

ONLINEAR DYNAMICS IN US MACROECONOMIC TIME SERIES

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Abstract

This paper investigates whether the inherent non stationarity of the US macroeconomic time series may be entirely explained by simple stochastic nonlinear models (like GARCH).

Applying the numerical tools of the analysis of dynamical systems to long time series for the US, we reject the hypothesis that the uncorrelated and homoskedastic residuals of the estimated GARCH models contain no structure. Contrary to the theories that attribute the source of the irregular behavior of the economic system to erratic factors, we are not able, using GARCH models, to obtain truly random residuals. Given this evidence we put forward the possibility that seemingly but not truly random residuals could be, in principle, better controlled and forecasted in the short run.

Introduction

In this paper we check whether the observed fluctuations in macroeconomic time series is solely due to random exogenous shocks which perturbate a stable system. While in a previous paper (Bevilacqua and van Zon 2001, MERIT wp (forthcoming)) it was shown that the uncorrelated residuals of an autoregressive linear AR model do have a structure while they are assumed not to have any, here we show that also the case where we model nonlinearities in variance by means of a GARCH model we still obtain estimated residuals that look random but nevertheless they contain non linear structure.

These results may suggest that there is still room to leave more about the dynamics of macroeconomic variables and that both linear and non linear autoregressive models (that are based on exogenous plugged in additive noise) are not able to fully explain the whole story when the phenomena we deal with are intrinsically unstable.

This paper is organized in the following way: in section 2 we underline, following the King, Rebelo, Plosser (1988a,b) papers, the intimate link between neoclassical economic theory and autoregressive models; in section 3 we outline how we processed the updated and extended Nelson and Plosser (1982) time series; in section 4 we show that there is unexplained deterministic structure left in the autoregressive models also in the case we use a GARCH model; in section 5 we conclude that, in line with previous

results (Bevilacqua and van Zon 2001), that both linear and nonlinear autoregressive models show not to have random residuals.

Therefore we might be found with economic systems that are intrinsically unstable because of some underlying but hidden non linear dynamic law.

Concluding remarks

We have first shown empirical evidence that seemingly random estimated residuals from a GARCH fit are not truly random. What is certain is that these residuals contain some non linear structure that a simple non linear model like GARCH is not able to capture.

In Bevilacqua and van Zon (2001), it was shown that the models with a deterministic (linear or broken) or stochastic trend, are based on the hypothesis of i.i.d residuals. There we found that these residuals contained non linearities. However, we also found that residuals were affected by heteroskedasticity. Any correction of an ARMA model for heteroskedasticity improved the estimation of the coefficients of the model, but the heteroskedasticity in the residuals could not be removed.

In this paper we have tried to capture the non linearity by modeling the variance. The obtained estimated residuals from a GARCH model turned out to be homoskedastic, so the non linearity arising from heteroskedasticity was successfully removed.

We have used the BDS test (which has power against ARCH-GARCH structures) on the residuals of the GARCH model to detect eventual non linearities that could not be captured by the GARCH model. We concluded that, for all the main time series of the US economy, estimated residuals show temporal causality.