Box F: Using a Large Bayesian VAR for short-run forecasting of Ireland's macroeconomy

As part of the Council's endorsement function, the Council prepares benchmark forecasts of Ireland's macroeconomy to allow for a comparison with the forecasts of the Department of Finance.[34] The Council adopts a suite of modelling approach (having multiple models), to forecast each individual macroeconomic indicator.[35] This box gives a brief summary of an additional forecasting tool the Council has developed—Large Bayesian Vector Auto-Regression (LBVAR)—for forecasting Ireland's underlying macroeconomy.

Given the large range of dynamics that can affect the economy in the short-run, modelling the macroeconomy in a system requires a large number of inputs. Often historical data availability is limited. This can give rise to a large number of parameters that need to be estimated with only a limited data set. For instance, in a Vector Auto-Regression (VAR) with P lags and N variables there are $N^2 \times P + N$ parameters that need to be estimated. Therefore, adding additional variables to a conventional VAR can significantly reduce the degrees of freedom. This can lead to in-sample overfitting and large out of sample forecast errors.

Following the work of Bańbura *et al*. (2010), LBVARs offer a solution to this problem. LBVARs apply Bayesian shrinkage to the parameters of the model, which allows for the use of large information sets to forecast the macroeconomy. LBVARs have been shown to have superior forecasting performance to that of smaller VARs, smaller Bayesian VARs, Factor-Augmented VARs and small DSGE models (Bańbura *et al*., 2010; Gupt & Kabundi, 2010).

The basic intuition behind an LBVAR is to start with a standard VAR model and take a prior belief, typically a so called "Minnesota prior", which is a belief that each equation in the model is centred around a random walk with drift:

$$Y_t = c + Y_{t-1} + u_t$$

Where Y_t is the variable of interest, c is a constant and u_t is a normally distributed error term. This is equivalent to a prior belief that the variable depends on its own lagged value (the coefficient of Y_{t-1} is equal to 1) and not on other variables (the coefficient on the lags of other variables is 0). The overall tightness of the prior distribution around this central estimate is then controlled by a hyper-parameter, λ. The idea behind an LBVAR is to increase the overall tightness of the prior distribution around the central estimates as the number of variables increases, thus reducing overfitting that occurs in larger conventional VARs and reducing the impact of omitted variable bias that smaller VARs are prone to.

Comparing the historical forecasting performance of the Large Bayesian VAR with the Council's other models

This section provides a brief analysis of the forecasting performance of the LBVAR. Forecasts from the LBVAR are compared with the forecasts produced by two models, one for employment growth, and one for personal goods consumption growth, currently in use by the Council. The LBVAR was estimated using a dataset of 47 variables from Q1 2000 to Q4 2018. Figure F.1A shows the outturn for employment growth alongside the one-year-ahead forecast of employment growth from the LBVAR and from one of the Council's benchmark models for forecasting employment.[36] Both models perform relatively similar. The average absolute forecast error for the LBVAR of 0.78 versus 0.80 for the benchmark model. The relative mean

[34] The Council's mandate includes endorsing, as it considers appropriate, the official macroeconomic forecasts of the Department of Finance that are the basis for Budgets and SPUs.

[35] See Conroy & Casey (2017) for an outline of the Council's Suite of Models approach.

