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A Bayesian interpretation of the Federal Reserve's dual mandate and the Taylor Rule ☆

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ABSTRACT

When the Federal Reserve was established by the US Congress in 1913, its charter mandated that the new central bank "promote an elastic currency" and the institution was given extraordinary powers to serve as a lender of last resort to the banking system. Congress was reacting to the cycle of financial panics that had beset the country since the Civil War and had worsened with the Panic of 1907. Congress sought to find a remedy to prevent runs on banks turning into full-fledged financial crises. The term "elastic" in the opening words of the charter was intended to underscore the need for a robust banking system that could withstand shocks and not collapse upon itself. There was no mention whatsoever of a dual mandate of promoting price stability and encouraging full employment.

With prodding from the US Congress, the Federal Reserve became highly involved in the management of the economy of the United States after WWII, focusing on inflation and full employment objectives. In 1993 Professor John Taylor set forth an elegant and simple framework (aka, the Taylor Rule) for analyzing the interest rate policy of the Federal Reserve in terms of its dual mandate.

This paper examines Federal Reserve behavior from the mid-1950s to 2011 through the lens of the Taylor Rule. Our contribution is to use a dynamic linear model with Bayesian inference to update the evolution through time of the key parameters surrounding the inflation and full employment mandates, using only the information available to the Federal Reserve at each point in time. Our findings provide a more nuanced quantitative view than is previously available in the literature of how the Federal Reserve shifted its management of its dual mandate over time and in response to different economic challenges. Moreover, our research leads to serious questions of how Federal Reserve decision making may change in the future, following the financial panic of 2008, pointing toward numerous avenues for new research.

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1. Introduction

After the Panic of 1907, the US Congress moved to establish a central bank with the powers to serve as a lender of last resort and prevent runs on banks turning into full-fledged financial crises. The Federal Reserve came into being in 1913, and its charter mandated that the new central bank "promote an elastic currency". The term "elastic" in the opening words of the charter was intended to underscore the need for a robust banking system that could withstand shocks and not collapse upon itself. There was no mention whatsoever of a dual mandate of promoting price stability and encouraging full employment. The dual mandate concept emerged after World War II, as the US Congress reflected back on the Federal Reserve's near total abrogation of its assigned duties in the 1930s with its failure to serve as a lender of the last resort as had been intended.

Congress passed the Employment Act of 1946, and later the Full Employment and Balanced Growth Act of 1978 (Humphrey–Hawkins), along with other amendments to the Federal Reserve Act, which collectively and over time enshrined the dual mandate of price stability and full employment into law. Since the 1950s and well before the Humphrey–Hawkins Act of 1978, the Federal Reserve had become highly involved in the management of the economy of the United States to serve both inflation and full employment objectives.

In 1993 Professor John Taylor set forth an elegant and simple framework (aka, the Taylor Rule) for analyzing the interest rate policy of the Federal Reserve in terms of its dual mandate. Our Bayesian inference methodology allows for a sophisticated and nuanced quantitative perspective of how the Federal Reserve shifted its management of its twin objectives over time and in response to the different economic challenges it faced.

To highlight the research implications, our interpretation of our empirical results suggests the following:

- ➢ Our Bayesian approach broadly confirms that the Federal Reserve pays active attention to balancing the inflation and full employment of its dual mandate more or less along the lines suggested by the original Taylor Rule.

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- ➢ The Federal Reserve typically puts more emphasis on output and employment data than inflation data, however, we believe this is because the Federal Reserve in its collective wisdom appears to use its output projections as a critical input into whether it is willing to project rising or falling inflation for the future. This dependence of the inflation projection on the output projection is a severe complication for estimation techniques that assume that the output and inflation factors are truly independent, when they may not be.
- ➢ We also note that from time to time in the past, there appears to have been short periods when inflation pressures pre-occupied the Federal Reserve. Periods such as in the late 1960s or the 1979–1982 period were interesting, because during these periods the Federal Reserve may well have been willing to risk (or even cause) a recession to get better control of inflation. In the same vein, the Federal Reserve appears to have acted in the periods following the 2008 financial crisis in a manner that suggests the Federal Reserve was either worried about deflation or actively would like to have encouraged a little more inflation.
- ➢ These nuanced observations and interpretations are made possible by the use of the Bayesian dynamic linear modeling approach which treats the beta coefficients as time-varying parameters to be estimated as they evolve through time. This Bayesian approach allows for a much more sophisticated and rich interpretation of the Federal Reserve's interest rate decision process than could have been obtained by standard regression analysis techniques that assume away the possibility of time-varying beta coefficients in the first place.

