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Forecast-error-based estimation of forecast uncertainty when the horizon is increased☆

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ABSTRACT

Past forecast errors are employed frequently in the estimation of the unconditional forecast uncertainty, and several institutions have increased their forecast horizons in recent times. This work addresses the question of how forecast-error-based estimation can be performed if there are very few errors available for the new forecast horizons. It extends the results of Knüppel (2014) in order to relax the condition on the data structure that is required for the SUR estimator to be independent of unknown quantities. It turns out that the SUR estimator of the forecast uncertainty, which estimates the forecast uncertainty for all horizons jointly, tends to deliver large efficiency gains relative to the OLS estimator (i.e., the sample mean of the squared forecast errors for each individual horizon) in the case of increased forecast horizons. The SUR estimator is applied to the forecast errors of the Bank of England, the US Survey of Professional Forecasters, and the FOMC.

1. Introduction

The forecast horizons of many important macroeconomic forecasts have increased in recent times. For example, since 2009, the members of the Federal Open Market Committee (FOMC) have been providing forecasts for the "longer run" in their Economic Projections, which might correspond to a horizon of about five years, in addition to their forecasts for the current year and the next two years.[1] In the same year, the forecast horizons for the annual forecasts of real GDP, the unemployment rate, and 3-month and 10-year Treasuries in the US Survey of Professional Forecasters (SPF), conducted by the Federal Reserve Bank of Philadelphia, were extended from one to three years ahead. In the SPF, conducted by the European Central Bank (ECB), respondents have been asked about their 2-year-ahead forecasts for annual real GDP growth, HICP inflation and the unemployment rate in the first two quarters of the current year since 2013. Before 2013, the forecasts for this horizon were requested only in the last two quarters.[2] Since 2014, the ECB staff and the Eurosystem staff have been publishing 2-year-ahead forecasts of annual real GDP growth and HICP inflation in every quarter. Previously, such forecasts were made only in the last quarter of the current year, while the longest forecast horizon in the first three quarters was one year. Finally, the Bank of England (henceforth BoE) extended its forecast horizons for real GDP growth and CPI inflation from 8 to 12 quarters in 2004.

At the same time, there appears to be an increased interest in forecast uncertainty in the field of economics. Recent contributions include the papers by Jurado, Ludvigson, and Ng (2015), who estimate time-varying macroeconomic uncertainty, and Abel, Rich, Song, and Tracy (2016), Boero,

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[1] According to the FOMC, "[t]he longer-run projections are the rates of growth, inflation, and unemployment to which a policymaker expects the economy to converge over time–maybe in five or six years–in the absence of further shocks and under appropriate monetary policy." See http://www.federalreserve.gov/monetarypolicy/fomc_projectionsfaqs.htm.

[2] In addition, the ECB SPF also contains a longer-run-type forecast for a forecast horizon of four or five years. When the survey started in 1999, this forecast was surveyed only for the first quarter, but since 2001, it has been included in every quarter.

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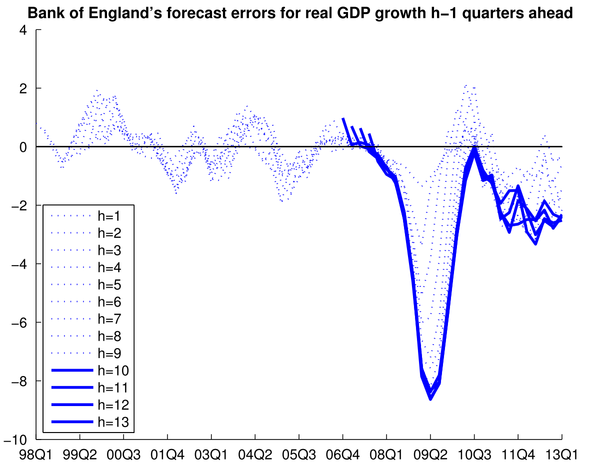

Fig. 1. Forecast errors of the Bank of England for quarterly real GDP growth in the UK for quarterly horizons of $h = 1$ to $h = 13$, where $h = 1$ corresponds to the nowcast.

