Econometric modelling of carbon dioxide emissions and concentrations, ambient temperatures and ocean deoxygenation

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Abstract

This paper analyzed several longitudinal data sets for investigating the dynamic inter-relationships between CO_2emissions and atmospheric concentrations, ambient temperatures, and ocean acidification and deoxygenation. The methodological framework addressed issues such as the use of temperature "anomalies", diffusion of CO_2 to atmospheric stations, distributional misspecification and non-stationarity of the errors affecting empirical models, and use of spline functions for modelling the trends in temperatures. Longitudinal data on CO_2 emissions for 160 countries and atmospheric CO_2 concentrations at ten stations, ambient temperatures from 8,500 weather stations, and seawater composition from 45,000 oceanographic stations were analyzed for 1985-2018 by estimating dynamic random effects models employing maximum likelihood methods. The main findings were that CO_2 emissions exhibited rapid upward trends at the country level, while minimum and maximum temperatures showed cyclical patterns; economic activity and population were associated with higher CO_2 emissions. Second, there were gradual upward trends in annual and seasonal temperatures compiled at weather stations, and atmospheric CO_2 concentrations were significantly associated with higher temperatures in hemispheres. Third, there was a steady decline in dissolved oxygen levels and the interactive effects of water temperatures and pH levels were significant. Overall, the results underscored the benefits of reducing CO_2 emissions for ambient temperatures and for ocean deoxygenation. Synergies between CO_2 emissions, temperatures, and ocean acidification are likely to exacerbate the melting of polar ice.