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Abstract: International tourism is an important source of service exports to Spain and its regions, particularly the Canary Islands. Tourism is the major industry in the Canary Islands, accounting for about 22% of GDP. This paper examines time series of international tourism demand to the Canary Islands collected by the National Airport Administration (AENA) at airports from information regarding the number of tourist arrivals from abroad. The data set comprises monthly figures for the Canary Islands from 14 leading tourist source countries, as well as total tourist arrivals, from 1990(1)-2003(12). Tourist arrivals and associated volatilities for the monthly tourism data are estimated for the 14 source countries, as well as total tourist arrivals, using univariate and multivariate volatility models for the 15 data series. The univariate estimates suggest that the GARCH(1,1) model provides an accurate measure of conditional volatility in international monthly tourist arrivals for the 14 leading source countries, and total monthly tourist arrivals. The estimated conditional correlation coefficients provide useful information as to whether tourist source markets are similar in terms of shocks to international tourism demand. At the multivariate level, the conditional correlations in the shocks to monthly tourist arrivals are generally positive, varying from small negative to large positive correlations.

Keywords: International tourist arrivals, volatility, conditional correlation, seasonality, asymmetry, GARCH.

1. INTRODUCTION

Domestic and international tourism is a fast growing industry, attracting investment and scarce economic resources in different countries and destinations. This process is driven by a growing market which accommodates new destinations and transformations in the products offered by established destinations, both nationally and internationally. In this context, an understanding of tourism demand plays an important role in decisions regarding the management of tourist products and investment decisions that are necessary to accommodate the growing numbers of tourists.

Tourism demand has traditionally been modelled using a variety of approaches, including structural equations and time series techniques. These have been able to forecast changes in the number of tourists over time. These models usually consider a random term which incorporates all the unknown effects on tourism demand over time. Until recently, the variability in the random component of tourism demand had not been of major concern to tourism researchers, apart from the standard approaches for modelling heteroscedasticity and/or serial correlation. Heteroscedastic and/or serially correlated errors could lead to imprecise estimates of tourism demand, thereby reducing the forecasting performance of the models.

Changes in the variance of shocks to tourism demand over time are often called conditional or stochastic volatility. As a result of many factors that can affect the tourism market, it is clear that shocks to demand may not have the same variability over time. In the case of tourism, volatility may be present due to various unexpected factors which can affect consumer decisions, such as changes in disposable income, advertising campaigns, wealth effects, and random events. Moreover, the variability could also be different across markets and products. Thus, for a single destination, changes in demand could show different volatilities according to the various origin markets of tourists, whereas a given market may be able to vary its volatile performance across different products or destinations.

In this paper we estimate univariate and multivariate volatility models of international tourist arrivals and volatility among a set of markets for a particular tourist destination, the Canary Islands, Spain. Annual international tourist arrivals to the Canary Islands range from a minimum of 3.5 million to a maximum of 12.4 million over the sample period, namely January 1990 to December 2003. Tourism is the major industry in the Canary Islands, accounting for about 22% of GDP. The tourism industry has grown rapidly over the last thirty years, with an average growth rate of 5.24% between 1990 and 2002. However, in the last few years, the rate of tourism growth has declined slightly as a result of saturation effects and the economic slowdown in the world economy.

The estimated correlation coefficients from the multivariate volatility model provide useful information as to whether particular tourist markets can be seen as substitutes or complements in demand, which is also reflected in the cross-market impacts of volatility. The fact that the degree of volatility can vary across different tourist source markets should be appreciated in order to reach management and marketing decisions regarding particular markets. In addition, multivariate volatility models permit a distinction to be made between the short and long run persistence of shocks to tourism demand, which provide useful information regarding the effects of the shocks. Shocks in one market can also affect tourism demand in other markets differently, depending on the degree of correlation between volatilities across markets. The inter-relationship of the short and long run effects of shocks to volatility, and the correlation coefficients across different source markets, permit a classification of markets according to volatility. Tourist source countries with a high positive or negative correlation in the volatility of shocks to tourist arrivals should be treated differently in terms of marketing decisions from those tourist sources that have lower correlations.

