (1) the relative terms of trade and (2) the relative real GDP per capita are apparent.

Figure 1. Productivity in Tradable and Non-Tradable Sectors in Australia and New Zealand

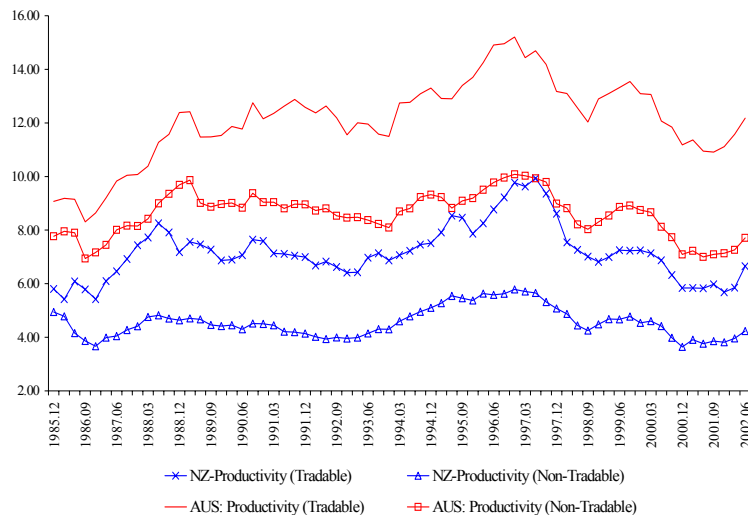


Figure 2. Real Exchange Rate and Terms of Trade

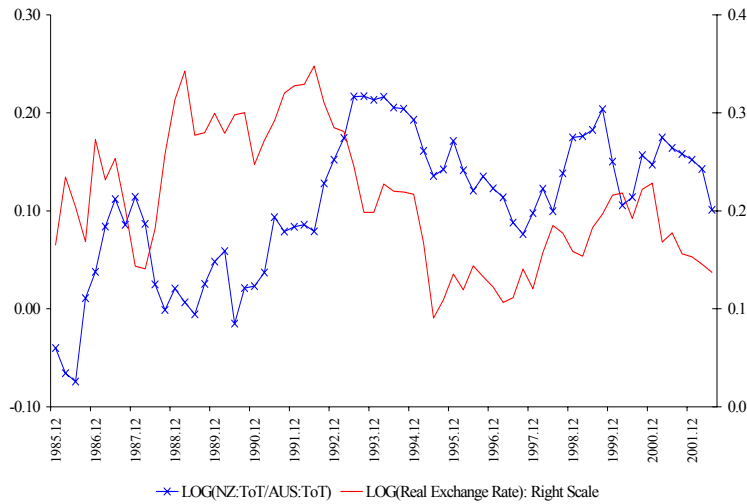
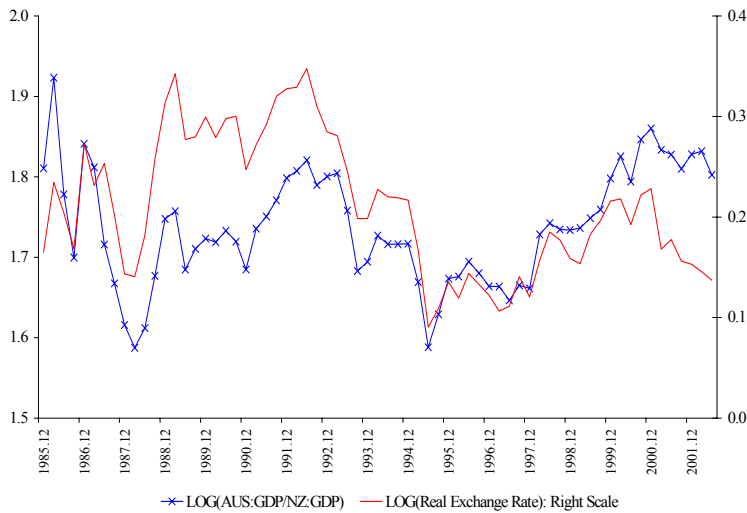


Figure 3. Real Exchange Rate and Real GDP Per Capita



The G-PPP theory can be interpreted in terms of an optimum currency area, which was first introduced by Mundell (1961). Mundell postulates that if nations experience similar types of real disturbances, they might constitute a possible common currency area. The formation of an optimum currency area stimulates the flow of trade and international resource movements between member nations. This is done through the elimination of exchange rate uncertainty because an optimum currency area operates under a single common currency.

