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Modelling Conditional Correlations in International Tourism Demand

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Abstract: International tourism demand, or tourist arrivals, to Australia has recently experienced dramatic fluctuations due to changes in the economic, financial and political environment. However, variations in tourism demand, specifically the conditional variance, or volatility, have not previously been investigated. An analysis of such volatility is essential for investigating the effects of shocks in tourism demand models. This paper models the conditional mean and conditional variance of the logarithm of the monthly tourist arrival rate from the four leading tourism source countries to Australia, namely Japan, New Zealand, UK and USA, using three multivariate static or constant conditional correlation (CCC) volatility models, specifically the symmetric CCC-MGARCH model of Bollerslev (1990), symmetric VARMA-GARCH model of Ling and McAleer (2003), and asymmetric VARMA-AGARCH model of Chan, Hoti and McAleer (2002). Monthly data from July 1975 to July 2000 are used in the empirical analysis. The results suggest the presence of interdependent effects in the conditional variances between the four leading countries, and asymmetric effects of shocks in two of the four countries. This is important as it emphasizes interdependencies between major tourism source countries, as well as the asymmetric effects of positive and negative shocks in tourism demand. The estimated CCC matrices for the three models are not substantially different from each other, which confirms the robustness of the estimates to alternative specifications of the multivariate conditional variance.

Keywords: International tourism demand, arrival rate, volatility, conditional variance, multivariate GARCH models, symmetries, asymmetries, constant conditional correlation.

1. INTRODUCTION

According to the World Tourism Organization (WTO), international tourism encompasses the activities of visitors who make temporary visits across international borders, outside their usual place of work and residence, and remain for more than 24 hours. The primary purposes of travel can be leisure, visiting friends and relatives, business, convention or meetings, health, education, religion or sport.

During the late 1980s, while the principal focus of macroeconomic policy was on a persistent and substantial current account deficit and rapid accumulation of foreign debt, the demand for international tourism to Australia grew rapidly. While Australia's share of total international tourism arrivals remains small in absolute terms**,** inbound tourism to Australia was increasing rapidly prior to the Asian currency and economic crises in late-1997, due primarily to the rapid rise in inbound tourism from East Asia. Australia's inbound tourism market is diverse, with arrivals from Japan and other parts of Asia, particularly East Asia, dominating the market share.

Although Australia's share of international tourism receipts is relatively small, accounting for 1.8% in 2000, its share has increased steadily, thereby positioning the country among the world's leading twenty tourism earners. Australia was ranked number 27 in 1985, 14 in 1990, and 11 in 2000, according to the World Tourism Organization (World Bank, 2001). In regional terms, as a tourist destination in East Asia and the Pacific, Australia moved from number 9 to 8 from 1990 to 2000. The emergence of travel and tourism as a significant force on the credit side of the balance of payments has not only reduced Australia's reliance on exports of primary (rural and mining) products, but also contributed to Australia's export earnings.

In the 1990s, there was strong growth in international tourist arrivals to Australia. The main factors that generally affect inbound travel are the confidence of tourists, the global economy and exchange rates**.** The share of short-term arrivals from Asia has also increased dramatically, from

15% in 1976 to 51% in 1996 and 42% in 2000. Between 1990 and 1996, Australia experienced the largest average annual percentage growth of 23% in tourist arrivals from Asia, which far exceeded the average annual percentage growth rate (10.5%) of all tourist arrivals to Australia (Australian Bureau of Statistics, 1997). Due to the Asian economic and financial crises, inbound tourist flows decreased in 1998, but growth returned in 1999. Strong growth was experienced in 2000 and the tourism industry benefited substantially from the Sydney Olympics. During 1999-2000, international tourism generated export earnings of $17.8 billion, or approximately 16% of Australia's aggregate export earnings and 63% of international trade in services, and created more than 550,000 jobs, comprising 6% of total employment in the country (Australian Bureau of Statistics, 2002). As the fluctuations, or volatility, in tourist arrivals can have a substantial impact on management decision making in both the private and public sectors, it is important to examine how volatility changes over time.

