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Forecasting UK GDP growth and inflation under structural change. A comparison of models with time-varying parameters

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ABSTRACT

Evidence from a large and growing body of empirical literature strongly suggests that there have been changes in the inflation and output dynamics in the United Kingdom. The majority of these papers base their results on a class of econometric models that allows for time-variation in the coefficients and volatilities of shocks. While these models have been used extensively for studying evolving dynamics and for structural analysis, there has been little evidence that they are useful for forecasting UK output growth and inflation. This paper attempts to fill this gap by comparing the performances of a wide range of time-varying parameter models in forecasting output growth and inflation. We find that allowing for time-varying parameters can lead to large and statistically significant gains in forecast accuracy.

1. Introduction

A large and growing body of literature has proposed and applied a number of empirical models that incorporate the possibility of structural shifts in the model parameters. The series of papers by Tom Sargent and his co-authors on the evolving dynamics of US inflation forms an often-cited example of this literature. In particular, Cogley, Primiceri, and Sargent (2008) and Cogley and Sargent (2002, 2005) use time-varying parameter VARs (TVP-VAR) to explore the possibility of shifts in inflation dynamics, with Benati (2007) applying this methodology to the modelling of the temporal shifts in UK macroeconomic dynamics. In contrast, Sims and Zha (2006) model changes in US macroeconomic dynamics using a regime-switching VAR (see Groen & Mumtaz, 2008, for an application to the United Kingdom). Balke (2000) highlights potential non-linearities in the output and inflation dynamics, and uses threshold VAR (TVAR) models to explore non-linear dynamics in output and inflation. Recent papers have estimated time-varying factor augmented VAR (TVP-FAVAR) models in order to incorporate more information into the empirical model. For example, Baumeister, Liu, and Mumtaz (2013) argue that incorporating a large information set can be important when modelling changes in the monetary transmission mechanism, and use a TVP-FAVAR to estimate the evolving response to US monetary policy shocks.

Most of this literature has focused on describing the evolution of macroeconomic dynamics. In contrast, studies on the forecasting ability of these models have been more limited in both number and scope. D'Agostino, Gambetti, and Giannone (2013) focus on TVP-VARs only, and show that they provide more accurate forecasts of US inflation and unemployment than fixed-coefficient VARs. In a recent contribution, Eickmeier, Lemke, and Marcellino (2011) present a comparison of the forecasting performances of

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the TVP-FAVAR, its fixed-coefficient counterpart, and AR models with time-varying parameters for US data over the period 1995–2007. The authors show that there are some gains (in terms of forecasting performances) from allowing time-variation in the model parameters and from exploiting a large information set.

The aim of this paper is to extend the forecast comparison exercises of D'Agostino et al. (2013) and Eickmeier et al. (2011) along two dimensions. First, our paper compares the forecast performances of a much wider range of multi-variate models with time-varying parameters. In particular, we compare the forecasting performances of (a range of) regime-switching models, TVP-VARs, TVP-FAVARs, TVARs, smooth transition VARs (ST-VARs), the unobserved component model with stochastic volatility proposed by Stock and Watson (2007), rolling VARs and recursive VARs. This extends the analysis of D'Agostino et al. (2013), where the focus is on the performances of TVP-VAR and TVP-AR models relative to those of fixed coefficient VARs;[1] our work instead provides a direct comparison of TVP-VARs with empirical models that provide an alternative specification for time-variation. Similarly, the focus of our application is broader than that of Eickmeier et al. (2011). Eickmeier et al. (2011) only consider an AR model with time-varying parameters as an alternative TVP model, whereas we compare the TVP-FAVAR model with a range of *multi-variate* forecasting models with time-varying and regime switching parameters. In addition, the forecast comparison is carried out recursively over the period 1976 Q1–2007 Q4, and thus covers a longer period than that of Eickmeier et al. (2011). Second, while previous papers have largely focused on the United States, we work with UK data and try to determine whether these time-varying parameter models are useful for forecasting UK inflation, GDP growth and the short-term interest rate. This question is highly relevant for policy, as the United Kingdom has experienced large changes in the dynamics of key macro variables over the last three decades. In addition, the recent financial crisis has been associated with large movements in inflation and output growth, again highlighting the possibility of structural change. Note also that the focus of our analysis differs from that of the analyses of Eklund, Kapetanios, and Price (2010) and Clark and McCracken (2009a). While these papers have focused largely on forecasting performances under structural change in a Monte Carlo setting, our exercise is a direct application to UK data using the time-varying parameter models that are currently popular in empirical work.[2]

The forecast comparison exercise brings out the following main results:

- On average, a VAR model estimated over rolling samples delivers the most accurate forecasts for GDP growth at the one-year forecast horizon, with a root mean squared error (RMSE) which is 6% lower than that of an AR(p) model. The ST-VAR and TVP-VAR models deliver similar performances.
- Models with time-varying parameters provide substantially better inflation forecasts. At the one-year horizon, the TVP-FAVAR model has an average RMSE which is 14% lower than that of an AR(p) model, and is the best performing model over the full forecast sample, which indicates the roles played by time-varying parameters and a large information set. The TVP-VAR model and Stock and Watson's unobserved component model also perform well, with the latter delivering the most accurate one-year-ahead forecasts over the post-1992 period.

The paper is organised as follows. Section 2 provides details of the data used in the study and describes the real time out-of-sample forecasting exercise. Section 3 describes the main forecasting models used in this study. Section 4 describes the main results in detail. Finally, Section 5 concludes.

2. Data and forecasting methodology

2.1. Data

Our main UK dataset consists of data on quarterly annualised real GDP growth, quarterly annualised inflation and the three month treasury bill rate. Quarterly data on these variables are available from 1955Q1 to 2010Q4.

The GDP growth series is constructed using real time GDP data obtained from the Office of National Statistics. Vintages of GDP data covering our sample period are available from 1976Q1 onwards, and these are used in our forecasting exercise as described below. GDP growth is defined as 400 times the log difference of GDP.

The inflation series is based on the seasonally adjusted harmonised index of consumer prices spliced with the retail price index excluding mortgage payments. These data are obtained from the Bank of England database. Inflation is calculated as 400 times the log difference of this price index. The three month treasury bill rate is obtained from Global Financial Data.

2.2. Forecasts and evaluation

The forecasting models (described in Section 3) are estimated recursively. The estimation starts from the initial sample from 1955Q1 to 1975Q4 and proceeds by adding one quarter of data at a time and re-estimating the forecasting model. Note that, in the case of GDP growth, we add a new vintage of GDP data (i.e., the vintage available in that quarter) at each iteration of this recursive estimation. The forecasting models are estimated recursively $R = 129$ times until 2007Q4.

At each iteration, we forecast GDP growth, inflation and the three-month treasury bill rate up to 12 quarters ahead. For models with time-varying parameters, we assume that the parameters are fixed over the forecast horizon when calculating forecasts. That is, following D'Agostino et al. (2013), the forecasts are calculated recursively using the last estimated value of the parameters, and do not account for parameter variation over the forecast period. An economic justification for this assumption is provided by Cogley and Sargent (2008).

[1] D'Agostino et al. (2013) compare the forecast performances of TVP-VARs and TVP-AR models with those of fixed coefficient VARs that allow for stochastic volatility and fixed coefficient VARs that are estimated using rolling or recursive windows.

[2] Faust and Wright (2011) compare the performances of a large number of models for forecasting US inflation. However, they do not focus exclusively on models with time-varying parameters. Ferrara, Marcellino, and Mogliani (2012) also compare the forecasting performances of a range of forecasting models, but limit their attention to single equation models.