

# A Model for Caribbean Tourism Demand Volatility

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# Summary

- This paper, focuses on the application of ARCH, GARCH and MGARCH processes to the integrative utility maximization model developed.
- It derived the time varying movement of demand amongst the markets as well as the cross volatility spillover effects.

- The ARCH and MGARCH models with the lowest Theil inequality coefficient were found to be the most efficient in explaining and forecasting tourist arrivals when compared to the other univariate and multivariate models, respectively.
- The countries showing the highest own market volatility were the Dominican Republic, The Bahamas, and Saint Vincent and the Grenadines followed by Grenada. On the other hand, Antigua and Barbuda, Anguilla, Aruba, The Cayman Islands and Jamaica had the highest long-run volatility persistence after an unexpected shock.
- Using asymmetric models process, the paper found that with most markets negative shocks increase volatility, and have a greater impact than positive shocks.

# Content

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# Reason for Study

- The empirical literature on the volatility of tourism demand has been receiving increasing attention, with emphasis being placed on modelling volatility attributed to changes in economic activity, climate, natural and man-made disasters
- Limited evidence exists in the literature where GARCH is employed as a forecasting tool for tourist arrivals

- For the Caribbean, the research has followed the same basic direction, having examine the volatility of tourism demand to determine its co-movement and whether there are spill-over effects among destinations or regions.
- However, all of these authors did not include any analysis of multiple crises, events or the impact of return visitors on arrivals to these markets.

# What approach was used

- Model:
  - An integrative utility maximization model which incorporated both qualitative and quantitative variables was used.
  - The most frequently used models that measure conditional and unconditional volatility are the univariate Markov switching process as well as the ARCH, GARCH, TGARCH, EGARCH and CGARCH specifications .
  - This study considered these models along with their multivariate counterparts - MS-VAR and MGARCH processes - to determine which set up fits the data best.

- Econometric method:
  - Focus on the application of ARCH, GARCH and MGARCH processes to the integrative model, the study derived the time varying movement of demand amongst the markets, as well as the cross volatility spill over effects.
  - This approach has the following advantages over the alternative MS and MS-VAR conditional variance models which are also estimated and forecasted for comparative purposes:
    - (i) more accurate confidence intervals can be derived, and (ii) more efficient estimators can be obtained if heteroskedasticity in the errors are handled properly.
  - In summary, the empirical conditional variance models will assess, as in, the impact of repeat or return visitors on current tourism demand, the effect of seasonal and multiple crises/special events on tourism flows, the influence of qualitative factors, a wide cross section of countries or markets with a history of differing cultural influences, plus the forecasting performances of the various conditional variance models.



- The application of the conditional variance models involves the following steps:
  - The first step in the methodology is to deseasonalise the series.
  - After seasonally adjusting the series, the panel unit root tests are employed to check the properties of the variables.
  - This is followed by utilising the correlogram to investigate the autoregressive characteristics of the variables.
  - Next, applying the Maximum Likelihood method, the conditional variance models are estimated to explore the effects of economic shocks and volatility on the observed mean values of the variables, as well as to test for the presence of persistence of volatility in the variances and to undertake forecasts of volatility.
  - To specify the unknown conditional distributions the unconditional distributions (standardised on their means) are compared with commonly used distributions such as the normal and  $t$ , employing the quantile plots found in EVIEWS 6.1.
    - This provides a first sense of the nature of the conditional distribution.

- Data:
  - Briefly they cover the quarterly period 1999Q1 to 2009Q4 for seventeen developing markets and were obtained from the Caribbean Tourist Organisation Statistical Department in March and September 2010.
  - The dependent variable is tourist arrivals (TA ) and the independent variables that enters the mean equations are:
    - Past visitors (TA )
    - Return visitors (R )
    - Relative prices between destination market and primary source markets (CPI )
    - Per capita GDP (Y )
    - International oil prices times distance from major cities of the source markets as a proxy for transportation cost (TC )
    - Special events or crises represented by dummy variables (DUM ).
  - The qualitative factors: population size (source markets) (POP ), and internet usage – destination market (IU ) as a measure of communication.

