Volatility analysis of international tourist arrivals to Sri Lanka using GARCH models

A. G. S. Shanika[a]*, A. Jahufer[b]

Department of Mathematical Sciences, Faculty of Applied Sciences,
South Eastern University of Sri Lanka

([a]samoshi112@gmail.com, [b]jahufer@seu.ac.lk)

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Introduction

The main objective of this research study is to fit generalized autoregressive conditional heteroscedastic (GARCH) models for the international tourist arrivals to Sri Lanka and check the volatility.

Sri Lanka is an island country located off the southern coast of India. Sri Lanka is surrounded by the Indian Ocean, Gulf of Mannar, the Pak Strait, and lies in the vicinity of India and the Maldives. Tourism has traditionally been the third foreign exchange earner in Sri Lanka.

Europe countries to be the largest source of tourist traffic to Sri Lanka recording a share of 46.4%. Asia Pacific is the second major source market with a share of 43.9% (Tourism Industry Report, 2019). Volatility analysis for international tourist arrival was studied by [1-3]. This paper analyzed the volatility of international tourist arrivals in Sri Lanka using GARCH, GJR-GARCH and EGARCH model and compare the volatility among monthly, quarterly and annually arrivals using monthly time series data from 1970 January to 2019 December are obtained from "Sri Lanka Tourism Development Authority".

Methodology

1. Unit root tests. To test the stationarity of a series is the unit root test. This paper model used ADF test and Phillips-Perron test to test the stationarity, used both tests to increase the accuracy.

2. Conditional volatility models. The Generalized ARCH(GARCH) model in which conditional variance is also a linear function of its own lags and has the following form and to be stationarity $\alpha + \beta < 1$,

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \qquad (1)$$

The 'GJR' stands for Glosten, Jagannathan, and Runkle. It is an asymmetric GARCH model. This means it allows for the variance to react differently depending on the sign or size of the shock it receives. The GJR model to be stationarity $\alpha + \frac{1}{2}\gamma + \beta < 1$. The GJR model is given as:

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \left[\alpha_i + \gamma_j I, \varepsilon_{t-i>0.1}\right] \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j} \qquad (2)$$

The EGARCH model can be represented in the logarithm of conditional variance as:

$$\log(\sigma_t^2) = \omega + \sum_{i=1}^{q} \left(\alpha_i \left| \frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}} \right| + \gamma_i \frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}} \right) + \sum_{j=1}^{p} \beta_j \log(\sigma_{t-j}^2) \qquad (3)$$

Results and Discussion

1. Unit root tests. To study the stationary of the variables Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests are used and results are reported in Table 1.

Table 1. The result of unit root tests.

	ADF level	1st difference	PP level	1st difference
Monthly arrivals	0.9558	0.0000***	0.6886	0.0000***
Quarterly arrivals	0.9794	0.0013***	0.0200	0.0001***
Annually arrivals	1.0000	0.0000***	0.9501	0.0000***

Notes:***denotes the null hypothesis of a unit root is rejected at the 5%significance level

From the above table it can be said that at 5% level ADF and PP test results are significant. In general, a p-value of less than 0.05 means we can reject the null hypothesis that there is the series are stationary. All the probability values are less than 0.05 so, reject the null hypothesis, Therefore, the series are stationary at first difference.

2.Volatility model. The monthly international tourist arrivals in Sri Lanka from 1970 January to 2019 December are given in Figure 1. The largest number of tourists have arrived in 2018 December and the smallest number of tourists have arrived in 1971 May.

Volatility clusters exist in Monthly, Quarterly and Annually are shown in figure 2.

3. GARCH (1, 1), GJR (1, 1) and EGARCH (1, 1) models. The GARCH (1, 1), GJR (1, 1) and EGARCH (1, 1) models are estimated using QMLE for the case p=q=1 and results are given in Tables 3 to 5.

4. Fitting of GARCH model. The estimated GARCH (1, 1) equation for monthly tourist arrivals is given as follows:

$$\sigma_t^2 = 1.44E{+}08 + 0.707\, \varepsilon^2_{t-1} + 0.089\, \sigma^2_{t-1}$$

The above model shows the short run persistence lies at 0.707, while the long run persistence lies at 0.796. In the monthly tourist arrivals, the respective estimate of the second moment conditions $\alpha_1+\beta_1 < 1$ for GARCH (1, 1) are satisfied and the QMLE are consistent and asymptotically normal. But quarterly and annually arrivals not satisfied the second moment condition.

