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Model and survey estimates of the term structure of US macroeconomic uncertainty

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ABSTRACT

Survey data on macro-forecasters suggest that their assessments of future output growth and inflation uncertainty tend to be too high. We find that model estimates of the term structure of *ex ante* or perceived macro uncertainty are more in line with *ex post* RMSE measures than are the survey respondents' perceptions. At shorter horizons, the models' assessments of the uncertainty characterising the outlook are lower than those indicated by the survey data histograms, and closer to the RMSE estimates. Recent developments in econometric modelling ensure that the models' information sets line up with the timing of information available to the survey respondents, thus enabling a fair comparison.

1. Introduction

The effects of macroeconomic uncertainty on economic activity have long been of interest to economists, including the question of whether surprises in uncertainty cause declines in output, or vice versa.[1] It is common to measure the general uncertainty about the macroeconomic outlook using either option-implied volatility estimates from stock market or exchange rate data, or survey-based data on consumer confidence or the dispersion of forecasts.[2] Rather than attempting to measure general macroeconomic uncertainty, we are interested in a narrower definition of uncertainty: uncertainty about the future course of inflation and about future output growth. This is because direct estimates of inflation and output growth uncertainty are provided by survey respondents' reported histograms, and our aim is to compare survey measures of uncertainty with model-based estimates.[3]

Recently, Rossi and Sekhposyan (2015) proposed a measure of macroeconomic uncertainty based on comparing the realized forecast error with the historical distribution of forecast errors made by respondents to the US Survey of Professional Forecasters (SPF). Their measure was *ex post* in the sense that the realization of the variable (output growth) was required for the computation. The SPF also provides respondents' forecast distributions of the annual rate of output growth and the inflation rate, in the

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[1] For example, Carroll (1996) considers the effects of uncertainty about labour income on households' spending decisions, while Bloom (2009) and Dixit and Pindyck (1994) consider the effects on firms and their investment plans.

[2] Bloom (2009, Table 1, p. 629) shows that stock market volatility is correlated with various cross-sectional measures of uncertainty: the cross-sectional standard deviation of firms' pre-tax profit growth; a cross-sectional stock-return measure; the cross-sectional spread of industry productivity growth; and the dispersion of the Livingstone half-yearly survey forecasts of GDP.

[3] Of course, the survey respondents may well base their forecasts on models, so the distinction is actually between mechanical model-based forecasts and forecasts which make use of model(s) and judgment to varying degrees.

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form of histograms. These histograms can be employed for computing survey estimates of the *ex ante* uncertainty. Clements (2014a) computes these *ex ante* uncertainty measures from survey forecasts, and compares them with measures based on past forecast errors (see e.g. Knüppel, 2014; Reifschneider & Tulip, 2007), which are typically expressed in terms of the root mean squared error (RMSE). He finds that the *ex ante* uncertainty exceeds the RMSE 'realized uncertainty' for both inflation and output growth at within-year horizons.

This paper aims to obtain a better understanding of the mismatch between the *ex ante* and *ex post* survey estimates of uncertainty. A natural question to ask is whether the mismatch would have arisen if the SPF respondents had based their probability assessments and point predictions on macroeconomic forecasting models. To this end, we estimate the *ex ante* and *ex post* uncertainty using models that, in principle, could have been used by the respondents, in the sense that the models are real-time and use only information that was available at the times when that the corresponding survey forecasts were made. In order for the model estimates to shed light on the mismatch between the *ex ante* and *ex post* survey estimates, we need the model forecasts to be close to the survey forecasts in terms of their forecast accuracies (i.e., *ex post* uncertainty). This leads us to consider MIDAS models, so that the information set used by the model is similar to that available to the survey respondents in terms of timeliness. We find MIDAS models nearly as accurate as the survey forecasts at short horizons, though not at all longer horizons. We then consider whether the models' *ex ante* forecasts of uncertainty are more closely attuned with RMSE estimates.[4]

