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New Cointegration Methods for Detection and Attribution of Climate Trends

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The reliable detection and attribution of climate trends is fundamental in enabling decision makers to manage climate-related risk (Hegerl et al., 2010). Ordinary least squares (OLS) and/or total least squares (TLS) regression methods have been employed to detect changes in climate and attribute the changes (if any) to specific external force(s).

This study evaluates performances of the OLS and TLS estimators and compares the results with a vector autoregressive (VAR) based maximum likelihood estimators (MLE) of the cointegrating relations. Using synthetic data simulated from some toy models for the global mean temperature and the atmospheric concentration of CO_2, we found that:

1. OLS estimates are negatively biased especially for small samples less than 100 years, even for large ensemble sizes;
2. TLS estimates look less biased than the OLS. But highly inefficient and tend to be positively biased relative to those of the cointegrating VAR estimates.
3. Estimates from cointegrating VAR analysis are least biased as well as more efficient than TLS estimates. They also have faster rate of convergence with length of time series to the true values.

Analysis using the real historical observations and CMIP5 simulations also shows similar pattern among estimates from the three approaches implying that VAR based cointegration analysis could be useful in detection and attribution studies.

Key words: Cointegration, VAR, OLS, TLS, MLE