This paper models the time series behaviour of the logarithm of the monthly arrival rate and its conditional variance from the four leading tourism source countries to Australia, namely New Zealand, Japan, UK and USA. These four countries comprise over 58% of total tourist arrivals to Australia from foreign countries.

The plan of the paper is as follows. Section 2 discusses inbound tourism to Australia, and provides some qualitative descriptions regarding the changes in tourist arrivals from the four leading tourism source countries to Australia. Section 3 describes the data used in the paper. Section 4 discusses alternative specifications of three static or constant conditional correlation multivariate GARCH models. Section 5 provides some concluding remarks.

2. INBOUND TOURISM TO AUSTRALIA

International tourist arrivals to Australia have more than doubled in the ten years from 2.1 million visitors in 1989-1990 to 4.6 million in 1999-2000. Over this ten-year period, growth was strongest from Asia (excluding Japan), with an average annual increase of almost 14%. In 1999, tourist arrivals from Japan and New Zealand, each representing a 16% share of the inbound market, were Australia's major source markets for overseas arrivals. Although ranked fourth in the 1970s and 1980s, Japan was Australia's most important tourist-source country for much of the 1990s. After growing rapidly in the early 1990s, tourist arrivals from Japan rose moderately, resulting in a decrease in market share from 22% in 1993 to 18% in 1998.

New Zealand was Australia's largest inbound market until 1990, and has returned to this leading position in 1999 until the present. As Australia's closest neighbour, New Zealand is expected to be a prominent source market, especially given a similar cultural heritage and immigration procedures. In return, Australia is New Zealand's leading tourist destination, and attracts more than 50% of New Zealand's total outbound tourists. The high market share is due to Australia's geographical proximity, frequent air services between the two countries, and affordability for New Zealand tourists. Over 80% of New Zealand tourists to Australia are repeat visitors.

With a 12% share of total short-term arrivals from the UK, the latter has been Australia's third main tourism source country since 1989, followed by the USA in fourth place. Besides the extensive historical ties, Australia also has strong visiting friends/relatives (VFR) links with the UK. The UK accounted for about 53% of total European arrivals to Australia in 1999-2000, and is the largest source of backpackers and working holidaymakers from Europe to Australia. Although VFR has been the main purpose of visit indicated by UK tourists, there has been a gradual shift since 1998 for holidays to be the main reason for travelling to Australia. The largest group of visitors by age group is the 55 years and over cohort.

North America, particularly the USA, is Australia's biggest competitor for UK tourists on long-haul travel. Tourist arrivals from the USA to Australia grew strongly in the late 1980s. This was due largely to the invaluable media exposure Australia received as a result of the popular Crocodile Dundee movies in 1986 and 1988, the America's Cup yacht race in Fremantle, Western Australia in 1987, and Australia's Bicentennial Celebrations and the World Expo in 1988. International travel by US residents continued to grow between 1990 and 2000, in spite of the Gulf War, political conflicts in Europe and the Middle East, and the Asian economic and financial crises. The USA was ranked second in international travel debits in 1996, but its share of the world travel debit decreased from 15% in 1990 to 13% in 1996 (International Monetary Fund, 1997). Although only 1% of US residents travel to Australia, about 10% of total tourist arrivals in Australia were from the USA in the 1990s.

3. DATA

The primary aim of the empirical component of the paper is to model the logarithm of the monthly arrival rate and the conditional volatility of the logarithm of the monthly arrival rate to Australia (hereafter, the log arrival rate) from the leading four tourism source countries, namely Japan, New Zealand, UK and USA. International tourism demand, or tourism arrivals, to Australia has experienced dramatic changes in recent years due to changes in the economic, financial and political environment.

