Appendix 1. Granger causality test

This section aims to identify causal relationships between time series that are useful in forecasting.

Causality implies that the estimated future values of a time series variable are affected by the past values of another related time series variable.[28] According to Granger (1969), causality refers to the relationship between X and Y in the presence of two variables. If the prediction of variable X is better than the prediction based only on lagged values of X, then variable Y is a Granger cause of X.[29] The formulae used for the Granger causality test are given in equations 1 and 2.

$$X_t = \sum_{i=1}^{m} a_i X_{t-i} + \sum_{j=1}^{m} \beta_j Y_{t-j} + \lambda_1 t + u_{1t} \quad (1)$$

$$Y_t = \sum_{i=1}^{m} \gamma_i Y_{t-i} + \sum_{j=1}^{m} \delta_j X_{t-j} + \lambda_2 t + u_{2t} \quad (2)$$

In equations 1 and 2, t is the time variable, and u_1t and u_2t are the error terms. u_1t and u_(2t) are assumed to be uncorrelated.

In equation 2, if δj is different from zero, it can be stated that there is a Granger causality relationship from X to Y. If βj coefficients are significantly different from zero, it can be stated that there is a Granger causality relationship from Y to X. The null hypothesis in the Granger causality test is "X is not a Granger Cause of Y".[30]

In the Granger causality test, the null hypothesis is "independent variables are not Granger causes of the dependent variable," while the alternative hypothesis is "independent variables are Granger causes of the dependent variable".[28] The null hypotheses for this study were as follows; "CO is not a Granger cause of asthma. SO_2 is not a Granger cause of asthma. PM_{10} is not a Granger cause of asthma. CO is not a Granger cause of COPD. SO_2 is not a Granger cause of COPD. PM_{10} is not a Granger cause of COPD. CO is not a Granger cause of pneumonia. SO_2 is not a Granger cause of pneumonia. PM_{10} is not a Granger cause of pneumonia. CO is not a Granger cause of bronchitis. SO_2 is not a Granger cause of bronchitis. PM_{10} is not a Granger cause of bronchitis. CO is not a Granger cause of URTI. SO_2 is not a Granger cause of URTI. PM_{10} is not a Granger cause of URTI."