The plan of the paper is as follows. Section 2 describes the data sources for the empirical analysis, and discusses the salient features of the monthly international tourist arrivals data for the Canary Islands from 14 leading tourist source countries, as well as total tourist arrivals. Seasonality in the tourist arrivals data from the various country sources, as well as total tourist arrivals, is also discussed. Univariate and multivariate models of conditional volatility for monthly tourist arrivals are presented in Section 3. The empirical results for the univariate and multivariate models are analysed in Section 4.

2. DATA SOURCE AND DESCRIPTION

The Canary Islands account for about 20% of total tourism in Spain, with a larger proportion in the winter season as compared with the summer season. The effect of seasonality varies significantly across the tourism source countries, showing the largest patterns for the Scandinavian countries. In particular, tourist arrivals from the Scandinavian countries to the Canary Islands drop dramatically during the period from May through to September, which includes the European summer.

Seasonality for the total number of tourists is inverted with respect to tourism demand in the rest of Spain, with the strong season for the Canary Islands being mid-November to mid-March. During this time of the year, the Canary Islands still enjoys pleasant weather. Moreover, the travel time to the Canary Islands from virtually any European tourism source country is relatively short. During the summer season, the Canary Islands compete in similar conditions with other tourist destinations, such as those in the Mediterranean.

This paper examines time series of international tourism demand to the Canary Islands collected by the National Airport Administration (AENA) at airports from information regarding the number of tourist arrivals from abroad. The data set comprises monthly figures for different islands in the Canary Islands from 14 leading international tourist source countries, as well as total tourist arrivals, for the period 1990(1)-2003(12), thereby giving 15 data series.

3. CONDITIONAL VOLATILITY MODELS FOR TOURIST ARRIVALS

The purpose of this section is to model the volatility in monthly international tourist arrivals from the 14 leading source countries, as well as total monthly international tourist arrivals, to the Canary Islands. The specification and properties of the Constant Conditional Correlation (CCC) Multivariate GARCH model of Bollerslev (1990) will be discussed briefly in this section.

Consider the following specification:

$$\begin{aligned} y_t &= E(y_t \mid F_{t-1}) + \varepsilon_t \\ \varepsilon_t &= D_t \eta_t , \end{aligned} \qquad (1)$$

where $y_t = (y_{1t},...,y_{mt})'$, $\eta_t = (\eta_{1t},...,\eta_{mt})'$ is a sequence of independently and identically distributed (iid) random vectors, F_t is the past information available to time t, $D_t = diag(h_{1t}^{1/2},...,h_{m1t}^{1/2})$, m (=15) is the number of tourism source countries, including total tourist arrivals, and t = 1,…,168 monthly observations for the period 1990(1) to 2003(12). The CCC model assumes that the conditional variance for tourist arrivals from source i, h_{it}, $i = 1,...,m$, follows a univariate GARCH process, that is,

$$h_{it} = \omega_t + \sum_{j=1}^{r} \alpha_{ij} \varepsilon_{it-j}^2 + \sum_{j=1}^{p} \beta_{ij} h_{it-j} \qquad (2)$$

where α_{ij} represents the ARCH effects, or the short-run persistence of shocks to tourist source *i*, and β_{ij} represents the GARCH effects, or the contribution of shocks to tourist source *i* to long-run persistence, namely $\sum_{j=1}^{r}\alpha_{ij} + \sum_{j=1}^{p}\beta_{ij}$.

Although the CCC specification in (2) has a computational advantage over other multivariate GARCH models with constant conditional correlations, such as the Vector Autoregressive Moving Average GARCH (VARMA-GARCH) model of Ling and McAleer (2003) and VARMA Asymmetric GARCH (VARMA-AGARCH) model of Chan, Hoti and McAleer (2002), it assumes independence of the conditional variances across tourism sources and does not accommodate the asymmetric effects of shocks.

It is important to note that the conditional correlation for the CCC model is assumed to be constant. As $\Gamma = E(\eta_t\eta_t^{'} \mid F_{t-1}) = E(\eta_t\eta_t^{'})$, the (constant) conditional correlation matrix of the unconditional shocks, ε_t, is equivalent to the (constant) conditional correlation matrix of the standardized shocks, η_t, where $\Gamma = \{\rho_{ij}\}$ for *i*, *j* = 1,…,*m*.

