International Journal of Forecasting 32 (2016) 1306–1316

Contents lists available at ScienceDirect

International Journal of Forecasting

journal homepage: www.elsevier.com/locate/ijforecast

Modeling the impact of forecast-based regime switches on US inflation

Koen Bel *, Richard Paap

Erasmus School of Economics, Erasmus University Rotterdam, Burg. Oudlaan 50, 3062 PA Rotterdam, The Netherlands
Econometric Institute, Erasmus University Rotterdam, Burg. Oudlaan 50, 3062 PA Rotterdam, The Netherlands

ARTICLE INFO

Keywords:
Nonlinear time series
Forecasting
Regime switching
Inflation

ABSTRACT

Forecasts of key macroeconomic variables may lead to policy changes by governments, central banks and other economic agents. Such policy changes in turn lead to structural changes in macroeconomic time series. We describe this phenomenon in US inflation by introducing a logistic smooth transition autoregressive model where the regime switches depend on the Michigan Inflation Expectation Series. Our results show that (i) forecasts lead to regime changes and have an impact on the level of inflation; (ii) the absorption time of shocks in the forecast of inflation is about four quarters; and (iii) a positive (negative) shock in the forecast results in actions which increase (decrease) the inflation rate.

1. Introduction

Lucas (1976) showed that macroeconometric models with constant parameters cannot be used for evaluating policy changes, since policy changes usually lead to behavioral changes by economic agents, which result in inconstant model parameters. It is well known that agents also react to macroeconomic forecasts. This suggests that unexpected economic forecasts may also lead to changes in the model parameters.

Several theoretical and empirical studies have indicated this effect of forecasts. Theoretically, Fellner (1976) explained that the public's expectations are prone to self-justifying skepticism about policy makers, and policy makers react to that. Empirically, Givoly and Lakonishok (1979) found that serious upward revisions in financial earnings forecasts have significant effects on stock prices. Steiner, Großand Entorf (2009) showed that asset prices demonstrate an immediate reaction to returns in macroeconomic announcements. Moreover, they find that the reactions to positive news are faster than those to negative news. Sinclair, Gamber, Stekler, and Reid (2012) showed that forecast errors have an impact on the target interest rate set by the Federal Reserve Bank.

Although the literature suggests that forecasts have an impact in various fields, this paper focuses on US inflation time series data. It is well known that the dynamic character of this series is affected by policy changes; see for example Cogley and Sargent (2002, 2005) and Primiceri (2005). Furthermore, inflation forecasts play an important role, since (i) policy makers react to forecasts due to the FED Volcker-regime inflation targeting (Clarida, Galí, & Gertler, 2000); and (ii) companies and consumers use inflation forecasts to decide upon future savings and expenditure levels. Carroll (2003) states that people update their expectations to public forecasts rather than to past inflation rates. Furthermore, economic theory also provides support for the impact of forecasts on the inflation rate. It is mainly mentioned as either the expectations trap (Christiano & Gust, 2000) or self-fulfilling expectations,

* Corresponding author at: Erasmus School of Economics, Erasmus University Rotterdam, Burg. Oudlaan 50, 3062 PA Rotterdam, The Netherlands.
E-mail address: bel@ese.eur.nl (K. Bel).

http://dx.doi.org/10.1016/j.ijforecast.2016.06.002

where the public's expectations of high inflation increase the actual inflation rate. Albanesi, Chari, and Christiano (2003) stated that "expectations of high or low inflation lead the public to take defensive actions, which then make accommodating those expectations the optimal monetary policy". Both the expectations trap before 1979 (Leduc, Sill, & Stark, 2007) and inflation targeting since the 1980s suggest that inflation forecasts play a key role.

We describe the effects of forecasts by proposing a nonlinear time series model which accounts for the dynamic effects of (inflation) forecasts. The model allows for structural breaks in the parameters based on the relative size of a forecast of the underlying time series. Sims and Zha (2006) describe regime switches using an exogenous first-order Markov process, but this paper employs a smooth transition autoregressive (STAR) model (Chan & Tong, 1986; Teräsvirta & Anderson, 1992). The most accurate variable for determining the current regime is probably the value of the dependent variable itself. As it is not feasible to use this variable to describe regime changes, the transitions are often based on a lagged value of the dependent variable; see Teräsvirta (1994), among many others. In this paper, we opt for a different approach, and predict regime changes using the level of the forecast of the underlying dependent variable. The forecast may be better at indicating the direction in which the time series is heading.

The resulting model is applied to the gross domestic product (GDP) based inflation rate of the United States (US). The results show that inflation forecasts do indeed lead to regime changes. That is, positive shocks in the inflation forecast result in actions which increase the future inflation rate. Further, it takes about four quarters for such shocks to be absorbed.