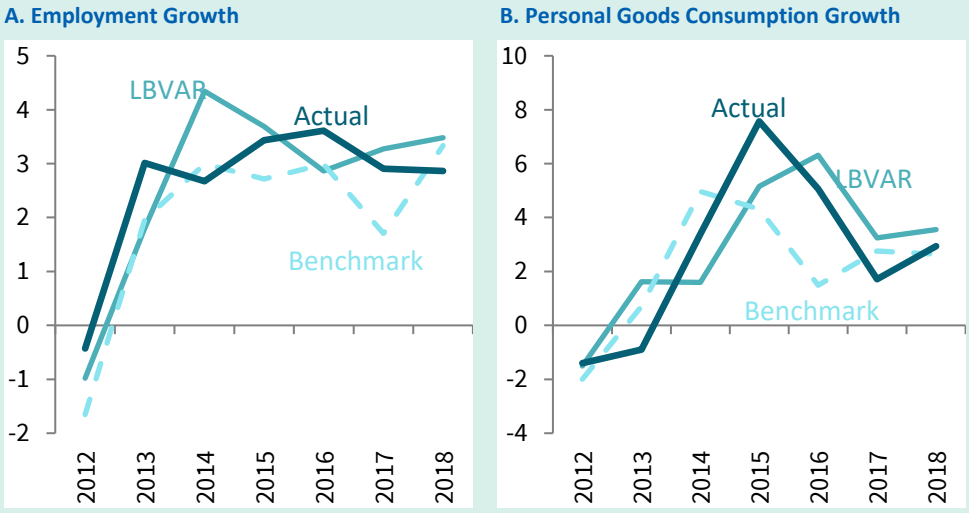
[36] The benchmark model for forecasting employment growth is an error correction model with Underlying Domestic Demand as the macro-driver.

squared forecast error is 1.08, indicating that the benchmark model performs slightly better over this time horizon.[37]

A similar exercise is carried out for personal goods consumption growth (Figure F.1B).[38] Again, both models' performance is relatively similar; however, the LBVAR outperforms the benchmark model in terms of the average absolute forecast error and the relative mean squared forecast error. The average absolute forecast error is 1.46 and 1.71 for the LBVAR and the benchmark model respectively. The relative mean squared forecast error is 0.66 over this horizon, indicating that the LBVAR has a superior forecasting performance.

Figure F.1: Comparison of LBVAR forecasts with the Council's benchmarks

Year-on-year percentage change



Sources: CSO; and Internal Fiscal Council calculations.

Note: Left Panel: Data shows the one-year ahead forecasted employment growth rate for the LBVAR and the benchmark model, as well as the actual employment growth for that year (as of the March 2019 release of the Quarterly National Accounts (QNA)). Right panel: Data show the one-year-ahead forecasted personal goods consumption growth rate for the LBVAR and the benchmark model, as well as the actual personal goods consumption growth rate for that year (as of the March 2019 release of the QNA).

What is the LBVAR currently forecasting?

Table F.1 shows the LBVAR's forecasts for 2019 and 2020 for employment growth and personal goods consumption. The LBVAR forecasts are purely model based with no judgement applied. These forecasts are shown alongside the Council's benchmark forecasts for these variables. For 2019, the LBVAR forecasts employment growth to be 2.6 per cent and personal goods consumption to be 2.7 per cent, relatively close to the benchmark forecast of 2.4 per cent and 2.5 per cent respectively. For 2020, the forecasts for employment growth are only marginally different, with the LBVAR forecasting a growth rate of 1.4 per cent, while the benchmark forecast is 1.5 per cent. There is however, a slight divergence in the forecasts for personal consumption growth for 2020, with the LBVAR forecasting growth of 2.4 per cent, while the benchmark forecast is 2.0 per cent.

[37] That is, the mean squared forecast error of the LBVAR divided by the mean squared forecast error of the benchmark model. Values below one, indicate that the LBVAR has superior forecasting performance relative to the benchmark model.

[38] The benchmark model for forecasting personal consumption growth is an error correction model with personal disposable income in the long-run equation, and both personal disposable income and household wealth in the short-run equation.

Table F.1: LBVAR statistical forecasts

Year-on-year percentage change

	2019	2020
LBVAR employment growth	2.6	1.4
Benchmark employment growth	2.4	1.5
LBVAR personal goods consumption growth	2.7	2.4
Benchmark personal goods consumption growth	2.5	2.0

Sources: CSO; and internal Fiscal Council calculations.

Note: Forecasts are based on data up to Q2 2019. Figures for the benchmark correspond to those in Appendix C relating to the orderly Brexit scenario. The benchmark figures in this table are based on the suite of models for each variable, of which the models outlined above constitute one of the models in the suite for each variable. The benchmark figures may include some element of judgement.

While the analysis above gives a brief outline of the LBVAR and its forecasting performance, a forthcoming working paper will provide a more detailed description of the model estimation and a more comprehensive analysis of its forecasting performance for a wider range of variables.