When the number of tourism source countries is set to *m* = 1, such that a univariate model is specified rather than the multivariate model, equations (1)-(2) become:

$$\varepsilon_t = \eta_t\sqrt{h_t}$$
$$h_t = \omega + \sum_{j=1}^{r}\alpha_j\varepsilon_{t-j}^2 + \sum_{j=1}^{s}\beta_j h_{t-j}, \qquad (3)$$

and $\omega > 0$, $\alpha_j > 0$ for *j* = 1,…,*r* and $\beta_j > 0$ for *j* = 1,…,*s* are sufficient conditions to ensure that the conditional variance $h_t > 0$. Using results from Nelson (1990), Ling and Li (1997) and Ling and McAleer (2002a, 2002b), the necessary and sufficient condition for the existence of the second moment of ε_t, that is $E(\varepsilon_t^2) < \infty$, for the case *r* = *s* = 1 is $\alpha_1 + \beta_1 < 1$.

Equation (3) assumes that a positive shock ($\varepsilon_t > 0$) to monthly tourist arrivals has the same impact on the conditional variance, h_t, as a negative shock ($\varepsilon_t < 0$), but this assumption is likely to be violated in practice. In order to accommodate the possible differential impact on the conditional variance between positive and negative shocks, Glosten, Jagannathan and Runkle (1992) proposed the following specification for h_t:

$$h_t = \omega + \sum_{j=1}^{r}\left(\alpha_j + \gamma_j I\left(\varepsilon_{t-j}\right)\right)\varepsilon_{t-j}^2 + \sum_{j=1}^{s}\beta_j h_{t-j} \qquad (4)$$

When $r = s = 1$, $\omega > 0$, $\alpha_1 > 0$, $\alpha_1 + \gamma_1 > 0$ and $\beta_1 > 0$ are sufficient conditions to ensure that the conditional variance $h_t > 0$. The short-run persistence of positive (negative) shocks to monthly tourist arrivals is given by α_1 ($\alpha_1 + \gamma_1$). Under the assumption that the conditional shocks, η_t, follow a symmetric distribution, the average short-run persistence of shocks is $\alpha_1 + \gamma_1/2$, and the contribution of shocks to average long-run persistence is $\alpha_1 + \gamma_1/2 + \beta_1$. Ling and McAleer (2002a) showed that the necessary and sufficient condition for $E(\varepsilon_t^2) < \infty$ is $\alpha_1 + \gamma_1/2 + \beta_1 < 1$.

The parameters in equations (1), (3) and (4) are typically obtained by Maximum Likelihood Estimation (MLE) using a joint normal density for the standardized shocks. When η_t does not follow a joint multivariate normal distribution, the parameters are estimated by Quasi-MLE (QMLE), which is less efficient than MLE. The conditional log-likelihood function is given as follows:

$$\sum_{t=1}^{n} l_t = -\frac{1}{2}\sum_{t=1}^{n}\left(\log h_t + \frac{\varepsilon_t^2}{h_t}\right).$$

Ling and McAleer (2003) showed that the QMLE for GARCH(r,s) is consistent if the second moment is finite, that is $E(\varepsilon_t^2) < \infty$. Jeantheau (1998) showed that the log-moment condition given by

$$E\left(\log\left(\alpha_1\eta_t^2 + \beta_1\right)\right) < 0 \qquad (5)$$

is sufficient for the QMLE to be consistent for GARCH(1,1), while Boussama (2000) showed that the QMLE is asymptotically normal for GARCH(1,1) under the same condition. It is important to note that (5) is a weaker condition than the second moment condition, namely $\alpha_1 + \beta_1 < 1$. However, the log-moment condition is more difficult to compute in practice as it is the expected value of a function of an unknown random variable and unknown parameters.