This note empirically examines the existence of co-movements of bilateral real

exchange rates of New Zealand and Australia with two of their major trading partners, Japan and the United States, as base countries to see whether they might constitute a possible common currency area as suggested by the data. The results show that New Zealand and Australia bilateral real exchange rates with Japan as the base country share a common stochastic trend, which can be interpreted in terms of an optimum currency area. Such a relationship does not exist with the United States as the base country. This would seem to provide an empirical support for the gravity model.

2. Methodology

We define the bilateral real exchange rates of New Zealand and Australia with Japan as the base country in the following way: $R_t^{J/N} = E_t^{YEN/NZD} * (P_t^{NZ} / P_t^{JP})$ and $R_t^{J/A} = E_t^{YEN/AUD} * (P_t^{AUS} / P_t^{JP})$, where $E_t^{YEN/NZD}$ and $E_t^{YEN/AUD}$ are the spot exchange rates of the Japanese yen prices per unit of New Zealand and Australia currency, respectively. Let P_t^i be the consumer price index (CPI) of country i at time t . Analogously we define the bilateral real exchange rates of New Zealand and Australia with the United States as the base country by $R_t^{U/N} = E_t^{USD/NZD} * (P_t^{NZ} / P_t^{US})$ and $R_t^{U/A} = E_t^{USD/AUD} * (P_t^{AUS} / P_t^{US})$. We take a logarithm on $R_t^{J/N}$, $R_t^{J/A}$, $R_t^{U/N}$, and $R_t^{U/A}$ and then normalize them so that the logs of real rates in 1975:Q1 are equal to zero, which will be denoted by $r_t^{J/N}$, $r_t^{J/A}$, $r_t^{U/N}$ and $r_t^{U/A}$.

Quarterly time series data for nominal spot exchange rates and consumer price indexes (CPI) of Australia, Japan, New Zealand, and the United States were collected from IFS CD-ROM (International Monetary Fund, 2002), and the time span of the data covers 1975:Q1 to 2000:Q3.

First, we performed the Augmented Dickey-Fuller (1979, 1981) test to determine the stationarity of each bilateral real exchange rate. There have been several theoretical and empirical studies on the stationarity and determinants of the bilateral real exchange rate. Most empirical studies (e.g., Adler and Lehman, 1983; Corbae and Ouliaris, 1988; Enders 1988; Patel, 1990; and Kim and Enders, 1991) fail to reject the null hypothesis of a unit root in many of the bilateral real exchange rate series. If a unit root is present in a bilateral real exchange rate, then there exist real variables determining the real exchange rate and permanent deviations from the purchasing power parity (PPP). Real disturbances, including changes in terms of trade, tax systems, or productivity can lead to a new equilibrium real exchange rate.

Suppose that data were generated from an AR(p) process, $r_t = \alpha + \sum_{i=1}^p \phi_{i-1} r_{t-i} + \varepsilon_t$; we can rewrite the process in an error correction form:

$$\Delta r_t = \alpha + c r_{t-1} + \sum_{i=1}^{p-1} \varphi_{t-i} \Delta r_{t-i} + \varepsilon_t, \quad (1)$$

where $\Delta r_t = r_t - r_{t-1}$, $c = -1 + \sum_{i=1}^p \phi_i$, and $\varphi_i = -(\phi_{i+1} + \dots + \phi_p)$ for $i = 1, \dots, p-1$.

The error correction form above is convenient since only one term, r_{t-1} , is the integrated process of order one, I(1), under the unit root hypothesis, while the rest of the terms are stationary. The regression “t-ratio” of the estimator of c to its “standard error” from OLS regression of (1) is used to test the null hypothesis of a unit root with the critical values. Relatively high p-values suggest that we cannot reject the null hypothesis of a unit root in each series—i.e., every series is I(1); however, we reject the null hypothesis in their first differenced series (Table 1).