The comparison of model and survey forecasts is performed in terms of the term structure of uncertainty; that is, the way in which uncertainty is resolved as the forecast horizon shortens. The forecasts underlying the survey uncertainty estimates are fixed-event (see e.g. Clements, 1995; Nordhaus, 1987); that is, repeated forecasts made at different origins of a given target (the year-on-year calendar growth rate of output or prices in a particular year). This characteristic of the survey data determines the nature of the uncertainty estimates required from the models to ensure a fair comparison. The importance of data timeliness when comparing survey and model forecasts was stressed by Faust and Wright (2009), *inter alia*, and motivates the use of mixed-frequency forecasting models. Such models can be set up to draw on data up to the point in time at which the corresponding survey return was made, so that the model and survey information sets are aligned closely in the time dimension. The models' outputs are designed carefully to match the quantities which can be calculated from the survey responses. For example, the survey measures of forecast uncertainty relate to calendar-year annual inflation and output growth forecasts made at horizons of (approximately) one to eight quarters ahead. We show how estimates of these quantities can be obtained from the forecasting models' outputs. In addition, the models are specified and estimated using the data which would have been available in real time, to match the surveys, which are real time by definition. That is, we use only vintages or maturities of data that would have been available at the point in time at which each forecast was made (see e.g. Croushore, 2011a,b, on real-time data analysis).

In calculating the term structure, we average over forecast origins, so that any time variation in the uncertainty levels ought to largely cancel out. As a consequence, our benchmark model estimates the term structure of calendar-year output growth and inflation uncertainty without modelling the time-varying heteroscedasticity, but including both monthly and daily predictors so as to match the model information sets with those available to the survey respondents. As a robustness check, we also consider the model proposed by Pettenuzzo, Timmermann, and Valkanov (2016), which incorporates time-varying heteroscedasticity in models with mixed-frequency data.

Note that the RMSEs are unconditional measures, in that they capture average performances (for a given horizon). On the other hand, *ex ante* uncertainty is a conditional notion, as it measures the uncertainty at each point in time. However, averaging the *ex ante* estimates over time – to generate the term structure of uncertainty – results in estimates which are essentially unconditional, and therefore are comparable to the RMSE estimates in this respect. The *ex ante* assessments would be expected to be broadly in line with the RMSEs if they are calibrated well.

Finally, one of our underlying assumptions for many of the calculations is that survey forecasters target an early-vintage release of GDP growth or inflation, such as the official estimate released shortly after the reference quarter (specifically, two quarters later). This is common practice in the real-time forecasting literature, because it seems reasonable to assume that the three rounds of annual revisions and the occasional benchmark revisions which are known to occur will result in changes which are largely unpredictable (see e.g. Fixler, Greenaway-McGrevy, & Grimm, 2014; Landefeld, Seskin, & Fraumeni, 2008, on the release of the Bureau of Economic Analysis' data revisions). Moreover, the relative rankings of competing forecasting models may not be sensitive to the vintage used for the actual values, and the best forecasting model for predicting early-release data may remain the best for predicting fully-revised data, even though all of the models' forecasting performances would be expected to deteriorate. However, the choice of early-release versus fully-revised data is shown to be less benign for comparisons of *ex ante* uncertainty and RMSE.

To anticipate our main finding, our models' *ex ante* measures are markedly lower than the survey *ex ante* estimates for within-year horizons, and are in fact lower than the model and survey RMSE estimates at the one- and two-quarter horizons. If the survey respondents had used such a model to generate *ex ante* uncertainty estimates, they would have tended to under-estimate the *ex post* uncertainty at the two shortest horizons.

Our paper is related to that of Patton and Timmermann (2011), who estimate the degree of predictability of state

[4] In the context of assessing DSGE model forecasts, Herbst and Schorfheide (2012) similarly assess whether the realized RMSEs are commensurate with what would be expected given the DSGE model's predictive distribution.