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Financial conditions and nonlinearities in the European Central Bank (ECB) reaction function: In-sample and out-of-sample assessment

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ABSTRACT

Our purpose is to investigate how the European Central Bank (ECB) sets interest rates in the context of both linear and nonlinear policy reaction functions. This work contributes to the current debate on central banks having additional objectives over and above control of inflation and output. Three findings emerge. First, the ECB takes financial conditions into account when setting interest rates. Second, amongst Taylor rule models, linear and nonlinear models are empirically indistinguishable within sample, and model specifications with real-time data provide the best description of in-sample ECB interest rate setting behaviour. Third, the 2007–2009 financial crisis witnessed a shift from inflation targeting to output stabilization, and a shift from an asymmetric policy response to financial conditions at high inflation rates to a more symmetric response regardless of the state of inflation. Finally, guidance is provided as regards models for forecasting interest rates in the Eurozone area. Without imposing an a priori choice of the parametric functional form, semiparametric models and autoregressive processes forecast the out-of-sample ECB interest rate setting behaviour better than linear and nonlinear Taylor rule models.

1. Introduction

Monetary policy reaction functions typically assume that interest rates relate linearly to the gap between actual and desired values of inflation and output (see e.g. Taylor, 1993; Clarida et al., 2000, and Swamy et al., 2005). Nonlinear policy rules emerge from either asymmetric central bank preferences (e.g. Nobay and Peel, 2003; Cukierman and Muscatelli, 2008) or a nonlinear (convex) aggregate supply or Phillips curve (e.g. Dolado et al., 2005), or even when central banks follow the opportunistic approach to disinflation (Aksoy et al., 2006). Dolado et al. (2004) discuss a model which comprises both asymmetric central bank preferences and a nonlinear Phillips curve. Another strand of the monetary policy literature, dynamic stochastic general equilibrium models (see e.g. Smets and Wouters, 2003), makes use of a linear policy reaction function.

Orphanides (2001) warns that ex post revised data sets (commonly used in the empirical literature) provide a misleading description of the Federal Reserve Bank's behaviour in real time. Orphanides and van Norden (2005) demonstrate that ex post revised estimates of the output gap significantly overstate the ability of the output gap model to predict inflation.

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Herrmann et al. (2005) reiterate the importance of using real-time data to understand the behaviour of policymakers in real time.

The recent financial crisis has added to the debate on whether Central Banks can improve macroeconomic stability by targeting financial asset prices. Amongst others, De Grauwe (2007) argues that asset prices should be targeted as Central Banks cannot avoid taking more responsibilities beyond inflation targeting. On the other hand, the former Federal Reserve Governor Mishkin (2008) points out that asset price bubbles are hard to identify and even if they are identified, their response to interest rates is far from certain. Amongst other work, earlier joint research by the Federal Reserve Chairman Bernanke and Gertler (2001) concludes that "there is no significant additional benefit to responding to asset prices".

However the concern that Central Banks should have additional objectives (and instruments) is gaining momentum (Walsh, 2009). The ECB President Trichet (2005) takes a more cautious view, noting that "the ECB's monetary policy strategy does allow for taking into account [asset price] boom developments without any amendments to the strategy and without providing any additional role to asset prices". The ECB Vice President Papademos (2009) moves a step closer towards acknowledging the importance of monitoring asset prices as part of ECB's monetary policy. He notes that "leaning against the wind" of booming asset prices by raising the policy interest rates would, even in the short to medium term, be compatible with the ECB's monetary policy strategy aiming at consumer price stability". He then adds that the "leaning against the wind" policy "would be expected to be more effective in maintaining price stability over the longer term, by helping to prevent the materialisation of deflation risks when the asset bubble bursts". Martin and Milas (2010b) formally develop a theoretical model in which policymakers have preferences for financial conditions being close to equilibrium, reflecting their desire to stabilize the financial system, and Castro (forthcoming) shows that ECB policymakers do indeed pay close attention to financial conditions.

Perhaps surprisingly, Taylor-type monetary policy rules have mainly been concerned with in-sample fits of linear and nonlinear models. A notable exception is the case of Qin and Enders (2008) using US data to compare the in-sample and out-of-sample properties of linear Taylor rules and a nonlinear one driven by large versus small values of past interest rates.

This marks a significant point of departure for our paper: using inflation, the output gap and a proxy for financial conditions as the main underlying variables, we examine, on the basis of real-time as well as revised data, whether nonlinear Taylor rules can dominate standard linear Taylor rules in both in-sample and out-of-sample analysis. Second, we investigate how the coefficients of response to inflation, the output gap and financial conditions have varied across time and across regimes (high against low inflation rates) by providing recursive estimation of all policy rules. By using estimation over expanding windows of data to evaluate ECB monetary policy across individual as well as combined reaction functions, we believe that we go some way towards addressing the point made by Bank of England Governor King (2007), that it is impossible to write down any stable reaction function. Third, it is known that significant in-sample evidence of predictability does not guarantee significant out-of-sample predictability. This might be due to a number of factors such as the power of tests (Inoue and Kilian, 2004). We therefore provide both in-sample and out-of-sample results in order to shed light on the specification of the ECB policy rule and guidance as regards models for forecasting interest rates in the Euro area. Forecasts generated from the Taylor-type models are compared to those from autoregressive and nonparametric/semiparametric models. The latter models do not impose any distributional condition in interest rate modelling and are therefore able to reveal structure in data that might be missed by classical parametric linear and nonlinear models.

The paper proceeds as follows. Section 2 summarizes the models. Section 3 discusses the data. Section 4 reports the in-sample analysis and Section 5 presents our out-of-sample forecasting exercise. Section 6 provides some robustness analysis. Section 7 provides some concluding remarks and offers some policy implications.

2. Monetary policy rules

2.1. Linear and nonlinear Taylor rule models

Existing Taylor (1993)-type rules take the form

$$i_t^* = \hat{i} + \rho_\pi E_t(\pi_{t+p} - \pi^*) + \rho_y E_t y_{t+q} + \rho_f E_t \text{fin\_index}_{t+r}, \tag{1}$$

where i^* is the desired nominal interest rate, $\hat{i}$ is the equilibrium nominal interest rate, π is the inflation rate expected at time $(t+p)$, π^* is the inflation target (or desired rate of inflation), y is the output gap expected at time $(t+q)$, fin_index is a measure of the financial conditions gap at time $(t+r)$, ρ_π is the weight placed on inflation, ρ_y is the weight placed on the output gap, ρ_f is the weight placed on the financial index, and p, q and r may be positive or negative. Allowing for interest rate smoothing (e.g. Woodford, 2003) by assuming that the actual nominal interest rate, i_t, adjusts towards the desired rate via

$$i_t = \rho_i(L) i_{t-1} + (1-\rho_i) i_t^*, \tag{2}$$

we write the empirical Taylor rule as

$$i_t = \rho_i(L) i_{t-1} + (1-\rho_i)\{\rho_0 + \rho_\pi E_t \pi_{t+p} + \rho_y E_t y_{t+q} + \rho_f E_t \text{fin\_index}_{t+r}\} + \varepsilon_t. \tag{3}$$