



Short-term inflation forecasting: The M.E.T.A. approach



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ABSTRACT

Forecasting inflation is an important and challenging task. This paper assumes that the core inflation components evolve as a multivariate local level process. While this model is theoretically attractive for modelling inflation dynamics, its usage thus far has been limited, owing to computational complications with the conventional multivariate maximum likelihood estimator, especially when the system is large. We propose the use of a method called “*moments estimation through aggregation*” (M.E.T.A.), which reduces the computational costs significantly and delivers fast and accurate parameter estimates, as we show in a Monte Carlo exercise. In an application to euro-area inflation, we find that our forecasts compare well with those generated by alternative univariate and multivariate models, as well as with those elicited from professional forecasters.

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1. Introduction

Traditionally, the interest in inflation forecasting has been motivated by the existence of nominal contracts whose real values are determined by changes in the purchasing power of money, among other factors. Thus, the forecasting of inflation is crucial for nominal obligations, including those of governments. The importance of this issue has increased since the adoption by a large number of Central Banks of explicit or implicit inflation targets that have a forward-looking flavour, like the European Central Bank's (ECB) stated medium-term target of below but close to 2%, or the long-run 2% target adopted by the Fed in 2012.

Two issues arise when one is building models for predicting inflation. First, it is hard to find models that outperform naïve inflation forecasts; see for instance Marcellino, Stock, and Watson (2003), D'Agostino, Giannone, and Surico (2006), and Bańbura and Mirza (2013). Second, models that work well at very short horizons tend to perform poorly at longer horizons. Similarly, models that track *changes* in the inflation rate over the medium term

reasonably well often have difficulty in getting the starting point right, so that they can end up missing the level of inflation quite markedly.

The tension between short- and medium-term forecasting models is at the heart of the comprehensive review by Faust and Wright (2013). These authors stress that two crucial ingredients are necessary in order to obtain accurate inflation forecasts at different horizons: first, the starting point must be predicted accurately; second, longer-horizon forecasts must be anchored somewhat to the inflation target adopted by monetary policy. In practice, they find that it is hard to outperform a strategy in which the starting point is elicited from professional forecasters and the subsequent inflation path is obtained as a smooth transition to the inflation target.

These findings have far-reaching implications for the research on inflation forecasting, since they reduce the emphasis on long-term and trend inflation forecasting, which are the focus of a large and growing body of literature (Chan, Koop, and Potter, 2013; Clark and Doh, 2014; Cogley, 2002; Garnier, Mertens, and Nelson, 2013, among others), and instead emphasize shorter horizons, for which the literature is relatively scant. Motivated by this observation, our paper contributes to the debate on inflation forecasting

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by focusing on the short end of the inflation forecast curve. Specifically, we propose a modelling framework that provides accurate one-step-ahead inflation predictions, and therefore can be seen as a useful starting platform for longer-horizon forecasts.

Central to our forecasting framework is a *multivariate local level* model (MLL henceforth) that extracts the permanent components from a panel of elementary inflation series.¹ The model represents a multivariate extension of the approach originally proposed by Muth (1960) and subsequently employed for forecasting U.S. inflation (see for example Barsky, 1987 and Nelson and Schwert, 1977). In its *univariate* version, the local level model has attracted the attention of the recent literature due mainly to its ease of computation. For example, Stock and Watson (2007) use it for forecasting inflation in the U.S. during the Great Moderation period, allowing for changes in the signal to noise ratio over time. On the other hand, the *multivariate* version of the local level model has attracted less attention due to the computational issues that arise with maximum likelihood estimation, even for low-dimensional systems.²

Indeed, when the dimension of the local level model becomes relatively large, the maximum likelihood estimator may not perform well and can be computationally intensive to obtain. In this case, there are various other strategies that have been suggested in the literature, such as the univariate treatment of the Kalman filter as per Koopman and Durbin (2000) (see also Anderson and Moore, 1979 and Fahrmeir and Tutz, 1994).

However, this paper makes use of a new estimation method for the MLL model that was proposed recently by Poloni and Sbrana (2015), which allows us to circumvent these computational problems and makes it possible to evaluate the forecasting performances of relatively large systems. The method, defined as “*moments estimation through aggregation*” (M.E.T.A. henceforth), consists of breaking down the complex problem of estimating a (potentially large) multivariate system into the more manageable problem of estimating the parameters of many univariate processes. The latter are used to estimate the moments of the system, and eventually to derive the parameters of the multivariate model through a closed-form relationship between the moments and the model parameters.