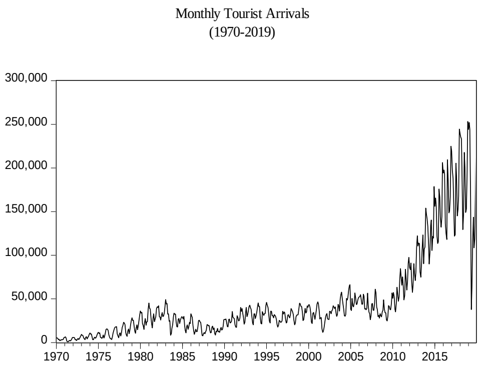


Figure 1. Monthly international tourist arrivals in Sri Lanka from 1970 to 2019.

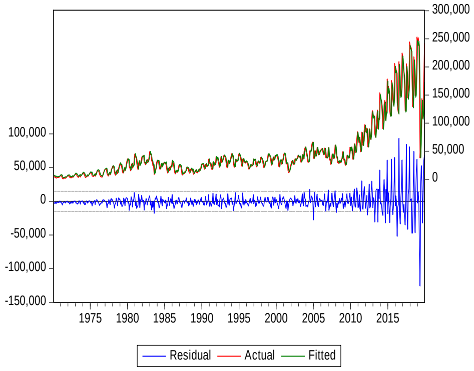
5. Fitting of GJR-GARCH model. The estimated GJR-GARCH (1,1) equation for monthly tourist arrivals is given as follows:

$$\sigma_t^2 = 1.43E{+}08 + 0.164\, \varepsilon^2_{t-1} - 1.182\, I\varepsilon^2_{t-1} + 0.122\, \sigma^2_{t-1}$$

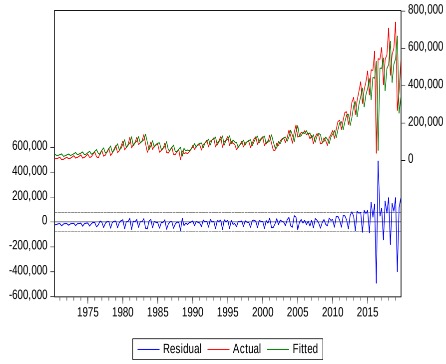
Table 2. Descriptive statistics (International tourist arrivals in Sri Lanka from 1970 to 2019).

Statistics	Monthly arrivals (1970-2019)	Quarterly arrivals (1970-2019)	Annually arrivals (1970-2019)
Mean	46361.50	137220.7	536530.3
Median	30819.00	92481.00	386656.5
Maximum	253169.0	740600.0	2333796.
Minimum	952.0000	3452.000	39654.00
Std.Dev.	50336.79	147701.8	549834.4
Skewness	2.158909	2.093363	2.016308
Kurtosis	7.299688	6.839962	6.218382
Jarque Bera	928.6604	268.9499	55.45827
Probability	0.000000	0.000000	0.000000

Monthly



Quarterly



Annually

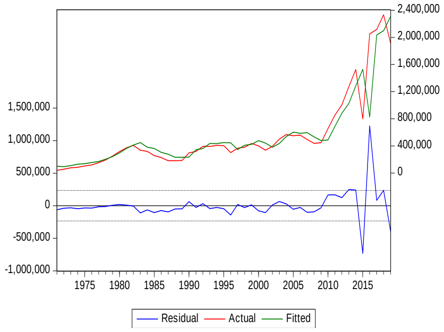


Figure 2. Volatility clusters.

Table 3. Estimated GARCH (1, 1) model.

	GARCH		
Parameters	Monthly arrivals	Quarterly arrivals	Annually arrivals
ω	1.44E+08***	26144315	5.56E+08
	(15639550)	(23962789)	(7.08E+08)
α	0.707***	0.474***	0.562**
	(0.106)	(0.180)	(0.235)
β	0.089***	0.586***	0.534**
	(0.032)	(0.136)	(0.239)
Second moment	0.796	1.06	1.096
AIC	21.698	23.720	25.800
BIC	21.735	23.802	25.994
Jarque Bera	8.628	21.364	1.978
P value	0.013	0.000	0.372

Notes: Numbers are parentheses are standard error. AIC and BIC denote the Akaike Information Criterioand Schwarz Criterion, respectively; *** denotes the estimated coefficient is statistically significant at 1%. **denotes the estimated coefficient is statistically significant at 5%. * denotes the estimated coefficient is statistically significant at 10%.