Table 1. Augmented Dickey-Fuller Tests

Variable	Level Form			First Difference Form		
	Lag Length	ADF Test Statistics	P-values	Lag Length	ADF Test Statistics	P-values
$r_t^{J/N}$	2	-1.057	0.729	1	-7.473	<0.0001
$r_t^{J/A}$	2	-1.316	0.620	0	-8.991	<0.0001
$r_t^{U/N}$	0	-1.256	0.648	3	-8.472	<0.0001
$r_t^{U/A}$	3	-1.157	0.691	0	-10.154	<0.0001

When the G-PPP theory holds, there exists a long-run cointegrating equilibrium relationship between New Zealand and Australia real exchange rates with Japan as the base country such that

$$r_t^{J/N} + br_t^{J/A} = a + \varepsilon_t^J, \tag{2}$$

where ε_t^J is the stationary equilibrium error. Any equilibrium relationship among a set of non-stationary variables implies that they share a common stochastic trend (Stock and Watson, 1988). Dynamic movements of such variables will bear some relationship to the current deviation from the long-run equilibrium. Recent work by Johansen (1988, 1991) and Johansen and Juselius (1990) on the cointegration of a group of dynamic variable models explain the long-run equilibrium relationship with short-run dynamic fluctuations. Procedures for evaluating the long-run equilibrium relationship within the framework of cointegration testing are developed in Johansen (1988, 1991, 1992), Stock and Watson (1988), Ahn and Reinsel (1988, 1990), and Reinsel and Ahn (1992).

We test the cointegration relationship between two variables based on the maximal eigenvalue and trace statistic tests. We consider a 2-dimensional VAR(p) model for $V_t = (r_t^{J/N}, r_t^{J/A})'$:

$$V_t = \delta + \sum_{i=1}^p \Phi_i V_{t-i} + \varepsilon_t, \tag{3}$$

where δ is a 2×1 vector of constant terms, Φ is a 2×2 matrix of parameters, and ε_t is white noise with positive definite covariance matrix $\Sigma \varepsilon$.

When $V_t = (r_t^{J/N}, r_t^{J/A})'$ are cointegrated, (3) has the error correction representation form:

$$\Delta V_t = \delta + \Phi V_{t-1} + \sum_{i=1}^{p-1} \Phi_i^* \Delta V_{t-i} + \varepsilon_t, \quad (4)$$

where $\Phi = -I_2 + \sum_{i=1}^p \Phi_i$ has a rank of one, $\Phi_i^* = -\sum_{k>i}^p \Phi_k$, and I_2 is a 2×2 identity matrix.

When the rank of Φ is one, $\Phi = \alpha\beta'$, where α is a non-zero 2×1 parameter matrix of speed of adjustment and β' is a normalized 1×2 row vector of long-run equilibrium such that $\beta'V_{t-1}$ is stationary. Therefore, the rank of the coefficient matrix Φ is examined for the long-run equilibrium information. We need to determine the rank of the coefficient matrix Φ as well as the AR order p of the model (3).

The AR order p of V_t in model (3) can be identified by partial canonical correlation analysis (PCCA) between V_t and V_{t-1} , given $V_{t-1}, \dots, V_{t-i-1}$ ($i=1, 2, \dots, p$) (Reinsel and Ahn, 1992), and AR(4) is chosen. We further test whether the cointegrating space for V_t has rank one based on the maximal eigenvalue and trace test statistics using the AR(4) model, and these are summarized in Table 2 for Japan as the base country and Table 3 for the United States as the base country. The critical values in Tables 2 and 3 are taken from Osterwald-Lenum (1992) with significance level 0.05.

Table 2. Cointegration Rank Test (Japan as the Base Country)

H ₀	Eigenvalues	Trace Statistic	Maximal Eigenvalue	5% Critical Value*	
				Trace	Maximal
Rank(Φ) = 0	0.1579	19.17	17.02	15.41	14.07
Rank(Φ) \leq 1	0.0214	2.148	2.148	3.76	3.76

*The critical values are taken from Osterwald-Lenum (1992).

3. Common Trends in Real Exchange Rates

3.1 Japan as the Base Country

The estimated normalized cointegrating vector and estimated speed of adjustment vector are