The paper is organized as follows. In Section 2, we present a brief synopsis of the Taylor Rule literature and present the original equation describing how the Federal Reserve might target its interest rate policy decisions to meet its dual mandate of price stability and full employment. Section 3 focuses on how we setup the equations for our empirical analysis and describes the data used in the study. Section 4 answers the question of why we decided to apply Bayesian inference methods and chose a one-step ahead dynamic linear modeling process. Section 5 presents our findings and provides possible interpretations. In Section 6, we conclude the paper with some observations about how Federal Reserve decision making may change in the coming decade and point toward potential paths for future research.

2. Original Taylor Rule formulation from the economic literature

What has become known as the Taylor Rule was first set forth in Taylor (1993a, 1993b), with later modifications by Taylor (1994, 1996). While the modifications to the Taylor Rule are interesting, the original formulation provides an extremely clear framework for analyzing how a short-run interest rate policy might be conducted to balance the trade-offs of the dual mandate to promote price stability and encourage full employment. The original Taylor Rule formulation was as follows:

$$\begin{aligned}\text{Target federal funds rate}\\ &= (\text{actual inflation rate}) - (\text{short} - \text{term real rate assumption})\\ &\quad + 0.5 \times (\text{actual inflation} - \text{desired inflation})\\ &\quad + 0.5 \times (\text{output gap in percentage terms}).\end{aligned} \tag{1}$$

With the Taylor Rule framework in hand, one could compare the target federal funds rate as implied by the Taylor Rule to the effective federal funds rate that prevailed in the short-term money markets over time (See Fig. 1.)

The usefulness of the Taylor Rule as a framework for analyzing the trade-offs involved in the dual mandate of the Federal Reserve is probably nowhere better underscored than the mere fact that such a straightforward equation became widely known as the Taylor Rule. Indeed, there have been numerous Taylor Rule studies, including Woodford (2001), Smets (2002), and Orphanides (2003), which contain many more references to previous studies. The overriding message from the economic literature is that the Taylor Rule is a great starting point for analyzing Federal Reserve interest rate policy decisions, and then expanding the analysis into the subtleties of how the Federal Reserve measures and monitors the data informing its policy decisions. That is, for example, on the full employment side, is the Federal Reserve more focused employment data, unemployment data, or output gap data? On the inflation side, the data monitoring questions revolve around the use of the personal consumption expenditure deflator, core consumer prices excluding energy and food, or the generally inclusive consumer price index. There are also different formulations of the Taylor Rule, to look at changes in the trends for employment or inflation to add more information and nuance to the original equation.

What has been missing from the literature is a dynamic estimation approach that allows one to analyze how the Federal Reserve's adherence to the Taylor Rule has changed over time or in response to different economic conditions. The dynamic linear modeling approach utilized here is the one-step ahead Bayesian methodology with its theoretical origins outlined succinctly in Harrison and West (1997), which is based on their earlier work from the 1980s. An applied example of the one-step Bayesian dynamic linear modeling methodology is contained in Harrison, Pole, and West (1994). Early applications of the Harrison and West one-step ahead Bayesian approach to financial modeling problems were pioneered by Putnam and Quintana (1994) and Putnam, Quintana, and Wilford (1998), among others.

Our approach is to combine these different strands of literature. We pair the study of the Federal Reserve's interest rate decision process using the Taylor Rule as the basic framework for analysis with dynamic Bayesian statistical methods. Using this dynamic estimation approach we can observe how the Federal Reserve shifted its emphasis from full employment to inflation or to some other external factor given the economic context.

3. Estimation equations, data sources and transformations

Our first estimation equation using the Taylor Rule framework to analyze Federal Reserve behavior is simply to compare the target federal funds rate as specified by the original Taylor Rule (Eq. (1)) with the observed effective federal funds rate. Our initial estimation equation is as follows:

$$\begin{aligned}\text{Level of federal funds rate}\\ &= \beta(1)\times \text{target federal funds rate given by the original Taylor Rule}\\ &\quad + \text{error term}.\end{aligned} \tag{2}$$

While this basic estimation equation yields some interesting insights as described later, we also wanted to decompose the Taylor Rule framework into its two parts representing the dual mandate for price stability and full employment. Specifically, our decomposition estimation equation is as follows:

$$\begin{aligned}\text{Adjusted level of federal funds rate}\\ &= \beta(0) \times \text{constant} + \beta(1) \times (\text{inflation–desired inflation}) + \beta(2)\\ &\quad \times (\text{output gap}) + \text{error term}.\end{aligned} \tag{3}$$

Where, the adjusted level of federal funds rate = actual level of federal funds rate − actual Inflation rate + short-term real rate assumption. This adjustment takes us back to the original Taylor Rule equation so that we can assess whether the estimated β(1) and β(2) are stable and close to their expected values of 0.5 given the Taylor Rule or not as well as to learn from their evolution through time.

Our last formulation is to focus on whether shorter-term data that provides the Federal Reserve with information about how inflation and employment trends are evolving, such as toward the Federal Reserve's objectives or away from them, could further influence the

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