North American Journal of Economics and Finance 23 (2012) 228–245

Contents lists available at SciVerse ScienceDirect

North American Journal of Economics and Finance

Decomposing Federal Funds Rate forecast uncertainty using time-varying Taylor rules and real-time data

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ARTICLE INFO

Article history:
Received 24 March 2011
Received in revised form 29 January 2012
Accepted 31 January 2012

JEL classification:
E52
E37
C22
C53

Keywords:
Monetary policy reaction function
Interest rate uncertainty
state-space model

ABSTRACT

This paper studies uncertainty about out-of-sample interest rate forecasts implied by an estimated Taylor rule. It is shown that the Taylor rule leads to a decomposition of forecast uncertainty into an element that depends on uncertainty about the future state of the economy and another element that is related to uncertainty about the monetary policy reaction function of the Federal Reserve. Uncertainty about one-quarter ahead Federal Funds Rate forecasts from 1975 to 2007 is estimated and analyzed using a real-time data set for the U.S.

1. Introduction

The Taylor rule (Taylor, 1993) is the most widely used approximate description of the Federal Reserve's monetary policy. It relates the Federal Funds Rate – the Federal Reserve's policy instrument – to the state of the economy as expressed by the current or expected inflation rate and output gap. In the standard New Keynesian macroeconomic model the central bank's interest rate policy is most often assumed to follow a Taylor rule or some variation of it (e.g. Galí, 2008; Woodford, 2003). Furthermore, there is a wealth of empirical papers that estimate Taylor rules for the Federal Reserve or other central banks applying a broad range of econometric approaches (e.g. Boivin, 2006; Clarida, Galí, & Gertler, 2000; Kim & Nelson, 2006). Since estimated Taylor rules have shown considerable success in tracking

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doi:10.1016/j.najef.2012.01.003

the actual time series of the Federal Funds Rate participants in financial markets have started using Taylor rules as forecasting tools (e.g. Payne, 2001).

One very interesting implication of using Taylor rules to forecast the Federal Funds Rate is that it links systematically the expected Federal Funds Rate to expectations of future economic fundamentals (inflation rates and output gaps). This allows for a decomposition of forecast uncertainty into a component related to uncertainty about expected future fundamentals and another component related to uncertainty about how the Federal Funds Rate will respond to these fundamentals, i.e. uncertainty about the Taylor rule.

The first uncertainty component results from the fact that forecasting with a Taylor rule requires predictions of the state of the economy the central bank will have to respond to in the future. Since the information the central bank will respond to in the future is not known by private agents today and has to be forecast itself there is uncertainty about the interest rate predictions due to uncertainty about future fundamentals.

The second element of uncertainty is caused by imperfect knowledge about how the central bank will react to given future economic conditions: Estimated Taylor rule coefficients have been shown to change over time (e.g. Clarida et al., 2000; Gordon, 2005; Judd & Rudebusch, 1998; Mehra, 1999; Tchaidze, 2001). This variation in the reaction coefficients is a second source of uncertainty about the Federal Funds Rate forecast derived from a Taylor rule.

A final element of uncertainty about Federal Funds Rate forecasts is due to the fact that the estimated Taylor rule is an approximation to the actual monetary policy reaction of the central bank. It is captured by the error term in the empirically estimated interest rate rule.

In this paper I demonstrate how interest rate forecast uncertainty implied by an estimated Taylor rule can be decomposed into these different components. For this we combine an estimated time-varying Taylor rule and a forecasting model for economic fundamentals. In order to approximate the information set Federal Funds Rate forecasts would have been based on the results presented in this paper are derived from recursive estimates using a real-time data set of macroeconomic variables.

Our results show that uncertainty about the reaction of the central bank to given expectations about economic fundamentals contributed strongly to interest rate uncertainty in specific time periods. In particular, uncertainty about future interest rates was dominated by uncertainty about the Fed's behavior in the 1970s and early 1980s. We show this to be not only caused by an increase in the volatility of the unsystematic component of monetary policy (the residual variance) but also by a rise in uncertainty about possible changes in the Fed's systematic reaction to economic conditions, i.e. the reaction function coefficients. Furthermore, this uncertainty element is found to be much more volatile than uncertainty about the future state of the economy which tends to evolve more gradually.

The empirical importance of time variation in uncertainty about short-term interest rates has been documented in many studies, e.g. Caporale and Cippolini (2002), Chuderewicz (2002), Fornari (2005), Lanne and Saikkonen (2003) and Swanson (2006). In contrast to these studies which all present results for the uncertainty about future interest rates our approach focuses on the decomposition of this uncertainty into uncertainty associated with systematic and unsystematic monetary policy reactions (coefficients and residual) and uncertainty about future economic fundamentals.

Quantitative estimates of interest-rate uncertainty are important because empirical studies have presented evidence for negative effects of interest-rate uncertainty on the real economy. Theoretical models of investment under uncertainty argue that an increase in uncertainty raises the option value of waiting and depresses investment (e.g. Dixit & Pindyck, 1994; Ingersoll & Ross, 1992). Leahy and Whited (1996) argue for the possibility of a positive relationship between investment and uncertainty that is based on the value of the firm being a convex function of interest rates. In their model a mean preserving increase in interest rate volatility raises the expected value of the firm and stimulates investment.

Empirical evidence on the sign of the relationship between real economic activity and interest-rate uncertainty is mixed.[1] Among the more recent empirical studies, Byrne and Davis (2005) estimate a significantly negative effect of uncertainty on investment in the G7 countries. Chuderewicz (2002)

[1] See Leahy and Whited (1996) for a survey.