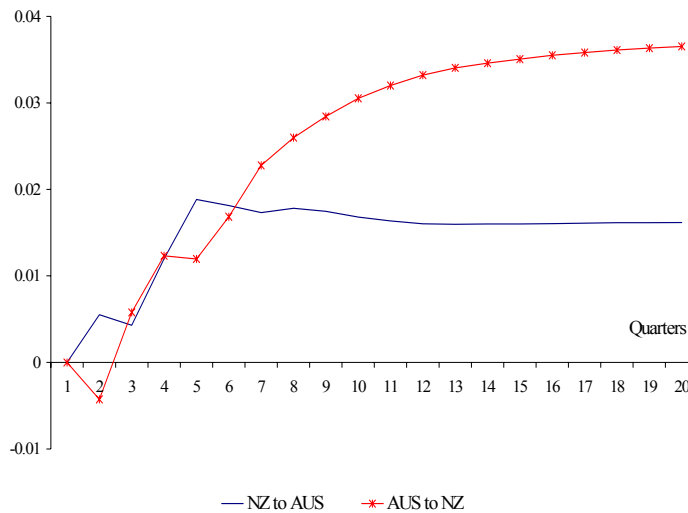
$$\hat{\beta}' = (1, \hat{b}) = (1, -0.57) \text{ and } \hat{\alpha}' = (-0.118, 0.169).$$

The relatively small speed of adjustment coefficients can imply that there will be a persistent long-run deviation from G-PPP. A deviation from the equilibrium due to positive shock in the real exchange of New Zealand negatively affects the changes in its own real exchange rate, while it affects more positively the changes in the real exchange rate of Australia.

The estimated long-run cointegrating vector can be represented in a linear form as shown in the equation (2), $r_t^{J/N} = 0.11 + 0.57r_t^{J/A} + \varepsilon_t^J$. Enders and Hurn (1994) emphasize that the magnitude of the coefficient in the cointegrating vector is related to the aggregate demand parameters in such a way that the more similar a country's demand parameters, the smaller the parameters of the cointegrating vector. The magnitude of the cointegrating vector reflects the trade relation as well as the level of capital and labor movements between nations.

We then use the VAR estimates to generate the responses of the real exchange rates to a positive, one standard deviation shock in the residuals. Figure 4 shows the impulse responses of the real exchange rates of New Zealand and Australia to Cholesky one standard deviation innovations on the real exchange rates of Australia and New Zealand. The standard deviations of New Zealand and Australia real exchange rates with Japan as the base country are 0.168 and 0.280, respectively. As the figure indicates, the fluctuations in the Australia real exchange rate with Japan as the base country will have a greater impact on the New Zealand exchange rate with Japan as the base country due to the different size of their standard deviations. The full response of the Australia real exchange rate to the real appreciation of the New Zealand exchange rate takes about three years with an initial temporary depreciation.

Figure 4. Impulse Response of Real Exchange Rates of Australia and New Zealand with Japan as the Base Country



Since there is a cointegration relation between the two real exchange rates, they share a common stochastic trend. There have been many studies on common trends (Ahn, 1997; Engle and Kozicki, 1993; and Vahid and Engle, 1993). For an m -dimensional $I(1)$ process Y_t , if an $m \times r$ matrix has $r < m$ and β is such that $\beta'Y_t$ is stationary, then for an $m \times (m-r)$ matrix β_{\perp} such that $\beta_{\perp}'\beta = 0$, the

$(m-r)$ components of the vector $\beta_{\perp} Y_t$ are common trends, or linearly independent linear combinations of these components are common trends as well.

In our case of

$$\hat{\beta} = \begin{pmatrix} 1.00 \\ -0.57 \end{pmatrix},$$

we obtain $\hat{\beta}_{\perp}$ by the orthogonal projection

$$I_2 - \hat{\beta}(\hat{\beta}'\hat{\beta})^{-1}\hat{\beta}' = \begin{pmatrix} 0.246 & 0.431 \\ 0.431 & 0.754 \end{pmatrix}.$$

Any linear combination of the columns of this matrix will form $\hat{\beta}_{\perp}$. The common trend corresponding to the first column of the matrix $\hat{\beta}_{\perp}$ can be constructed by the multiplication of New Zealand and Australia real exchange rates by the first column of the matrix $\hat{\beta}_{\perp}$; that is,

$$(r_t^{J/N}, r_t^{J/A}) \begin{pmatrix} \hat{\beta}_{\perp}^{11} \\ \hat{\beta}_{\perp}^{21} \end{pmatrix}, \text{ where } \begin{pmatrix} \hat{\beta}_{\perp}^{11} \\ \hat{\beta}_{\perp}^{21} \end{pmatrix} = \begin{pmatrix} 0.246 \\ 0.431 \end{pmatrix}.$$