# What is different

- First study to:
  - Use GARCH and MS processes to forecast long stay arrivals
  - Included analysis on return visitors, special events or multiple crises in determining the co-movement of tourist arrivals.
  - To factor the influence of qualitative variables on tourist flows.
  - Adequately compare forecasting performances of conditional volatility models such as ARCH, GARCH, MS, MGARCH and MS-VAR processes.

# Results and Implications

- Univariate Results: ARCH, GARCH and MS Processes.
  - The findings from estimating the various univariate conditional variance models indicate that in most cases, a significant ARCH (1) and GARCH (1, 1) process with the errors following mainly a generalised error distribution were revealed.
  - The R-square of all the models are reasonably high and the correlogram Q-statistics, using lag lengths of up to 10, indicate no significant amount of serial correlation

- The covariance stationarity property is upheld, as judged by the sum of the lagged squared errors and the lagged variance terms being less than one.
- The Bahamas (0.98), Saint Vincent and the Grenadines (0.96), Dominica (0.82) and Trinidad and Tobago (0.80), showed the highest volatility persistence.

- The estimation of the tourism series with the ARCH models and its variants include a set of qualitative and quantitative as well as a volatility component in the mean equation as arrivals displayed changes to unexpected shocks.
- The own volatility spill-over (ARCH) coefficients are highest for The Bahamas, Barbados, the Dominican Republic, Dominica, Curacao, Grenada and Saint Vincent and the Grenadines, ranging from 0.77 for the Dominican Republic to 0.19 for Curacao.
- Within the Windward Islands (Grenada (0.24), Saint Vincent and the Grenadines (0.28) and Dominica (0.22)) had relatively large own volatility movements in demand.
- Volatility persistence (GARCH) coefficients are of greatest concern to Anguilla, Antigua and Barbuda, Aruba, The Bahamas, the Cayman Islands, Dominica, the Dominican Republic, Saint Maarten, and Jamaica with several markets showing long-run effects after a shock.
- The coefficients of Anguilla, Aruba, the Cayman Islands and Jamaica were around 0.87 with Antigua and Barbuda having the highest of 0.89 while the lowest was seen in The Bahamas and the Dominican Republic (0.75).

- The asymmetric effects from the EGARCH and TGARCH models, which showed that negative shocks increase volatility and have a greater influence than positive shocks, were prominent for Aruba, the Dominican Republic, The Bahamas, Jamaica, Barbados, Bermuda, the Cayman Islands, Grenada, St Maarten and Saint Vincent and the Grenadines.
- With significant coefficients of -0.34,-0.68 and -0.80 for Aruba, Grenada and the Cayman Islands respectively, this indicates that negative shocks raise volatility in these markets.
- In Anguilla, Antigua and Barbuda, Saint Lucia, Dominica, Puerto Rico, Curacao and Trinidad and Tobago, positive shocks advance volatility and these effects on conditional volatility are greater than the negative shocks.
- Trinidad and Tobago has the highest positive shock coefficient of 2.52, followed by Anguilla, 0.80, and St. Lucia, 0.17, implying that positive events push volatility above the value recorded from negative unexpected shocks.

- Using the CGARCH process the following markets are seen to have a fairly rapid speed of adjustment to equilibrium after a shock (approximately two periods): Dominica (0.52) and The Dominican Republic (0.72).
- The markets that depict the slowest mean reversion speed were Antigua and Barbuda, Puerto Rico, Barbados and Trinidad and Tobago.
- For the univariate MS specification, the mean convergences are checked through the closeness of the autoregressive (AR) coefficients to unity, along with the transitional probabilities of the regimes in switching from one state of nature to another.
- From the results of the MS model the markets with the highest mean reversion coefficients were the Dominican Republic (0.95), Dominica (0.85), Jamaica (0.70), Anguilla (0.67) and Saint Lucia (0.65), indicating that adjustment to long-run equilibrium will take place within one quarter.
- These results seem comparable to the CGARCH model which found Dominica and the Dominican Republic with the fastest mean convergence.
- The lowest adjustment to equilibrium was recorded in The Bahamas (0.32), Aruba (0.35) and Curacao (0.39).



