



Can central banks' monetary policy be described by a linear (augmented) Taylor rule or by a nonlinear rule?☆

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ABSTRACT

The original Taylor rule establishes a simple linear relation between the interest rate, inflation and the output gap. An important extension to this rule is the assumption of a forward-looking behaviour of central banks. Now they are assumed to target expected inflation and output gap instead of current values of these variables. Using a forward-looking monetary policy reaction function, this paper analyses whether central banks' monetary policy can indeed be described by a linear Taylor rule or, instead, by a nonlinear rule. It also analyses whether that rule can be augmented with a financial conditions index containing information from some asset prices and financial variables. The results indicate that the monetary behaviour of the European Central Bank and Bank of England is best described by a nonlinear rule, but the behaviour of the Federal Reserve of the United States can be well described by a linear Taylor rule. Our evidence also suggests that only the European Central Bank is reacting to financial conditions.

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1. Introduction

Since the establishment, by Taylor (1993), of the linear algebraic interest rate rule that specifies how the Federal Reserve (Fed) of the United States (US) adjusts its Federal Funds target rate to current inflation and output gap, several papers have emerged to test the validity of that rule for other countries and time periods.

An important extension was provided by Clarida et al. (1998, 2000), who suggested the use of a forward-looking version of the Taylor rule where central banks target expected inflation and out-

put gap instead of past or current values of these variables. That practice allows the central bank to take various relevant variables into account when forming its forecasts.

More recently, some studies have extended the forward-looking Taylor rule by considering the effect of other variables in the conduct of monetary policy. One important extension is related to the inclusion of asset prices and financial variables in the rule.¹ This issue has caused a huge discussion in the literature: while some authors consider it important that central banks target asset prices, others disagree. To contribute to this discussion, we ask whether the basic Taylor rule could instead be augmented with an alternative variable that collects and synthesises the information from the asset and financial markets, i.e. whether central banks are targeting the relevant economic information contained in a group of financial variables and not simply targeting each financial variable *per se*. Thus, the first aim of this paper is to estimate a linear Taylor rule for the Eurozone, US and United Kingdom (UK) augmented with a financial conditions index that captures the relevant economic information contained in some financial variables. Instead

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¹ See, for example, Bernanke and Gertler (1999, 2001), Cecchetti et al. (2000), Chadha et al. (2004) and Driffill et al. (2006).

of relying on particular asset prices or financial variables, like other studies do, the index built in this paper synthesises the relevant information provided by those variables in a single variable where the weight of each asset and financial variable is allowed to vary over time. The central bank may not be targeting a particular asset or financial variable all the time, but it is possible that it may target it in some occasions, i.e. when, by some reason, it acquires particular economic relevance. Thus, synthesising the information from several assets and financial variables in a weighted index will permit to extract the particular economic relevance of each variable at each point in time and, therefore, put together an amount of information that is more likely to be targeted by the central bank at any time.

The results from the estimation of a linear forward-looking Taylor rule indicate that the European Central Bank (ECB) reacts to the information contained in the financial conditions index developed in this study, but the Fed and Bank of England (BOE) do not react to this information; they only take into account one or two financial variables and clearly do not target asset prices.

The traditional Taylor rule is a policy rule that is derived from the minimization of a symmetric quadratic central bank's loss function assuming that the aggregate supply function is linear. However, in reality, this may not be the case and the central bank can have asymmetric preferences, i.e. it might assign different weights to expected negative and positive inflation and output gaps in its loss function. In that case, they will be following not a linear but a nonlinear forward-looking Taylor rule. Only very recently some studies started to consider these asymmetries or nonlinearities in the analysis of monetary policy.² This paper extends the analysis into two areas not yet explored by those studies. First, it applies, for the first time, a nonlinear model to the study of the ECB's monetary policy, where the presence of asymmetries is taken into account directly in the structure of the model. This procedure will permit an answer to the following questions: Can the ECB's monetary policy be characterized by a nonlinear Taylor rule, or more precisely, is the ECB reacting differently to levels of inflation above and below the target? Does the ECB attempt to hit the inflation target precisely or keep inflation within a certain range? Second, this study also extends the nonlinear specification of the Taylor rule with the financial index used in the linear estimations to check whether, after controlling for nonlinearities, the ECB and the other two central banks are still (or not) reacting to the information contained in that index.