Smith, and Wallis (2015) and Lahiri and Sheng (2010), who investigate time-varying uncertainty in the context of survey forecasts. Other studies have focused on topics related to unconditional forecast uncertainty by employing empirical forecast errors.[3] For example, Clements (2014) discovers a horizon-dependent mismatch between the unconditional ex-ante uncertainty of survey forecasters and the unconditional variability of their empirical forecast errors. Rossi and Sekhposyan (2015) construct an uncertainty index that is based on the quantiles of the empirical forecast errors in the unconditional distribution of those errors. Patton and Timmermann (2011) set up forecasting models whose implied unconditional forecast uncertainties match the unconditional volatilities of the empirical forecast errors of survey forecasts.

Empirical forecast errors also play an important role in producing measures of the unconditional forecast uncertainty for institutions which publish forecasts. Model-based approaches for the estimation of unconditional forecast uncertainty, as described by Ericsson (2002) for instance, are used only rarely because, as Wallis (1989, pp. 55-56) noted, "This approach is of little help to the practitioner. It neglects the contribution of the forecaster's subjective adjustments [. . .]. More fundamentally, the model's specification is uncertain. At any point in time competing models coexist, over time model specifications evolve, and there is no way of assessing this uncertainty. *Thus, the only practical indication of the likely margin of future error is provided by the past forecast errors*" [emphasis added]. It is common for only the institution's own forecast errors to be used for estimating its forecast uncertainty. This error-based forecast uncertainty measure is regarded as information about the unconditional uncertainty that can serve as a benchmark when statements about the current forecast uncertainty are being made. For example, the FOMC members must state whether the uncertainty attached to their current forecasts is larger than, smaller than, or broadly similar to that observed in the past.

The construction of uncertainty measures in the literature for the forecasts of a specific model or institution based on its empirical forecast errors goes back to the work of Williams and Goodman (1971), who suggested that prediction intervals be constructed from the empirical distribution of forecast errors instead of being derived from the forecasting model. Recent contributions include those of Lee and Scholtes (2014), who study robustness issues concerning the prediction intervals proposed by Williams and Goodman (1971) and Jordà, Knüppel, and Marcellino (2013), who propose empirical prediction regions for forecast paths; and Knüppel (2014), who investigates ways of exploiting the information contained in the forecast errors of shorter forecast horizons for estimating the forecast uncertainty at longer horizons. Moreover, Clark, McCracken, and Mertens (2017) estimate the time-varying forecast uncertainty based on multi-step-ahead survey forecast errors. Studies that attempt to estimate the uncertainty of central bank forecasts include those by Reifschneider and Tulip (2007) and Tulip and Wallace (2012), for example, where the former focus on the Federal Reserve System in the US and the latter on the Reserve Bank of Australia.[4] Finally, Hartmann, Herwartz, and Ulm (2017) evaluate different measures of ex-ante uncertainty according to their abilities to predict squared forecast errors at different horizons.

If the past unconditional forecast uncertainty is to be estimated, the question arises as to how this can be accomplished in a reasonably precise manner if very few observations are available because a new forecast horizon was introduced only a short time ago. For example, the first "longer run" forecast error for the FOMC forecasts was observed in 2015 when the data for 2014 were released, if one assumes that the "longer run" corresponds to a forecast horizon of about five years. The first forecast errors of the US SPF 3-year-ahead forecasts became available in 2012. Even the sample of forecast errors for the new forecast horizons for the BoE, whose growth forecast errors are displayed in Fig. 1, appears relatively short because the large persistence of these forecast errors carries over to the squared errors, and many observations are required in order to obtain a reliable mean estimate for a persistent series. This work focuses on estimating the forecast uncertainty for such horizons as soon as the first forecast errors become available.

The SUR estimator used by Knüppel (2014) relies on the correlations between forecast errors from different horizons for the same period, which are a typical feature of empirical forecast errors such as those displayed in Fig. 1. This SUR estimator of the unconditional forecast uncertainty, which estimates the forecast uncertainty for all horizons jointly, tends to deliver efficiency gains relative to the OLS estimator (i.e., the sample mean of the squared forecast errors for each single horizon). However, in addition to the assumption of optimal forecasts, this SUR estimator

3 The terms "empirical forecast errors" and "past forecast errors" are used interchangeably in the literature.

4 Reifschneider and Tulip's approach differs from those of the other studies mentioned because they estimate their uncertainty measure from the errors of a *panel* of forecasters.