

A comparative analysis to forecast carbon dioxide emission in Sri Lanka

K. D. Madhubhashani, R. A. B. Abeygunawardana

Department of Statistics, Faculty of Science, University of Colombo, Sri Lanka

Most of the blame for the warming or change in climate is believed to be due to the increased concentration of the gaseous substance carbon dioxide (CO₂) in our atmosphere. This study aims to forecast annual CO₂ emissions in Sri Lanka, considering socioeconomic and energy related factors. Secondary data from the World Bank Open Data Source were utilized, including annual CO₂ emissions, total population, Gross Domestic Product (GDP) per capita, electricity production from oil, gas and coal sources, energy use and CO₂ intensity per energy consumption in Sri Lanka from 1971 - 2014. The dataset was split into a training period from 1971–2004 for model fitting and a testing period from 2005–2014 for out of sample validation. Among the explanatory variables, only the population data was log-transformed to stabilize variance and linearize its relationship with CO₂ emissions, as it exhibited exponential growth over time. The ARIMA model was developed using only CO₂ emissions data, while the ARIMAX model incorporated exogenous variables. Several model selection criteria such as Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) were applied to determine the best fitting models. The stationarity test was conducted using the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski Phillips Schmidt Shin test (KPSS) which confirmed the non-stationary nature of the CO₂ series, and exhibited a strong upward trend without seasonality. Among the tested models, ARIMA (2,2,3) and ARIMAX (2,0,2) with Log (Population), GDP per capita and CO₂ intensity were identified as the most suitable for forecasting. RMSE, AIC, BIC and MAPE of ARIMA (2,2,3) are 581.10, 674.05, 684.48 and 6.62 respectively and RMSE, AIC, BIC and MAPE of ARIMAX (2,0,2) are 350.92, 665.42, 681.48 and 3.99 respectively. Comparative analysis showed that the ARIMAX model outperformed the ARIMA model in terms of predictive accuracy, indicating that incorporating exogenous factors significantly improves forecasting performance. This study highlights the importance of time series modeling for environmental forecasting and provides valuable insights to manage carbon emissions in Sri Lanka.

Keywords: *Carbon dioxide emission, ARIMA, ARIMAX, RMSE, MAPE*