Table 4. Estimated GJR (1, 1) model.

	GJR		
Parameter	Monthly arrivals	Quarterly arrivals	Annually arrivals
ω	1.43E+08***	3.73E+09***	4.14E+08
	(15700109)	(7.32E+08)	(5.75E+08)
α	0.164*	1.594*	0.528**
	(0.099)	(0.832)	(0.389)
β	0.122***	-0.002	0.522
	(0.028)	(0.024)	(0.228)
γ	1.118***	-1.361	0.242
	(0.306)	(0.897)	(0.728)
Second moment	0.286	1.592	0.764
AIC	21.670	24.618	25.817
BIC	21.714	24.718	26.049
Jarque Bera	19.613	4.381	2.115
	0.000	0.111	0.347

Notes: Numbers are parentheses are standard error. AIC and BIC denote the Akaike Information Criterion and Schwarz Criterion, respectively; *** denotes the estimated coefficient is statistically significant at 1%. **denotes the estimated coefficient is statistically significant at 5%. * denotes the estimated coefficient is statistically significant at 10%.

Table 5. Estimated EGARCH (1, 1) model.

	EGARCH		
Parameter	Monthly arrivals	Quarterly arrivals	Annually arrivals
ω	-0.102**	-0.064	29.217***
	(0.041)	(0.595)	(4.308)
α	0.132***	0.494***	1.728***
	(0.035)	(0.157)	(0.327)
γ	0.066	0.212*	-0.262*
	(0.0411)	(0.188)	(0.197)
β	1.000***	0.983***	0.320*
	(0.002)	(0.032)	(0.183)
AIC	20.479	23.678	26.152
BIC	20.522	23.777	26.384
Jarque Bera	7.097	25.416	4.321
P value	0.028	0.000	0.115

Notes: Numbers are parentheses are standard error. AIC and BIC denote the Akaike Information Criterion and Schwarz Criterion, respectively; *** denotes the estimated coefficient is statistically significant at 1%. **denotes the estimated coefficient is statistically significant at 5%. * denotes the estimated coefficient is statistically significant at 10%.

The above model shows the asymmetry coefficient is found to be positive and significant, namely 0.164 which indicates that decreases in monthly international tourist arrivals to Sri Lanka increase volatility, and namely 0.528 which indicates that decreases in annually international tourist arrivals to Sri Lanka increase volatility. As the respective estimates of the second moment conditions, $\alpha_1+\frac{1}{2}\gamma_1+\beta_1 < 1$ for GJR-GARCH (1, 1). In monthly tourist arrivals long run persistence lies at 0.286 and in annually tourist arrivals long run persistence lies at 0.764 thus, second moment conditions for GJR-GARCH (1,1) are satisfied for monthly and annually tourist arrivals. In monthly tourist arrivals, as γ_1 is estimated significant and $\alpha_1+\gamma_1> \alpha_1$, volatility is affected asymmetrically.

6. Fitting of EGARCH model. The estimated EGARCH (1,1) equation for annually tourist arrivals is given as follows:

$$\log(\sigma_t^2) = 29.217 + 1.728\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| - 0.262\,\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.320\log(\sigma_{t-1}^2)$$

EGARCH (1,1) estimates statistically significant for annually arrivals, with the size of effect α=1.728 being positive which shows there is a positive relation between past variance and current variance in absolute value. This means the bigger the magnitude of the shock to the variance, then higher the volatility. γ =-0.262 being negative which indicates that bad news will increase volatility more than good news of the same size evidence of leverage effect $\gamma<0$ it implies that bad news generates larger volatility. The coefficient of the lagged dependent variable β, is estimated to be 0.320, which suggest that the statistical properties of the QMLE for EGARCH (1, 1) will be consistent and asymmetrically normal.

Conclusion

Models GARCH (1, 1) and GJR-GARCH (1, 1) are statistically significant for monthly arrivals and QMLE are consistent and asymptotically normal. The model EGARCH (1, 1) is statistically significant for annually arrivals data and QMLE are consistent and asymptotically normal. According to the GJR-GARCH model 0.164 decrease in international tourist arrivals to Sri Lanka increase volatility. The models GARCH (1, 1) and GJR-GARCH (1, 1) are conditional volatility in the international tourist arrivals to Sri Lanka and sensitive to the long memory nature. Moreover, EGARCH (1, 1) model is conditional volatility and sensitive to the short memory nature.

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