All four countries exhibit upward trends in the log arrival rate, with clear cyclical and seasonal patterns. Interestingly, while Japan and UK show a steady growth in the log monthly arrival rate, New Zealand and USA show some interesting patterns during the early and late 80s, respectively. For New Zealand, the log monthly arrival rate has decreased during the early 80's, but retains a similar seasonal pattern, and increases again towards the late 80s. However, there seems to be a structural change in the log arrival rate for the USA, where the time trend seems to have shifted downwards in the late 80s.

Volatility is calculated as the square of the estimated residuals from a ARMA(1,1) process with a deterministic time trend. If y_t denotes the log arrival rate for a given country and *L* denotes the lag operator, that is, $Ly_t = y_{t-1}$, then

$$Vol_t = \varepsilon_t^2 ,$$

$$(1-\phi L)y_t = (1-\theta L)\varepsilon_t .$$

The volatilities have similar patterns for all four countries, with volatility clusters but no outliers. Interestingly, there seems to be a structural change in the volatility in Japan. There is a larger variability in the log arrival rate before the 1990s, but this has been reduced considerably from 1990-2000, which seems to be a unique feature in the log arrival rate for Japan. Furthermore, the stylised features that often appear in financial time series data, such as clustering and excessive kurtosis, are common in the log arrival rate for each of the four countries.

A primary reason for modelling the logarithm of the monthly arrival rate rather than its level is the presence of unit roots in some of the series. The Phillips-Perron (1990) (PP) test for stationarity, with truncated lags of order 5, was conducted using EViews 4.0 for each of the countries. The PP test has been conducted in both levels and logarithms of the series. The test suggests the presence of a unit root in the monthly arrival rate from Japan and USA in levels, but shows strong evidence against unit roots for each of the countries in logarithms. Hence, all series are stationary after transformation by logarithms. The tests have also been conducted using several different lags, but the results were robust to such changes. Choosing the PP test over the conventional augmented Dickey-Fuller (ADF) test is due mainly to the presence of GARCH errors. While the ADF test accommodates serial correlation by explicitly modelling the structure of serial correlation, but not heteroscedasticity, the PP test accommodates both serial correlation and heteroscedasticity using non-parametric techniques. The PP test has also been shown to have higher power than the ADF test in a wide range of circumstances (Phillips and Perron (1990)).

Three different multivariate GARCH models of volatility will be estimated in Section 4 in order to examine the conditional volatility of the log arrival rate for each country, and to investigate their interdependent relationships.

4. MULTIVARIATE MODELS OF CONDITIONAL VOLATILITY

Consider the constant conditional correlation multivariate GARCH model of Bollerslev (1990):

$$\begin{gathered} Y_t = E(Y_t \mid F_{t-1}) + \varepsilon_t , \\ \varepsilon_t = D_t \eta_t \\ Var(\varepsilon_t \mid F_{t-1}) = D_t \Gamma D_t \end{gathered} \tag{1}$$

where F_t is the past information available up to time *t*, $D_t = diag(h_{it}^{1/2})$, $i = 1,...,m$, for which *m* is the total number of assets or markets, and $\Gamma = \{\rho_{ij}\}$, in which $\rho_{ij} = \rho_{ji}$ for $i, j = 1,...,m$, and $\eta_t = (\eta_{1t},...,\eta_{mt})'$.