- Examining the transitional probabilities which deals with movement from a period of downturn to one of normal growth, Trinidad and Tobago (0.4590) led the way followed by Dominica (0.4078), Puerto Rico (0.3895) and Jamaica (0.3790).
- The markets with the lowest transit probabilities were The Bahamas (0.0387), Curacao (0.0589) and Grenada (0.0457), implying that policy makers in these markets would need additional efforts and resources to return these markets to normal growth.

- Forecasting performances of ARCH, GARCH and MS models:
  - The forecasting performance of the various conditional variance models is assessed with the Theil inequality coefficient, which is considered the best for analysing forecast efficiency on the same variables across different models.
  - The results show that the ARCH models provided the best within sample forecast, for the majority of markets, followed by CGARCH and the simple GARCH process.
  - The findings from the MS model displayed weaker forecasting performance for most markets except the Bahamas (0.065) and Trinidad and Tobago (0.07).
  - Countries with a higher rate of own volatility (ARCH effects) and volatility persistence (GARCH impacts) performed poorly in the forecast, namely Saint Vincent and the Grenadines, the Cayman Islands, Anguilla, Grenada and Dominica.

- Forecasting performances of ARCH, GARCH and MS models
  - Using a dynamic forecast of various time horizons (4, 6 and 8) the Theil inequality coefficients were compared across the different models per markets.
  - The ARCH model gave the best within sample forecast results followed by the GARCH and EGARCH specifications while horizon 4 provided the most accurate result.

- The MGARCH and MS-VAR Models:
  - To appropriately model the conditional variance and the covariance of the error terms across markets in an autoregressive form, the MGARCH and MS-VAR models are utilised.
  - The error distribution of the series is tested against either the multivariate normal or student's t distribution of the residuals, in order to determine the nature of the conditional distribution, after completing the preliminary steps in the estimation procedure.
  - In most cases the estimation procedure revealed a significant MGARCH process with the errors following mostly a multivariate normal distribution.
  - The covariance stationarity property is satisfied, as evidenced by the sum of the lagged squared errors and the lagged variance terms being less than one.
  - The R-square of all the models are quite reasonable along with the Portmanteau tests which indicate no significant amount of autocorrelation.

- Note due to the relatively small degrees of freedom the complete seventeen MGARCH equations could not be estimated, so the tests were done in groups, that is, the markets were categorised according to proximity, colonial affiliation, language and cultural associations:
  - (A) The Bahamas, Barbados, The Cayman Islands and Jamaica (the largest English speaking destination markets)
  - (B) Dominica, St. Vincent and the Grenadines, St. Lucia, Grenada (Windward Islands markets (a))
  - (C) Barbados, St. Lucia and Grenada (Windward Islands markets (b))
  - (D) Anguilla, Antigua and Barbuda and Bermuda (Leeward Islands markets)
  - (E) Aruba, Curacao and St. Maarten (Dutch Islands markets)
  - (F) Dominican Republic and Puerto Rico (Spanish Islands markets)
- The results of the groups showed evidence of own volatility (ARCH) and volatility persistence (GARCH), confirming the previous results above.
- However there was no support for short-run cross over spill-over effects among the markets in Group A, but The Bahamas, The Cayman Islands and Jamaica all displayed statistically significant cross over spill-over influences in the long-run.
- The findings from Group B revealed statistically significant short and long-run cross spill-over impacts between Dominica and Saint Vincent and the Grenadines, thus indicating that shocks to arrivals in one market affects the other market.

