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Partial current information and signal extraction in a rational expectations macroeconomic model: A computational solution ☆

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Abstract

Previous attempts at modelling current observed endogenous financial variables in a macroeconomic model have concentrated on only one variable — the short-term rate of interest. This paper applies a general search algorithm to a macroeconomic model with an observed interest rate and exchange rate to solve the signal extraction problem. Firstly, the algorithm is tested against a linear model with a known analytical solution. Then, the algorithm is applied to all the observed current endogenous variables in a non-linear rational expectations model of the UK. The informational advantage of applying the signal extraction algorithm is evaluated in terms of the forecasting efficiency of the model.

JEL classification: E370

Keywords: Rational expectations; Partial current information; Signal extraction; Macroeconomic modelling

1. Introduction

The implication of partial current information in rational expectations models was first demonstrated by Lucas (1972) in his "islands story" of spatially separated markets. There is no doubt that the insights unveiled by Lucas (1972) and Lucas (1973), have had a major impact on modern macroeconomic thinking. The assumption of partial information alters the solution of rational expectations (RE) models since, current observed variables contain partial information about current disturbances. The inferences made from this information will in turn, influence the current state of the system, and hence the observation themselves.

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While Lucas's articles have been widely cited there has been little subsequent empirical work on macroeconomic models that embed the signal extraction assumption. Arguably, the most important reason why these papers have not generated more empirical and numerical results is because specifying and determining an equilibrium within which agents extract signals from endogenous variables have proved to be technically complex[1].

The method of solving forward-looking RE macro-models conditional on full past information is widely practiced by a variety of computer algorithms. The problem emerges when the agents' information set contains all past data and partial current data. Previous attempts[2] at modelling current observed endogenous financial variables in a macroeconomic model have concentrated on only one observed endogenous variable — namely the short term rate of interest (Matthews et al., 1994a,b). The solution method for dealing with more than one observed endogenous variable has so far been computationally intractable.

This paper applies a general search algorithm to a macroeconomic model with an observed interest rate and exchange rate to solve the signal extraction problem. The purpose of this paper is twofold. Firstly, the algorithm is tested against a linear model with a known analytical solution. The main purpose of this exercise is to confirm that the algorithm actually works. The model is solved numerically and then the implication of signal extraction for the interpretation of shocks in a simulation framework is examined. Observation of the current values of macroeconomic variables is shown to offer a possible explanation of why the economy might respond 'paradoxically' to shocks. As a further application the algorithm is also employed in a forecasting exercise. Standard forecast tests, applied on an artificially generated data set, show that the model forecast performance is improved when the signal extraction algorithm is used.

Secondly, the algorithm is applied to a large non-linear rational expectations model of the UK to test whether the use of partial current information improves the model's forecasting efficiency. In practice most macro models are non-linear and so, a real test for the signal extraction algorithm would be in its application to a complete empirical macroeconomic model.

The exposition is organised as follows. The conceptual framework is set out in Section 2. Section 3 describes a stylised open economy macro model with partial information and shows how the analytical solution is obtained. Section 4 applies the algorithm to a numerical version of the model. It examines the implication of partial current information for the interpretation of shocks to the model. Furthermore it checks whether the algorithm can improve the model's predictive power. The results of the forecasting exercise using partial current information on a large non-linear rational expectations model are outlined in Section 5. Section 6 concludes.

2. The conceptual framework

The application of partial current information can be viewed as a solution to the "ragged edge" problem of forecasting, where the forecaster is aware of the values of some endogenous variables only with a lag but can observe other current endogenous variables at the time of forecast. A typical example is the observation of current interest rates and exchange rates. The framework for the use of observed endogenous variables in forecasting with a linear model is examined in Wallis (1986), which applies the properties of the multivariate normal distribution in order to obtain the optimal forecast.

In brief the method considers a general structural form of a linear stochastic econometric model:

$$\mathbf{F}y_t + \mathbf{G}x_t = \varepsilon_t \tag{2.1}$$

where y_t is a vector of endogenous variables, x_t is a vector of pre-determined variables, ε_t is a vector of stochastic disturbance terms, and **F** and **G** are appropriate matrices of coefficients of the known structural parameters. The stochastic disturbances are assumed to be normally distributed with mean zero and the covariance matrix $\mathbf{E}=(\varepsilon_t\varepsilon_t^{\mathrm{T}})=\sum$,

[1] For some previous attempts on modelling the signal extraction in macro models see for example, Thomas Sargent (1991), Neil Wallace (1992), Jean-Pascal Benassy (1999, 2001), Pearlman et al. (1986).

[2] Methods, using state-space representations and the Kalman filter, for solution in linear models have been proposed by Pearlman et al. (1986) and Sargent (1991). However, these methods cannot be used for non-linear models unless linearised around a particular path, which could prove to be computationally expensive and costly in research time.