As $\Gamma = E(\eta_t \eta_t')$, the constant conditional correlation matrix of the unconditional shocks, ε_t, is definitionally equivalent to the constant conditional correlation matrix of the conditional shocks, η_t. Bollerslev (1990) proposed the above framework with

$$h_{it} = \omega_i + \sum_{l=1}^{r} \alpha_i \varepsilon_{it-l}^2 + \sum_{l=1}^{s} \beta_i h_{it-l} \tag{2}$$

where $i = 1,..,m$. Equation (2) is a standard GARCH(*r,s*) model of Bollerslev (1986) for asset *i* (see Bollerslev, Chou and Kroner (1992), Bollerslev, Engle and Nelson (1994) and Li, Ling and McAleer (2002) for comprehensive surveys), in which $\sum_{i=1}^{r} \alpha_i$ denotes the short run persistence (or ARCH effects of shocks) and $\sum_{i=1}^{r} \alpha_i + \sum_{i=1}^{s} \beta_i$ denotes the long run persistence (in which $\sum_{i=1}^{s} \beta_i$ are the GARCH effects). Although the conditional correlation is modelled, and hence can be estimated in practice, the CCC model does not allow any interdependencies of volatilities across different assets and/or markets, and does not accommodate asymmetric behaviour.

In order to allow for interdependencies of volatilities across different assets and/or markets, Ling and McAleer (2003) proposed the following VARMA-GARCH model:

$$\Phi(L)(Y_t - \mu) = \Psi(L)\varepsilon_t \qquad (3)$$

$$\varepsilon_t = D_t \eta_t$$

$$H_t = W + \sum_{l=1}^{r} A_l \vec{\varepsilon}_{t-l} + \sum_{l=1}^{s} B_l H_{t-l} \qquad (4)$$

where $D_t = diag(h_{it}^{1/2})$, A_l and B_l are $m \times m$ matrices with typical elements α_{ij} and β_{ij}, respectively, for $i, j = 1,...,m$, $\Phi(L) = I_m - \Phi_1 L - ... - \Phi_p L^p$ and $\Psi(L) = I_m - \Psi_1 L - ... - \Psi_q L^q$ are polynomials in L, and $\vec{\varepsilon}_t = (\varepsilon_{1t}^2, ..., \varepsilon_{mt}^2)'$.

If A_l and B_l are diagonal matrices, equation (4) reduces to equation (2), so that the VARMA-GARCH model has CCC as a special case.

Chan et al. (2002) extended the VARMA-GARCH model to accommodate the asymmetric impacts of the unconditional shocks on the conditional variances. They proposed the VARMA-AGARCH model as follows:

$$\Phi(L)(Y_t - \mu) = \Psi(L)\varepsilon_t \qquad (5)$$

$$\varepsilon_t = D_t \eta_t$$

$$H_t = W + \sum_{l=1}^{r} A_l \vec{\varepsilon}_{t-l} + \sum_{l=1}^{r} C_l I(\eta_{t-l}) \vec{\varepsilon}_{t-l} + \sum_{l=1}^{s} B_l H_{t-l} \qquad (6)$$

where C_l is an $m \times m$ matrix with typical element γ_{ij}, and $I(\eta_{it})$ is an indicator function, given as:

$$I(\eta_{it}) = \begin{cases} 1, & \varepsilon_{it} \le 0 \\ 0, & \varepsilon_{it} > 0. \end{cases} \qquad (7)$$

If $m = 1$, equation (6) reduces to the asymmetric GARCH, or GJR, model of Glosten et al. (1992). If $C_l = 0$, equations (5) and (6) collapse to the VARMA-GARCH model.

The parameters of (3)-(4) are typically obtained by maximum likelihood estimation (MLE) with a joint normal density, namely,

$$\hat{\theta} = \max_{\theta} -\frac{1}{2} \sum_{t=1}^{T} \left(\log |H_t| + |\varepsilon_t' H_t^{-1} \varepsilon_t| \right) \qquad (8)$$

where $|A|$ denotes the determinant of a matrix A. When η_t does not follow a joint normal distribution, equation (8) is defined as the Quasi-MLE (QMLE). As in the case of VARMA-GARCH, VARMA-AGARCH is also typically estimated by QMLE, as defined in equation (8).