Our contribution is twofold. First, an extensive Monte Carlo exercise is performed to show that the M.E.T.A. is considerably faster and more accurate (especially for large dimensional systems) than the traditional multivariate maximum likelihood estimator, and indeed that it is the only viable method beyond a certain model size,³ which

opens up the use of the MLL model to a wide set of applications. Our second contribution is to employ this model in an empirical application to the forecasting of euro-area inflation at short horizons. We find that the predictions derived from the MLL model estimated using the M.E.T.A. approach compare well with those generated by vector autoregressions (VAR) or alternative univariate constant and time-varying parameter models. Moreover, they are as accurate as those obtained on the basis of factor models that use large datasets. Furthermore, by making the estimation feasible regardless of the model dimension, the M.E.T.A. approach allows us to assess the relative benefits, in terms of the predictive accuracy, of different levels of aggregation of the elementary price indices. In this respect, we find that a preliminary aggregation of the price indices improves the forecast accuracy, which is a result that could not have been obtained on the basis of the traditional multivariate maximum likelihood estimator.

The rest of the paper is structured as follows. Section 2 describes the model, points out the problematic aspects of estimation and presents the M.E.T.A. methodology in detail. It shows the results as per Poloni and Sbrana (2015), as well as using a new closed-form expression. Through a Monte Carlo exercise, Section 3 then illustrates the computational and accuracy gains attained by the M.E.T.A. approach. Section 4 discusses the empirical application, and Section 5 concludes.

2. The multivariate local level model

Our paper uses a multivariate local level model to construct the inflation forecasts. This model posits that all of the series in the system are driven by series-specific random walks (Harvey, 1989). Its state space representation, which is also known as its structural form, is

$$\begin{aligned} \mathbf{y}_t &= \boldsymbol{\mu}_t + \boldsymbol{\epsilon}_t \\ \boldsymbol{\mu}_t &= \boldsymbol{\mu}_{t-1} + \boldsymbol{\eta}_t. \end{aligned} \quad (1)$$

The vector $\mathbf{y}_t$, of dimension d , collects the percentage change over the previous period of the elementary items that constitute the core index, and $t = 1, 2, \dots, T$ is the number of observations. Thus, Eq. (1) decomposes the multivariate time series $\mathbf{y}_t$ into a stochastic trend $\boldsymbol{\mu}_t$ that evolves as a multivariate random walk and a vector white noise ($\boldsymbol{\eta}_t$).

It is assumed that the noises are i.i.d., with zero mean and the following covariances:

$$\text{cov} \begin{pmatrix} \boldsymbol{\epsilon}_t \\ \boldsymbol{\eta}_t \end{pmatrix} = \begin{pmatrix} \boldsymbol{\Sigma}_\epsilon & \mathbf{0} \\ \mathbf{0} & \boldsymbol{\Sigma}_\eta \end{pmatrix}, \quad (2)$$

where $\boldsymbol{\Sigma}_\epsilon$ and $\boldsymbol{\Sigma}_\eta$ are $(d \times d)$ error covariance matrices (also defined as structural parameters).

It is also assumed that $\boldsymbol{\Sigma}_\epsilon$ and $\boldsymbol{\Sigma}_\eta$ are both positive definite (i.e., all of their eigenvalues are non-negative). The positive definiteness assumption can be relaxed by allowing $\boldsymbol{\Sigma}_\eta$ to have a reduced rank and eigenvalues that are equal to zero. This is the case when cointegration arises such that the model is driven by a smaller number of random walks. This is a special case that will be the object of a separate paper.

¹ Our application focuses mainly on a measure of the *core* inflation, i.e., the percentage change in the overall index net of food and energy, which is watched closely by the ECB. The elementary series that compose this inflation measure are strongly persistent (unlike food and energy prices), and therefore lend themselves best to being modelled using the MLL. As a robustness check, we also consider forecasting the overall inflation; see Section 4 for a detailed discussion.

² Notable exceptions are the studies by Proietti (2007), in the context of U.S. monthly core inflation rates, and Stella and Stock (2012).

³ Refer to Kascha (2012) for an overview and a comparison of the estimation algorithms proposed in the literature for the general class of VARMA models.

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