The common trend depicted in Figure 5 apparently represents a weighted average of New Zealand and Australia real exchange rates with Japan as the base country. The ratio of the weights between Australia and New Zealand is approximately 1.75—i.e., $\hat{\beta}_{\perp}^{21}/\hat{\beta}_{\perp}^{11} = 0.431/0.246 \cong 1.75$ and this aforementioned weighted-average ratio between the two rates is compatible with the ratio of openness of the two economies, where the openness is defined by the ratio of the sum of total exports and imports to GDP. Australia and New Zealand are small open economies and their exports of goods and services as a percentage of GDP were 23 percent and 37 percent in 2000, respectively. The major export commodities from New Zealand are dairy products and wool while the primary Australian exports are minerals and agricultural commodities. Due to this fact, the real exchange rates of New Zealand and Australia are called “commodity currencies” (Koya and Orden, 1994). The common trend as a weighted average of two real rates can be shared by the dependence of two economies on the international sector.

Figure 5. Common Stochastic Trend

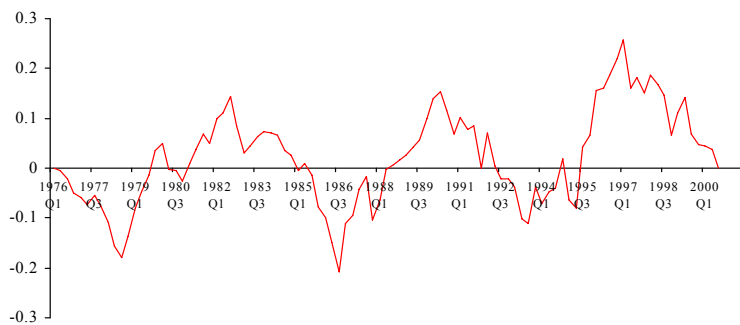


Figure 6. Relative Openness between Australia and New Zealand

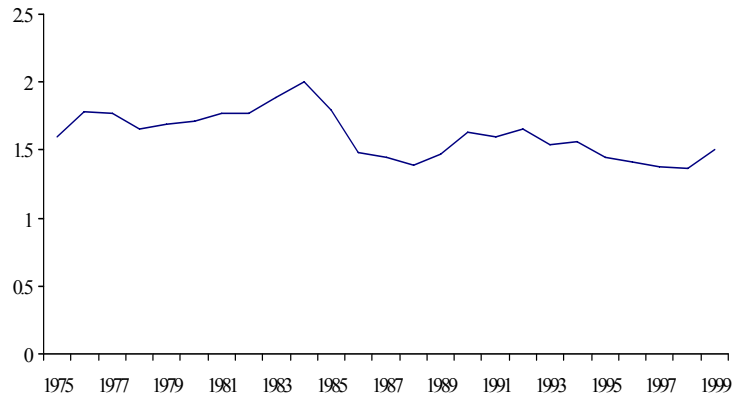


Figure 6 shows this openness ratio fluctuates around 1.7 with a standard error of 0.167. An alternative approach to explaining the common trend as the weighted average of New Zealand and Australia real exchange rates is to compare it with the ratio of productivity levels between Australia and New Zealand in their tradable sectors. The average ratio has been about 1.7 since 1985.

3.2 The United States as the Base Country

From the partial canonical correlation analysis, the AR(3) is appropriate. Table 3 reports the rank test statistics. Unlike the previous case, we conclude that there is no cointegration in this case. This would seem to bolster the impact of geographic proximity, hence supporting the gravity model.

Table 3. Cointegration Rank Test (The United States as the Base Country)

H ₀	Eigenvalues	Trace Statistic	Maximal Eigenvalue	5% Critical Value*	
				Trace	Maximal
Rank(Φ) = 0	0.0761	8.37	7.91	15.41	14.07
Rank(Φ) ≤ 1	0.0045	0.45	0.45	3.76	3.76

*The critical values are taken from Osterwald-Lenum (1992).

4. Conclusions

Our analysis shows an asymmetry in the generalized PPP. When we use Japan as the base currency there is a long-run cointegration relation, implying a common trend shared by the currencies and possible constitution of a common currency area. This no longer holds should the United States be selected as the base country. This would seem to shed light on the impact of comparative advantage in the regional

trade between Australia, New Zealand, and Japan, indicating the dominance of that regional trade in determining the real exchange rate in a liberalized environment. Our results also indicate the importance of regional trade relationships in determining the exchange rate of a small country, even when it is integrated into the global economy. Such rates may reflect a long-run regional but not necessarily global equilibrium.

