

Polynomial Cointegration Tests of Anthropogenic Impact on Global Warming

Michael Beenstock, Yaniv Reingewertz and Nathan Paldor

Considering the complexity and variety of the processes that affect Earth's climate, it is not surprising that a completely satisfactory and accepted account of all the changes that occurred in the last century has yet to be reached (IPCC, AR4, 2007). Of particular interest to the present study are those processes involved in the greenhouse effect, whereby some of the longwave radiation emitted by Earth is re-absorbed by some of the molecules that make up the atmosphere, such as (in decreasing order of importance): water vapor, carbon dioxide, methane and nitrous oxide (IPCC, AR4, 2007).

We use statistical methods for nonstationary time series to test the anthropogenic interpretation of global warming (AGW), according to which an increase in atmospheric greenhouse gas concentrations raised global temperature in the 20th century. Specifically, the methodology of polynomial cointegration is used to test AGW since during the observation period (1880 – 2007) global temperature and solar irradiance are stationary in 1st differences whereas greenhouse gas and aerosol forcings are stationary in 2nd differences. The I(2) variables, which are anthropogenic, are cointegrated I(1). We refer to this I(1) variable as the “anthropogenic anomaly”. If the latter is cointegrated with temperature and solar irradiance, which are both I(1) variables, the variables are polynomially cointegrated, and AGW would be corroborated. We show that although these anthropogenic forcings share a common stochastic trend, this trend is empirically independent of the stochastic trend in temperature and solar irradiance. Therefore, greenhouse gas forcing, aerosols, solar irradiance and global temperature are not polynomially cointegrated, and the perceived relationship between these variables is a

spurious regression phenomenon. On the other hand, we find that greenhouse gas forcings might have had a temporary effect on global temperature.

Currently, most of the evidence supporting AGW theory is obtained by calibration methods and the simulation of GCMs. Calibration shows that to explain the increase in temperature in the 20th century, and especially since 1970, it is necessary to specify a sufficiently strong anthropogenic effect. However, calibrators do not report tests for the statistical significance of this effect, nor do they check whether the effect is spurious. The implication of our results is that the permanent effect is not statistically significant. Nevertheless, there seems to be a temporary anthropogenic effect. Indeed, the increase in temperature during 1975 – 1995 and its subsequent stability are in our view related in this way to the acceleration in carbon emissions during the second half of the 20th century.