McAleer, Chan and Marinova (2002) established the log-moment condition for GJR(1,1), namely

$$E\left(\log\left(\left(\alpha_1 + \gamma I\left(\eta_t\right)\right)\eta_t^2 + \beta_1\right)\right) < 0, \qquad (6)$$

and showed that it is sufficient for the consistency and asymptotic normality of the QMLE for GJR(1,1). Moreover, the second moment condition, namely $\alpha_1 + \gamma_1 / 2 + \beta_1 < 1$, is also sufficient for consistency and asymptotic normality of the QMLE for GJR(1,1). In empirical examples, the parameters in (5) and (6) are replaced by their respective QMLE, η_t is replaced by the estimated standardized residuals from the GARCH and GJR models, respectively, for $t = 1,\ldots,n$, and the expected values in (5) and (6) are replaced by their respective sample means.

4. EMPIRICAL RESULTS

Using the monthly data on international tourist arrivals, univariate and multivariate conditional volatility models are estimated for 15 tourism source countries, including total tourist arrivals, for the period 1990(1)-2003(12). As there is a distinct seasonal pattern for each series, twelve seasonal dummy variables are included in the respective conditional mean specifications. The conditional mean of monthly international tourist arrivals, TA_t, is given as:

$$TA_t = \sum_{i=1}^{12} \phi_i D_{it} + \varepsilon_t \qquad (7)$$

where D_{it} = 1 in month i = 1,..,12, and D_{it} = 0 elsewhere.

In addition to estimating the tourist arrivals for each source country, the univariate ARCH(1), ARCH(2), GARCH(1,1) and GJR(1,1) models are used to provide estimates of the volatilities associated with the 14 leading tourism source countries and total tourist arrivals. As the estimated GARCH(1,1) model was always found to be preferable to the ARCH(1) and ARCH(2) models, and also generally superior to the GJR(1,1) model, in what follows the empirical results will be discussed for only the GARCH(1,1) model.

On the basis of the univariate estimates of the standardized residuals, the CCC model is used to estimate the conditional correlation coefficients of the standardized shocks to monthly international tourist arrivals between pairs of tourism source countries. This can provide useful information as to whether particular tourist markets are similar in terms of the shocks to international tourism demand.

All the estimates in this paper are obtained using the Berndt, Hall, Hall and Hausman (BHHH) (1974) algorithm in EViews 4. Virtually identical estimates are obtained from using RATS 6. Several different sets of initial values have been used in each case, but do not lead to substantial differences in the estimates.

4.1 Univariate Models

Estimates of the parameters of the conditional mean are available on request, while the estimates of the conditional variance for the univariate GARCH(1,1) model are presented in Table 1. The conditional mean estimates vary across the 15 tourism source countries, including total tourist arrivals. There is highly significant seasonality in tourist arrivals for each country and each month, except for Finland for the months of May-September inclusive.

Although not reported here, the univariate estimates of the conditional volatility generally suggest that there is little asymmetry, such that positive and negative shocks to monthly international tourist arrivals have similar effects on the volatility in tourism arrivals. Table 1 reports the GARCH(1,1) estimates for tourist arrivals by 15 tourism source countries, including total tourist arrivals. Both the asymptotic and the Bollerslev-Wooldridge (1992) robust t-ratios are reported. In general, the robust t-ratios are smaller in absolute value than their asymptotic counterparts.

The persistence of shocks to the volatility in monthly tourist arrivals is an important aspect of modelling volatility. Total tourist arrivals, as well as tourist arrivals from UK, Ireland and Sweden, have only short run persistence of shocks of about one month. On the other hand, Germany has only long run persistence of shocks, such that shocks to tourist arrivals from Germany do not have an immediate impact but accumulate over several months.

Regarding the regularity conditions of the GARCH(1,1) model, both the log-moment and second moment conditions are satisfied for Austria, Belgium, France, Germany, Italy and Switzerland. Although the log-moment condition could not be calculated for Finland, Norway and Sweden, the second moment condition is satisfied, so that the QMLE are consistent and asymptotically normal. Three interesting results are found for Holland, Ireland and Total, in which the second moment condition is not satisfied, but the log-moment condition is satisfied, so that the QMLE are consistent and asymptotically normal. Only three sets of regularity conditions are not satisfied, namely Denmark, Other and UK, in which the log-moment condition could not be calculated and the second moment condition was not satisfied.

