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Inferring monetary policy objectives with a partially observed state

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ABSTRACT

Accounting for the uncertainty in real-time perceptions of the state of the economy is believed to be critical for monetary policy analysis. We investigate this claim through the lens of a New Keynesian model with optimal discretionary policy and partial information. Structural parameters are estimated using a data set that includes real-time and *ex post* revised observations spanning 1965–2010. In comparison to a standard complete information model, our estimates reveal that under partial information: (i) the Federal Reserve demonstrates a significant concern for stabilizing the output gap after 1979, (ii) the model's fit with revised data improves, and (iii) the tension between optimal and observed policy is smaller.

1. Introduction

Central banks face the difficult task of conducting monetary policy in situations where real-time uncertainty about the state of the economy is pervasive. Uncertainty of this kind has two sources. One is the noise contained in preliminary measures of economic activity, such as output and inflation, that are used by policymakers to forecast the state. Data on these variables are continually revised over time, so the true values are not known until long after they are first released and policy decisions have been made (e.g., Croushore and Stark, 2001). A second source of uncertainty concerns estimates of economic concepts that are not directly observable but still play a vital role in the policy process. The natural rates of output and unemployment are prominent examples. Forming inferences about these variables requires a statistical model that specifies how they are related to observed data. Given the uncertainty over such models and in published data, it is common for real-time estimates of the natural rates to be way off the mark (e.g., Kuttner, 1994; Orphanides and van Norden, 2002).

Because monetary policy depends on the central bank's perception of the state of the economy, correctly interpreting historical policy behavior demands that one account for the type of informational limitations described above. Athanasios Orphanides was one of the first to point this out in a series of influential papers (e.g., Orphanides, 2001, 2002, 2004) that questioned the value of policy analysis based on data other than what policymakers actually encountered at the time decisions were being made. Using the simple rule proposed by Taylor (1993) as an example, Orphanides (2001) showed that

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policy recommendations implied by real-time data are often at odds with those obtained from *ex post* revised data. Moreover, estimating rules using only the latest information can obscure one's view of the way monetary authorities reacted to economic conditions as they appeared at the time. To identify the policy motives of the past, it is thus imperative to understand what the central bank was seeing at the moment its policies were implemented.

The papers written by Orphanides belong to a large literature that uses the Taylor rule as a means of describing historical monetary policy (e.g., Clarida et al., 2000). Yet, some have argued that these rules are hard to interpret because the feedback coefficients do not map uniquely into the deep parameters that represent the preferences of the policy authority. The key insight is that Taylor-type rules can be derived endogenously by solving an explicit optimization problem for the central bank (e.g., Svensson, 1997). It follows that estimated policy-rule coefficients may depend on the various weights in the central bank's objective function in addition to the parameters characterizing the structure of the economy. Disentangling the two requires an econometric procedure that acknowledges the policymaker's optimization problem during the course of estimation (e.g., Favero and Rovelli, 2003; Ozlale, 2003; Dennis, 2006; Salemi, 2006). The usual strategy is to estimate a model of private behavior subject to the restriction that monetary policy is optimal. Such an exercise enables one to obtain joint estimates of the structural parameters and the weights in the policy objective function that identify central bank preferences.

To date, most of the papers that try to explain policy as the outcome of an optimization problem assume that agents are perfectly informed about the state of the economy. Since there is no conflict between real-time and revised concepts under perfect information, the models featured in this literature are typically estimated with *ex post* revised data. However, this type of analysis appears as vulnerable to the Orphanides critique as those based on the Taylor rule, which treats central bank behavior as a primitive rather than the product of rational optimization. By endowing agents with full information and ignoring the intrinsic uncertainty of real-time data, the researcher is viewing history through a distorted lens. Attempts to validate such a model empirically may produce biased estimates of the economic structure and, in particular, the policy objective function.

Our paper continues the line of research dating back to Salemi (1995) that estimates the parameters of the central bank's objective function.[1] However, we break from standard practice by utilizing a model in which agents only have partial knowledge of the state. Every period private agents and the central bank derive an optimal estimate of the state vector by filtering information contained in a small set of noisy indicators. The central bank then implements an optimal policy conditional on its current beliefs while the private sector forms expectations consistent with the chosen policy. Thus in our model policy decisions depend on real-time perceptions of the state instead of the actual state as would be the case under complete information. The optimal-filtering (signal-extraction) mechanism also provides a way to track the evolution of these perceptions through time. Orphanides (2004) contends that both features are essential for correctly identifying historical policy objectives.

Estimation is performed on a semi-structural New Keynesian model of output-inflation dynamics. The concept of natural output has a dual role; it appears as an exogenous forcing variable in the Phillips curve and as the target for real output in the policy objective function. Regarding the information structure, we assume that private agents and the central bank observe noisy current-period measures of output growth, inflation, and the unemployment rate, the latter of which is linked to the model through an Okun's Law relationship. Using the methodological approach outlined in Svensson and Woodford (2003), both sets of agents obtain an efficient estimate of the state vector by means of a Kalman-filter updating equation. Given its estimate of the state, the central bank sets the nominal interest rate to minimize a weighted quadratic loss function under discretion. The arguments in the loss function include deviations of inflation and output from target and changes in the interest rate.

To estimate our partial information model, we employ a data set that combines real-time and *ex post* revised data from 1965:Q4 to 2010:Q1. Using real-time data to estimate the loss function is a departure from much of the extant literature that relies exclusively on revised data (e.g., Dennis, 2006; Ilbas, 2012). In those studies omitting real-time data makes sense because agents are assumed to know the true value of the state at each point in time. By contrast, our model recognizes a distinction between the true state and the indicators that agents observe in real time. The consistent approach here is to identify the former with revised data but the latter with data that was available when past decisions were made.

Since the goal of this paper is to ascertain the empirical consequences of placing information constraints on a model with optimal policy, we take a page from the previous literature by estimating a second model that differs from our preferred model only in assuming agents have complete knowledge of the state. We then report those estimates alongside our partial information estimates. Comparing the results helps clarify the effect that informational assumptions have on estimates of structural parameters and loss function weights.

We find that uncertainty about the state impacts estimates of the model and the loss function in particular. Because our sample includes the chairmanship of Paul Volcker, a period in which a shift in Federal Reserve policy is believed to have occurred, we split the data set into two subsamples. The first covers the period ending in 1979:Q2 and the second covers the period starting in 1979:Q3. The breakpoint marks the beginning of Volcker's term. Under partial information the weight on the output gap objective (i.e., the gap between actual output and the natural rate) relative to inflation is about one-fourth and is statistically significant after 1979. Under complete information the output gap weight is not significantly different from zero before or after 1979, echoing results from previous studies that disregard information frictions altogether. The

[1] Early examples in this literature are Cecchetti et al. (2002), Dennis (2004), Söderström et al. (2005), and Cecchetti et al. (2006). More recent contributions include Givens and Salemi (2008), Ilbas (2012), and Givens (2012).