- There was significant short-run cross spill-over effects between Barbados and Grenada in Group B, and long-run cross spill-over influences in all three markets - Barbados, Grenada and Saint Lucia - in Group C, while Anguilla, Antigua and Barbuda, Bermuda, Aruba, Curacao, and Saint Maarten revealed similar long-run impacts in Groups D and E.
- For group F, there was no evidence of short and long-run cross over spill-over impacts.
- The multivariate model was forecasted to obtain the Theil inequality coefficient for the six groups. The results showed that Group E (Aruba, Curacao and St. Maarten) had the best forecast of 0.038, followed by Group A (The Bahamas, Barbados, The Cayman Islands and Jamaica) of 0.0495, Group F (Dominican Republic and Puerto Rico) and Group C (Barbados, St Lucia and Grenada).
- Comparing the generated Theil inequality to the MS-VAR and simple average individual forecast coefficient, the MGARCH was found to be the most efficient estimator with more accurate forecasts.

- Using the MS-VAR model, which was well specified with residual tests showing no evidence of serial correlation, heteroskedasticity, parameter constancy and non-normality, checks were done on the recovery process of the 17 Caribbean markets by allowing the growth rate in arrivals in a downturn to be different from a normal period.
- The results of the transitional probabilities showed how the model will move from one state of nature to another. To determine the mean reversion speed after a shock the sum of the autoregressive (AR) coefficients was examined, the closer they are to unity the faster is mean convergence.
- The results showed that there is a 9.8% probability to move from normal growth into downturn, but it was difficult to get out of a downturn with a probability of less than 15% (0.148%) each quarter.
- Implications from this finding are that additional efforts and resources will be required to move the economy back to normal growth after a downturn.
- The sum of the autoregressive (AR) coefficients revealed strong evidence of mean convergence (0.723).
- This result while similar to previous findings for the Dominican Republic and Dominica, indicate that Jamaica, Saint Lucia and Anguilla have high AR coefficients.

# Conclusion

- This essay critically evaluates the literature on the volatility of tourism demand, especially as it pertains to the Caribbean region with the objective of producing models and forecasts that rectify the major problems highlighted in the literature.
- ARCH, GARCH, MS, MS-VAR and MGARCH processes are estimated to derive short-run estimates of own market volatility, volatility persistence in the long-run, and cross spill-over short and long-run effects in the markets.
- The results showed the markets displaying the highest own market volatility are Dominican Republic (0.77), The Bahamas (0.36), and Saint Vincent and the Grenadines (0.28), followed by Grenada (0.24). Antigua and Barbuda (0.89), and Anguilla, Aruba, The Cayman Islands and Jamaica (all 0.87) revealed the highest long-run volatility persistence after an unexpected shock.
- In assessing the asymmetric models using EGARCH and TGARCH processes, the paper found that with most markets negative shocks increase volatility, and had a greater impact than positive shocks.
- For Anguilla, Antigua and Barbuda, Dominica, Puerto Rico, Saint Lucia, Curacao and Trinidad and Tobago positive shocks were greater than negative shocks and they increased volatility in these markets.



- There was similarity of results between the MS model and CGARCH as Dominica and the Dominican Republic had the fastest mean convergence results.
- In addition to these markets the MS model found Jamaica (0.70), Anguilla (0.67) and Saint Lucia (0.65) with autoregressive coefficients close to unity.
- The transitional probabilities showed that Trinidad and Tobago (0.4590) and Dominica (0.4078) were the quickest markets to switch to normal growth after a downturn within a quarter.
- The forecasting performance of the conditional variance models are compared to each other using several selection criteria.
- ARCH models were found to be the most efficient in forecasting, while markets with high levels of volatility persistence provided the weakest forecast accuracy.
- The forecasting performance of the multivariate models (MGARCH and MS-VAR) were compared and with a Theil inequality coefficient of 0.038 (Aruba, Curacao and St. Maarten) had the best forecast.
- The cross spill-over effects of the markets were assessed with the MGARCH models, which provided short and long-run effects.