The results of the estimation of the nonlinear smooth transition regression model are very interesting. First, they show that the ECB's monetary policy is better described by a nonlinear monetary rule than by a linear Taylor rule: it only reacts actively to inflation when it is above 2.5%; and it only starts to react to the business cycle when inflation is stabilised, i.e. well below 2.5%. Although this estimated threshold is slightly higher than the official target of 2%, this is an empirical result that confirms quite remarkably the main principles of the ECB's monetary policy. Second, the results also show that the ECB – contrary to the other central banks – continues to consider the information contained in the financial index even after nonlinearities are controlled for. Third, we find weak evidence to reject the linear model for the US but not for the UK, where the BOE seems to be pursuing a target range of 1.8–2.4% for inflation rather than the current official point target of 2%.

The remainder of this paper is organized as follows: Section 2 presents a brief review of the literature on the Taylor rule. The specification used to estimate the linear Taylor rule is described

in Section 3; this section also presents the data and analyses the empirical results of the estimation of that specification. The model used to estimate the nonlinear Taylor rule is presented and analysed in Section 4, as well as the results of its estimation. Section 5 emphasises the main findings of this paper and concludes.

2. A brief review of the literature on the Taylor rule

This section intends to provide a brief review of the literature on the Taylor rule, emphasizing the main contributions that motivate the analysis presented in this paper.

In its original form, the Taylor rule assumes that central banks use past or current values of inflation and output gap to set up the interest rate. However, in practice, they tend to rely on all available information – concerning the expected evolution of prices – when defining the interest rate. For that reason, [Clarida et al. \(1998, 2000\)](#) suggest the use of a forward-looking version of the Taylor rule where central banks target expected inflation and output gap instead of past or current values of these variables. That practice allows the central bank to take various relevant variables into account when forming its forecasts.³ They prove its advantages in the analysis of the policy behaviour of the Fed and other influential central banks. [Fourçans and Vranceanu \(2004\)](#) and [Sauer and Sturm \(2007\)](#) also stress the importance of considering a forward-looking Taylor rule in the analysis of the ECB's monetary policy.

Some studies extend this linear rule by considering the effect of other variables in the conduct of monetary policy. For example, [Fourçans and Vranceanu \(2004\)](#) present some evidence of an ECB response to the exchange rate deviations from its average. A similar result is found by [Chadha et al. \(2004\)](#) for the Fed, Bank of England and Bank of Japan and by [Lubik and Schorfheide \(2007\)](#) for the central banks of Canada and England. Considering the role of money supply in the ECB reaction function, [Fendel and Frenkel \(2006\)](#) and [Surico \(2007b\)](#) conclude that it does not affect the ECB's behaviour directly but it is a good instrument to predict future inflation.

The role of asset prices is an important issue considered in some studies. However, no consensus was reached about whether the central bank should or should not target this kind of variables. [Cecchetti et al. \(2000\)](#), [Borio and Lowe \(2002\)](#), [Goodhart and Hofmann \(2002\)](#), [Sack and Rigobon \(2003\)](#), [Chadha et al. \(2004\)](#) and [Rotondi and Vaciago \(2005\)](#) consider it important that central banks target asset prices. They also provide strong support and evidence in that direction. On the contrary, [Bernanke and Gertler \(1999, 2001\)](#) and [Bullard and Schaling \(2002\)](#) do not agree with an ex-ante control over asset prices. They consider that once the predictive content of asset prices for inflation has been accounted for, monetary authorities should not respond to movements in assets prices. Instead, central banks should act only if it is expected that they affect inflation forecast or after the burst of a financial bubble in order to avoid damages to the real economy.⁴

On the other hand, [Driffill et al. \(2006\)](#) analyse the interactions between monetary policy and the futures market in the context of a linear reaction function. They find evidence supporting the inclusion of futures prices in the central bank's reaction function as a proxy for financial stability. Moreover, [Kajuth \(forthcoming\)](#) shows that monetary policy should also react to house prices due

³ [Clarida et al. \(1998, 2000\)](#) also suggest the inclusion of an interest rate smoothing in the estimation of the Taylor rule. The reasons for its inclusion are discussed below in the description of the model.

⁴ [Disyatat \(2010\)](#) examines how an appropriate monetary policy reaction to asset prices could be operationalized when a concern for financial stability is explicitly included in the central bank loss function. On a different level, [von Peter \(2009\)](#) looks at a model where asset prices affect banks' balance sheets.

² See [Martin and Milas \(2004\)](#), [Taylor and Davradakis \(2006\)](#), [Surico \(2007a, 2007b\)](#) and [Petersen \(2007\)](#).

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