References

- Ahn, S. K. and G. C. Reinsel, (1988), "Nested reduced-rank autoregressive models for multiple time series," *Journal of the American Statistical Association*, 83, 849-856.
- Ahn, S. K. and G. C. Reinsel, (1990), "Estimation for Partially Nonstationary Multivariate Autoregressive Models," *Journal of the American Statistical Association*, 85, 813-823.
- Ahn, S. K., (1997), "Inference of Vector Autoregressive Models With Cointegration and Scalar Components," *Journal of the American Statistical Association*, 92, 350-356.
- Adler, M. and B. Lehman, (1983), "Deviations from Purchasing Power Parity in the Long Run," *Journal of Finance*, 38(5), 147-187.
- Corbae, D. and S. Ouliaris, (1988), "Cointegration and Tests of Purchasing Power Parity," *Review of Economics and Statistics*, 70, 508-512.
- Dickey, D. A. and W. Fuller, (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of American Statistics Association*, 74, 427-431.
- Dickey, D. A. and W. Fuller, (1981), "Likelihood ratio test statistics for autoregressive time series with a unit root," *Econometrica*, 49, 1057-1072.
- Enders, W., (1988), "ARIMA and Cointegration Tests of PPP Under Fixed and Flexible Exchange Rate Regimes," *Review of Economics and Statistics*, 504-508.
- Enders, W. and S. Hurn, (1994), "Theory and Tests of Generalized Purchasing-Power Parity: Common Trends and Real Exchange Rates in the Pacific Rim," *Review of International Economics*, 2(2), 179-190.
- Engle, R. F. and S. Kozicki, (1993), "Testing for Common Features," *Journal of Business and Economic Statistics*, 11, 369-380.
- Fuller, W. A., (1976) *Introduction to Statistical Time Series*, New York: John Wiley.
- Johansen, S., (1988), "Statistical Analysis of Cointegration Vectors," *Journal of Economic Dynamics and Control*, 12, 231-254.
- Johansen, S., (1991), "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models," *Econometrica*, 52, 389-402.
- Johansen, S., (1992), "Determination of Cointegration Rank in the Presence of a Linear Trend," *Oxford Bulletin of Economics and Statistics*, 54, 383-397.
- Johansen, S., and K. Juselius, (1990), "Maximum Likelihood Estimation and Inference of Cointegration – with Applications to the Demand for Money," *Oxford*

- Bulletin of Economics and Statistics*, 52, 169-210.
- Kim, J. O. and W. Enders, (1991), "Real and Monetary Causes of Real Exchange Rate Movements in the Pacific Rim," *Southern Economic Journal*, 57, 1061-1070.
- Koya, S. and D. Orden, (1994), "Terms of trade and the exchange rates of New Zealand and Australia," *Applied Economics*, 26, pp.451-457.
- Lloyd, P. J.,(1994), "The future of the CER Agreement: a single market for Australia and New Zealand," in *Asia Pacific Regionalism: Reading in International Economic Relations*, Garnaut, R. and P. Drysdale, Harper-Educational Pty, Limited, NSW, Australia.
- Mundell, R., (1961), "A Theory of Optimum Currency Area," *Papers and Proceedings of the American Economic Association*, 51, 657-664.
- Osterwald-Lenum, M., (1992), "A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics," *Oxford Bulletin of Economics and Statistics*, 54(3): 461-472.
- Patel, J., (1990), "Purchasing Power Parity as a long-run relation," *Journal of Applied Econometrics*, 5: 367-379.
- Rayner, A. C. and R. Lattimore, (1991), "Liberalizing Foreign Trade: New Zealand," in *Liberalizing Foreign Trade, Volume 6, The experience of New Zealand, Spain, and Turkey*, Cambridge, Mass. and Oxford: Blackwell.
- Reinsel, G. C. and S. K. Ahn, (1992), "Vector Autoregressive Models with Unit Roots and Reduced Rank Structure: Estimation, Likelihood Ratio Test, and Forecasting," *Journal of Time Series Analysis*, 13, 353-375.
- Stock, J. H. and M. W. Watson, (1988), "Testing for Common Trends," *Journal of the American Statistical Association*, 83, 1097-1107.
- Vahid, F. and R. F. Engle, (1993), "Common Trends and Common Cycles," *Journal of Applied Econometrics*, 8, 341-360.
- Wooding, P., (1987), "Liberalizing the International Trade Regime" in *Economic Liberalization in New Zealand*, Alan Bollard and Robert Buckle.