These univariate results suggest that, in general, the GARCH(1,1) model provides an accurate measure of the conditional volatility in international monthly tourist arrivals for the 14 leading source countries, and total tourist arrivals, to the Canary Islands.

4.2 Multivariate Models

Estimates of the constant conditional correlation coefficients for monthly international tourist arrivals by source country, and total tourist arrivals, are given in Table 2. These conditional correlations are calculated using the estimated standardized residuals from the univariate models based on the 15 data sources.

In Table 2, there are a number of high conditional correlations in the standardized shocks, especially between total monthly tourist arrivals and some leading source countries. Of the 14 conditional correlations with total tourist arrivals, of which two are negative, the range is from -0.119 to 0.859, and the highest conditional correlations are with UK, Norway, Ireland, Sweden, Belgium, Denmark, Holland and Germany. With the exception of Finland, the Scandinavian countries have high conditional correlations in standardized shocks with total tourist arrivals. It is surprising that Germany, which is the second most important source of tourist arrivals to the Canary Islands, has the eighth highest conditional correlation in the standardized shocks with total tourist arrivals at 0.696.

Of the 91 possible pairs of conditional correlations between the 14 leading tourist source countries, of which 71 are positive, the ten highest conditional correlations in the standardized shocks hold for the following pairs of countries: (Norway, Sweden), (Denmark, Sweden), (Denmark, Norway), (Norway, UK), (Belgium, UK), (Ireland, UK), (Sweden, UK), (Belgium, Germany), (Ireland, Norway) and (Belgium, Norway), with the highest being 0.782 and the lowest 0.648. The conditional correlations vary from a low -0.277 to a high 0.782. The UK and three of the four Scandinavian countries have high conditional correlations in the standardized shocks to tourist arrivals, with Belgium, Ireland and Germany also having some high conditional correlations. On the other hand, Italy and Finland have very low conditional correlations in the standardized shocks with all countries.

5. ACKNOWLEDGMENTS

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6. REFERENCES

Berndt, E.K., B.H. Hall, R.E. Hall and J.A. Hausman (1974), "Estimation and inference in nonlinear structural models", *Annals of Economic and Social Measurement*, 3, 653-665.

Bollerslev, T. (1986), "Generalised autoregressive conditional heteroscedasticity", *Journal of Econometrics*, 31, 307-327.

Bollerslev, T. (1990), "Modelling the coherence in short-run nominal exchange rates: A multivariate generalized ARCH approach", *Review of Economics and Statistics*, 72, 498-505.

Boussama, F. (2000), "Asymptotic normality for the quasi-maximum likelihood estimator of a GARCH model", *Comptes Rendus de l'Academie des Sciences*, Serie I, 331, 81-84 (in French).

Chan, F., S. Hoti and M. McAleer (2002), "Structure and asymptotic theory for multivariate asymmetric volatility: Empirical evidence for country risk ratings", paper presented to the 2002 Australasian Meeting of the Econometric Society, Brisbane, Australia, July 2002.

Engle, R.F. (1982), "Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation", *Econometrica*, 50, 987-1007.

Glosten L., R. Jagannathan and D. Runkle (1992), "On the relation between the expected value and volatility of nominal excess return on stock", *Journal of Finance*, 46, 1779-1801.

Jeantheau, T. (1998), "Strong consistency of estimators for multivariate ARCH models", *Econometric Theory*, 14, 70-86.

Ling, S. and W.K. Li (1997), "On fractionally integrated autoregressive moving-average models with conditional heteroskedasticity", *Journal of the American Statistical Association*, 92, 1184-1194.

Ling, S. and M. McAleer (2002a), "Stationarity and the existence of moments of a family of GARCH processes", *Journal of Econometrics*, 106, 109-117.

Ling, S. and M. McAleer (2002b), "Necessary and sufficient moment conditions for the GARCH(r,s) and asymmetric power GARCH(r,s) models", *Econometric Theory*, 18, 722-729.

Ling, S. and M. McAleer (2003), "Asymptotic theory for a vector ARMA-GARCH model", *Econometric Theory*, 19, 278-308.

