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Forecast uncertainty and the Taylor rule [☆]

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ABSTRACT

In this paper, we derive a modification of a forward-looking Taylor rule by integrating two variables that measure the uncertainty of inflation and GDP growth forecasts into an otherwise standard New Keynesian model. We show that certainty-equivalence in New Keynesian models is a consequence of log-linearization and that a second-order Taylor approximation leads to a reaction function that includes the uncertainty of macroeconomic expectations. To test the model empirically, we use the standard deviation of individual forecasts around the median Consensus Forecast as a proxy for forecast uncertainty. Our sample covers the euro area, the United Kingdom, and the United States for the period 1990Q1–2016Q4. We find that the Bank of England and the European Central Bank have a significantly negative reaction to inflation forecast uncertainty. Our findings also reveal that the Federal Reserve (Bank of England) lowers (raises) its interest rate in response to higher GDP growth forecast uncertainty. We conclude by offering some implications for optimal monetary policy rules and central bank watchers.

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1. Introduction

The former Chairman of the Federal Reserve (Fed), Alan Greenspan, when writing about his inside view on how monetary policy is instituted, states that the Fed is well aware of the effects of uncertainty on macroeconomic variables (Greenspan, 2004). Such uncertainties may stem from two sources. On the one hand, future values of macroeconomic variables are part of the central bank's policy objectives and their expectations influence current values. On the other hand, there are unobservable variables and problems with measuring the relevant variables in real-time.

The relevance of macroeconomic uncertainty for the rule formation of central banks has been extensively discussed in the theoretical literature. Swanson (2004) states that “a standard result in the literature of monetary policy is that of certainty-equivalence: Given the expected value of the state variables of the economy, policy should be independent of the higher moments of those variables.” This view is based on a series of seminal papers. Orphanides (2003) shows that certainty-equivalence holds for linear-quadratic models with unobserved or real-time data and emphasizes that the independence of the parameters holds only if the optimal rule is based on the expected values of the macroeconomic variables rather than their measured values. Svensson and Woodford (2003) find that “the optimal response to the optimal estimate of potential

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output displays certainty-equivalence, whereas the optimal response to the imperfect observation of output depends on the noise in this observation.” These and all subsequent papers on certainty-equivalence deal with more or less complex, but still linear models of the economy. Central bankers consider this linearity to be a shortcoming of these models. Greenspan (2004), for example, states that when making their decisions, the Fed takes into account the insufficiencies of the commonly used linear macroeconomic models. Nevertheless, to this point in time and to the best of our knowledge, the certainty-equivalence principle holds for all derivations of monetary policy rules in linear New Keynesian models (NKM) (see also, the textbooks by Gali (2008) and Walsh (2010)).

So far, few alternatives have been analyzed. For instance, Swanson (2004) shows that an exception to the result of certainty-equivalence is possible only if the policy rule is expressed in reduced form and relevant unobserved variables are estimated in a signal extraction sense. Consequently, our paper's first contribution is to close this gap between academic theory and the de facto behavior of central bankers. Our results indicate that a small deviation from log-linearization, the second-order approximation of the DIS, leads to a failure of certainty-equivalence. The basic intuition is quite simple. Log-linearizing the variables within the expectation operator eliminates higher order moments. In contrast, using a second-order Taylor approximation preserves the second moments and the variance remains relevant for the optimal policy rule.¹

Accordingly, we present a modification of a forward-looking Taylor rule, which integrates two variables measuring the uncertainty of inflation and GDP growth forecasts into an otherwise standard NKM. One implication is that Taylor-type optimal policy rules should not ignore the uncertainty of macroeconomic variables when taking the cautious behavior of central bankers seriously. Because we do not rely on the signal extraction interpretation of the unobserved variables, but rather on a finer approximation of the optimization calculus, our policy rule is different from that developed by Swanson (2004). As a consequence, uncertainty enters the reaction function in Swanson's model, (2004) via the weight of the level variables, whereas our approach allows for a separate reaction to forecast uncertainty.²

There has also been little research into the question of how central banks empirically deal with the uncertainty of macroeconomic forecasts in their reaction function. Extant papers on Taylor (1993) and its modifications (see among many others, Clarida et al., 1998; Orphanides, 2001) have focused on the point estimates of macroeconomic forecasts and ignored the uncertainty of these forecasts. To the best of our knowledge, there are only three exceptions. Branch (2014) augments a Taylor rule for the US with indicators of uncertainty obtained from the *Survey of Professional Forecasters*. He finds that the Fed negatively responded to both uncertainty in the inflation nowcast and uncertainty to the output gap nowcast during the period 1993Q1–2008Q3. In addition, Martin and Milas (2009) assume noise dependent coefficients for a rule based on expected values and find that the Fed responded less vigorously to inflation and the output gap when these variables are observed with less certainty during the period 1983Q1–2003Q4. Gnabo and Moccerro (2005) find in a regime switching model that risk in the inflation outlook and volatility in financial markets are a powerful driver of monetary policy regime changes in the US.

Another branch of the empirical Taylor rule literature, which is closely related to this paper, includes work by Nobay and Peel (2003). If central bankers have an asymmetric loss function, this might translate into a reaction function with larger parameters for negative (positive) deviations of inflation or output from target compared to positive (negative) deviations, or into state-dependent parameters for contractions and expansions.³ Such an asymmetric loss function might also be relevant in the context of macroeconomic forecasts. As mentioned before, monetary policy is supposed to be forward-looking. Consequently, policymakers have to deal with more or less certain forecasts when they determine the appropriate level of the policy rate. They have to decide whether to weigh the upward and downward risks of a forecast as balanced, or to give one of these risks more weight in formulating their decision. For instance, a high degree of inflation forecast uncertainty, and a relatively stronger aversion of overshooting the inflation target (IT), should translate into a positive reaction to the uncertainty of inflation expectations. Similarly, when the central bank is more recession-averse and observes a high degree of GDP forecast uncertainty it should lower its policy rate. From this point of view, there are also possible scenarios that might compel a central bank to react to the second moment of inflation or growth expectations.⁴

Given the scant empirical literature on how central bankers deal with the uncertainty of macroeconomic forecasts, the second contribution of our paper is to empirically test a forward-looking Taylor rule with inflation forecast uncertainty and GDP growth forecast uncertainty. For that purpose, we rely on the dataset of individual forecasters provided by *Consensus Economics* and use the standard deviation of individual forecasts around the median forecast as a proxy for forecast uncertainty.⁵ Our sample covers, arguably, the three largest and most important central banks worldwide: the European Central Bank (ECB), the Bank of England (BOE), and the Fed for the period 1990Q1–2016Q4. Using this sample and time period allows us to compare not only the reaction to uncertainty of several central banks, but also to look at their forecast error risk aversion

¹ The results of Schmitt-Grohe and Uribe (2004), who discuss the properties of second-order Taylor approximations of a certain class of DSGE models, are not directly applicable to NKMs.

² We also use the dataset and empirical methodology described in Section 3 to estimate Swanson's model, (2004). However, the resulting coefficients on the uncertainty weights are, if significant at all, not robust for the three different sets of estimations.

³ Empirical contributions include, among others, Ruge-Murcia (2003) and Surico (2007a,b).

⁴ In addition, an asymmetric loss function can be relevant in the forecast-generating process, as well. See, for instance, Patton and Timmermann (2007) and Capistran (2008). If central bankers fear under-predicting inflation they will adjust their forecast of inflation up by a factor that increases in forecast uncertainty.

⁵ These forecasts are a reasonable proxy for central bank forecasts, because professional forecasters have very similar backgrounds to staff economists at central banks.

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