The remainder of this paper is organized as follows. Section 2 introduces our model specification for describing the impact of forecasts. Parameter estimation and statistical inference are discussed in Section 3. Section 4 illustrates our modeling approach on the US inflation rate. Finally, Section 5 concludes.

2. Model specification

We put forward a nonlinear time series model for US inflation which accounts for structural changes due to forecasts of the underlying time series. As we expect reactions to both relatively low and relatively high forecasts, we include three regimes. Furthermore, we expect the size of the structural change to depend on the size of the forecast; we therefore use smooth transition models, see Van Dijk, Teräsvirta, and Franses (2002) for a survey.

Formally, let y_t be US inflation at time $t = 1, \dots, T$. Let $p_{t|t-1}$ denote the forecast of y_t based upon all information up to and including time $t-1$. In this paper, we will take the Michigan Inflation Expectation Series for $p_{t|t-1}$. The three-regime smooth transition time series model is then given by

$$y_t = f(x_t, p_{t|t-1}; \theta) + \sigma_t \varepsilon_t, \tag{1}$$

with $\varepsilon_t \sim nid(0, 1)$ and

$$\begin{aligned} f(x_t, p_{t|t-1}; \theta) = {} & \phi_1' x_t + (\phi_0 - \phi_1)' x_t G_0(p_{t|t-1}; \gamma_0, \kappa_{0t}) \\ & + (\phi_2 - \phi_1)' x_t G_2(p_{t|t-1}; \gamma_2, \kappa_{2t}), \end{aligned} \tag{2}$$

where x_t is a k-dimensional vector containing a vector of ones, explanatory variables and lagged values of y_t; $\phi_i, i \in \{0, 1, 2\}$, are $(k \times 1)$-parameter vectors; and θ summarizes all parameters. The parameter σ_t describes the potentially time-varying standard deviation of the disturbances, which we will discuss later. The value of the variance is assumed to be independent of the forecast $p_{t|t-1}$.

The functions $G_0(\cdot)$ and $G_2(\cdot)$ take values between zero and one, depending on the level of the forecast $p_{t|t-1}$, and describe the probability as being below or above some (economically interesting) threshold value. We opt for the logistic function

$$G_i(p_{t|t-1}; \gamma_i, \kappa_{it}) = \frac{1}{1 + \exp(-\gamma_i(p_{t|t-1} - \kappa_{it}))}, \tag{3}$$

resulting in the logistic STAR (L-STAR) model (Teräsvirta, 1994). The parameter γ_i determines the smoothness of the transition function, and κ_{it} denotes the point of inflection of the logistic curve (see Chapter 2 of Van Dijk, 1999, for a graphical representation). It is easy to see that $G_0(\cdot)$ approaches one for small forecasts under the restrictions $\kappa_{0t} < \kappa_{2t}$, $\gamma_0 < 0$ and $\gamma_2 > 0$. Hence, the relevant parameter vector is ϕ_0. For large forecasts, $G_2(\cdot)$ approaches one, meaning that ϕ_2 is the relevant parameter vector. These restrictions are not necessary for the identification of the parameters, but other restrictions may lead to different interpretations of the regime parameters.

The original STAR specification assumes the threshold parameter κ_{it} in Eq. (3) to be constant over time. However, as US inflation has been fluctuating over recent decades, it is likely that the reactions to the forecast will vary over time. For instance, a forecast that was high during the low-inflation period of the 1990s would not have been striking during the oil crises of the late 1970s. We therefore allow the threshold to be time-varying, relative to the local level of inflation. That is, agents compare the forecast to the level of the inflation series in the near past.

We consider two specifications for the time-varying κ_{it}. First, let $\kappa_{it} = \kappa_i + \bar{y}_t^{(d)}$, where $\bar{y}_t^{(d)}$ is the average of the dependent variable over the previous d periods. The larger $\bar{y}_t^{(d)}$ is, the larger $p_{t|t-1}$ has to be before agents will react. This also implies that regime 0 is more likely to occur. For the second specification of κ_{it}, imagine a large forecast in a highly volatile period. As large changes are expected, it is likely that the reactions to this forecast will be less extreme than those to the same forecast in periods with a low volatility. We therefore impose that $\kappa_{it} = \kappa_i \sigma_t + \bar{y}_t^{(d)}$. Hence, we now also account for the local level of the variance in the inflation innovations.

In summary, the specification in Eqs. (1)–(3), where $G_0(\cdot)$ and $G_2(\cdot)$ depend on the level of the forecast $p_{t|t-1}$, provides the framework for investigating the impact of forecasts on agents' decisions. We allow for time-varying threshold parameters in order to take the local level of inflation into account. The model allows us to investigate the impact of the forecasts on macroeconomic variables of interest.