



Economic cycles and their synchronization: Spectral analysis of macroeconomic series from Italy, The Netherlands, and the UK

Lisa Sella (1,2), Gianna Vivaldo (3,4), Michael Ghil (5,6), and Andreas Groth (5)

(1) Dept. of Economics "S. Cogneetti de Martiis", University of Turin, Turin, Italy (lisa.sella@unito.it), (2) Laboratorio R. Revelli - Centre for Employment Studies, Moncalieri (TO), Italy, (3) Dept. of Physics "A. Avogadro", University of Turin, Turin, Italy (gianna.vivaldo@ph.unito.it), (4) Istituto di Fisica dello Spazio Interplanetario (IFSI - INAF), Turin, Italy, (5) Geosciences Department and Laboratoire de Météorologie Dynamique (CNRS and IPSL), Ecole Normale Supérieure, Paris, France (ghil@lmd.ens.fr; groth@lmd.ens.fr), (6) Department of Atmospheric and Oceanic Sciences and Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095-1565, USA

The present work applies several advanced spectral methods (Ghil et al., *Rev. Geophys.*, 2002) to the analysis of macroeconomic fluctuations in Italy, The Netherlands, and the United Kingdom. These methods provide valuable time-and-frequency-domain tools that complement traditional time-domain analysis, and are thus fairly well known by now in the geosciences and life sciences, but not yet widespread in quantitative economics. In particular, they enable the identification and characterization of nonlinear trends and dominant cycles — including low-frequency and seasonal components — that characterize the behavior of each time series.

We explore five fundamental indicators of the real (i.e., non-monetary), aggregate economy — namely gross domestic product (GDP), consumption, fixed investments, exports and imports — in a univariate as well as multivariate setting. A single-channel analysis by means of three independent spectral methods — singular spectrum analysis (SSA), the multi-taper method (MTM), and the maximum-entropy method (MEM) — reveals very similar near-annual cycles, as well as several longer periodicities, in the macroeconomic indicators of all the countries analyzed.

Since each indicator represents different features of an economic system, we combine them to infer if common oscillatory modes are present, either among different indicators within the same country or among the same indicators across different countries. Multichannel-SSA (M-SSA) reinforces the previous results, and shows that the common modes agree in character with solutions of a non-equilibrium dynamic model (NEDyM) that produces endogenous business cycles (Hallegatte et al., *JEBO*, 2008). The presence of these modes in NEDyM results from adjustment delays and other nonequilibrium effects that were added to a neoclassical Solow (Q. J. Econ., 1956) growth model. Their confirmation by the present analysis has important consequences for the net impact of natural disasters on the economy of a country: Hallegatte and Ghil (*Ecol. Econ.*, 2008) have shown that the presence of business cycles modifies substantially this impact with respect to their impact on an economy in or near equilibrium.

The present work concludes with a study of the synchronization of economic fluctuations, which follows a similar study of macroeconomic indicators for the United States, presented in a nearby poster. Since business cycles are not country-specific phenomena, but show common characteristics across countries, our aim is to uncover hidden global behavior across the European economies (cf. Mazzi and Savio, *Macmillan*, 2006).