A concise summary and comparison of various multivariate GARCH models were provided by Chan et al. (2002), including Engle and Kroner's (1995) Vech (or VAR) model, Bollerslev, Engle and Wooldridge's (1988) Diagonal model, Engle and Kroner's (1995) BEKK model, and the Dynamic Conditional Correlation (DCC) model of Engle (2002), which is a special case of the Varying Constant Correlation (VCC) model of Tse and Tsui (2002). The BEKK model is concerned with conditional covariances, but the primary purpose of multivariate models is to analyse conditional correlations.

In the next section, the CCC, VARMA-GARCH and VARMA-AGARCH models will be estimated using the log arrival rate from the leading four countries. Tests of asymmetric and interdependent effects will be conducted, and the stability of the constant conditional correlation matrices over time will be examined through the use of rolling windows.

5. EMPIRICAL RESULTS

This section models the conditional volatility of the log arrival rate from the leading four countries, namely New Zealand, Japan, UK and USA, using CCC, VARMA-GARCH and VARMA-AGARCH. The sample period is from July 1975 to July 2000, which gives 312 observations for each country.

Estimates of the three models are available on request. Corresponding to each of the parameters are the calculated estimate, asymptotic t-ratio and the Bollerslev-Wooldridge (1992) robust t-ratio. The time-varying nature of the conditional correlations is analysed through rolling regressions for the three models. In order to strike a balance between efficiency in estimation and a sensible number of rolling regressions, the rolling window size was set at 240 observations. The robustness of the conditional correlation estimates can be examined through their respective dynamic paths.

All models in this paper are estimated using EViews 4.0, and the Berndt-Hall-Hall-Hausman (1974) (BHHH) algorithm. Furthermore, $p = q = r = s = 1$, with a deterministic time trend in the case of VARMA-GARCH and VARMA-AGARCH, while the conditional mean for CCC follows an ARMA(1,1) process with a time trend.

4.1 Multivariate Constant Conditional Correlation Models

For the estimates of CCC, it is worth noting that all countries satisfy the second moment condition, namely $\alpha + \beta < 1$, and hence also the log-moment condition, which is a sufficient condition for the QMLE to be consistent and asymptotically normal (see McAleer, Chan and Marinova (2003)). Therefore, QMLE is consistent and asymptotically normal in all cases. Apart from New Zealand, for the which the GARCH estimate is negative, both the ARCH and GARCH estimates for the other three countries resemble those estimated from typical financial time series. Thus, the α (or ARCH) estimates are generally small (less than 0.l), and the β (or GARCH) estimates are generally high and close to one. Therefore, the long run persistence, (or $\alpha+\beta$), is generally close to one, which indicates a near long memory process.

It is interesting that CCC does not contain any information regarding cross-country or asymmetric effects. In order to examine the interdependent and dependent effects of volatility from one country to another, and to capture the asymmetric behaviour of the unconditional shocks on the conditional volatility, the VARMA-GARCH and VARMA-AGARCH models are also estimated.

Both VARMA-GARCH and VARMA-AGARCH suggest strong cross-country effects for the log arrival rate of the four leading countries. In addition, VARMA-AGARCH detects the presence of asymmetric behaviour in Japan and New Zealand. In the case of Japan, the asymmetric effect is 0.360 and is statistically significant, which implies that a negative shock in the log arrival rate from Japan has a greater impact on the conditional variance than a positive shock. On the contrary, the asymmetric effect for New Zealand is –0.218 and statistically significant, which implies that a negative shock in the log arrival rate from New Zealand will have a lower impact on the conditional volatility than a positive shock. However, the γ estimates for both UK and USA are insignificant, so that VARMA-GARCH is preferred to the VARMA-AGARCH model for these two countries.

The conditional variance of the log arrival rate from Japan is affected by its own previous short run shock, as well as the previous short and long run shocks from New Zealand, UK and USA. New Zealand is affected by its own previous short and long run shocks, as well as the short and long run shocks from UK and the short run shocks from the USA. In the absence of asymmetric effects, the cross-country effects for UK and USA are based on the estimates of VARMA-GARCH. The UK is affected by the previous short run shocks from Japan and UK, and the previous long run shocks from Japan and the USA. USA is affected by the short run shocks from Japan and UK, as well as the long run shocks from Japan, New Zealand and UK.