McAleer, M., F. Chan and D. Marinova (2002), "An econometric analysis of asymmetric volatility: Theory and application to patents", paper presented to the Australasian meeting of the Econometric Society, Brisbane, Australia, July 2002, to appear in *Journal of Econometrics*.

Nelson, D.B. (1990), "Stationarity and persistence in the GARCH(1,1) model", *Econometric Theory*, 6, 318-334.

Table 1: GARCH(1,1) Estimates

Country	ω	α	β	Log-Moment	2nd Moment
Austria	69277	0.30	0.69	-0.06	0.99
	0.76	2.12	6.71		
	1.48	3.89	10.50		
Belgium	564564	0.06	0.84	-0.11	0.90
	1.40	0.80	7.28		
	2.13	1.57	1.36		
Denmark	2119905	1.34	-0.03	N.C.	1.30
	1.73	4.70	-0.71		
	5.24	41.12	-9.80		
Finland	11673741	0.93	-0.06	N.C.	0.87
	4.72	5.32	-21.87		
	3.86	2.70	-0.85		
France	688185	0.35	0.61	-0.13	0.96
	1.34	2.78	4.86		
	2.85	5.96	13.15		
Germany	17930932	0.16	0.78	-0.08	0.94
	0.87	1.76	5.29		
	0.93	1.17	5.35		
Holland	1864	1.21	0.22	-0.03	1.43
	0.38	4.09	2.03		
	1.83	9.81	14.80		
Ireland	2674	1.02	0.32	-0.01	1.33
	0.29	3.67	2.28		
	1.26	3.82	2.38		
Italy	269723	0.08	0.87	-0.06	0.95
	1.92	1.58	18.15		
	2.04	2.59	64.76		
Norway	14201937	0.94	-0.14	N.C.	0.80
	2.50	5.24	-1.01		
	3.26	2.49	-1.74		
Other	1733949	1.23	-0.03	N.C.	1.20
	3.12	4.24	-7.60		
	5.35	25.07	-1.18		
Sweden	18004013	1.04	-0.16	N.C.	0.88
	3.33	3.09	-2.11		
	3.85	3.84	-3.02		
Switzerland	381806	0.38	0.61	-0.09	0.99
	1.27	2.02	4.04		
	0.46	7.26	19.75		
UK	47863434	1.12	-0.08	N.C.	1.03
	1.60	2.88	-0.73		
	1.59	2.58	-0.47		
Total	187968694	1.10	0.06	-0.17	1.16
	2.17	2.47	2.95		
	1.13	3.04	0.38		

Table 2: Constant Conditional Correlations

Country	Austria	Belgium	Denmark	Finland	France	Germany	Holland	Ireland	Italy	Norway	Other	Sweden	Switzerland	UK	Total
Austria	1.000	0.335	0.252	0.146	0.606	0.506	0.364	0.280	0.180	0.279	0.337	0.217	0.463	0.233	0.327
Belgium		1.000	0.634	0.231	-0.041	0.656	0.589	0.577	-0.031	0.648	0.328	0.642	0.059	0.679	0.727
Denmark			1.000	0.372	-0.120	0.576	0.559	0.623	-0.214	0.773	0.335	0.779	0.039	0.646	0.722
Finland				1.000	-0.084	0.259	0.165	0.241	-0.248	0.241	-0.036	0.318	0.111	0.227	0.337
France					1.000	0.166	0.051	-0.075	0.238	-0.092	0.155	-0.103	0.469	-0.171	-0.086
Germany						1.000	0.475	0.537	0.023	0.515	0.454	0.578	0.237	0.552	0.696
Holland							1.000	0.627	-0.060	0.627	0.346	0.544	0.175	0.613	0.708
Ireland								1.000	-0.277	0.654	0.393	0.558	0.135	0.667	0.757
Italy									1.000	-0.250	-0.059	-0.196	0.139	-0.187	-0.199
Norway										1.000	0.295	0.782	-0.046	0.755	0.789
Other											1.000	0.281	0.204	0.410	0.462
Sweden												1.000	-0.053	0.661	0.735
Switzerland													1.000	-0.001	0.106
UK														1.000	0.859
Total															1.000