In summarizing cross-country interdependence and dependence detected by the VARMA-GARCH and VARMA-AGARCH models, there are interdependent effects between Japan and UK, Japan and USA, New Zealand and USA. Moreover, New Zealand is affected by Japan, but not the reverse, while the USA is affected by both New Zealand and UK, but not the reverse.

4.2 Conditional Correlations

As with the findings in Chan et al. (2002) and Chan and McAleer (2003) for country risk and financial market data, respectively, the conditional correlation matrices for the three models are not significantly different from each other. UK and USA seem to have the highest conditional correlation, followed closely by Japan and UK. The conditional correlation between Japan and USA is ranked third, followed by Japan and New Zealand. New Zealand and UK and New Zealand and Japan are the only pairs with negative conditional correlations.

In order to examine the time-varying nature of the correlations of the conditional shocks, rolling regressions with window size 240 has been estimated for each of the three models. The dynamic paths of the conditional correlations for CCC, VARMA-GARCH and VARMA-AGARCH are available on request.

It is interesting to note that the dynamic paths for each model are not substantially different from each other. For each of the three models, the conditional correlations between New Zealand and the other three countries exhibited upward trends. Furthermore, the conditional correlations were negative in the early rolling samples, but gradually became positive. Moreover, the conditional correlations between Japan and UK and Japan and USA exhibited downward trends, but remained positive throughout the rolling samples.

The changes in conditional correlations throughout the rolling samples suggest the relationships between the conditional shocks of the four countries may not be constant over time. Therefore, the constant conditional correlation assumption underlying the three models may be a little restrictive. Multivariate models that allow time-varying conditional correlations, such as the DCC model of Engle (2002) and VCC model of Tse and Tsui (2002), may provide greater insight into the dynamic structure of the conditional correlations.

6. CONCLUDING REMARKS

This paper modelled the time-varying means and conditional variances, and constant conditional correlations, of the logarithm of the monthly arrival rate from the four leading tourism source countries to Australia, namely Japan, New Zealand, UK and USA, using the CCC, VARMA-GARCH and VARMA-AGARCH models, with a sample size of 312 observations from July 1975 - July 2000. The modelling and analysis of volatility in tourist arrivals in Australia's major tourism inbound markets can provide a useful tool for tourism organizations and government agencies concerned with travel and tourism. This will assist in evaluating the impact of tourism demand fluctuations and in working together closely for the successful management of the tourism industry.

The empirical results provided evidence of cross-country interdependent and dependent effects in the conditional variances between the different countries. Furthermore, asymmetric effects were detected in two countries, namely Japan and New Zealand. Interestingly, a negative shock had a larger impact on the conditional variance of Japan than a positive shock. On the contrary, a negative shock had a smaller impact on the conditional variance of New Zealand than a positive shock. This is an important result as it emphasizes interdependencies between major tourism source countries, as well as the asymmetric effects of positive and negative shocks in tourism demand.

As with the findings in Chan et al. (2002) and Chan and McAleer (2003), the conditional correlation matrices arising from the three constant conditional correlation multivariate GARCH models were not substantially different from one another. However, the dynamic paths of the conditional correlations based on the rolling regressions provided some evidence against the assumption of constant conditional correlations in the three models. In fact, three of the six possible conditional correlations exhibited upward trends for all three models, namely the conditional correlations between New Zealand and Japan, New Zealand and UK, and New Zealand and USA. Thus, models that allow time-varying conditional correlation, such as the DCC model of Engle (2002) and VCC model of Tse and Tsui (2002), may provide greater insight into the dynamic structure of the underlying process of international tourism demand to Australia.

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