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Monetary policy regimes and the term structure of interest rates☆

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ABSTRACT

US monetary policy is investigated using a regime-switching no-arbitrage term structure model that relies on inflation, output, and the short interest rate as factors. The model is complemented with a set of assumptions that allow the dynamics of the private sector to be separated from monetary policy. The monetary policy regimes cannot be estimated if the yield curve is ignored during estimation. Counterfactual analysis evaluates importance of regimes in policy and shocks for the great moderation. The low-volatility regime of exogenous shocks plays an important role. Monetary policy contributes by trading off asymmetric responses of output and inflation under different regimes.

1. Introduction

That monetary policy matters for the real economy is widely accepted in modern macroeconomics (e.g., Woodford, 2003). Moreover, many researchers believe that monetary policy has improved over time. In particular, the post-1982 decline in the volatility of output and inflation (the great moderation) is an outcome of changing monetary policy. However, this belief is a matter of active debate in the literature. Earlier studies (e.g., Clarida et al., 2000) assume a break point and find different reactions to expected inflation in the interest rate rules that are estimated before and after the break. More recent work (e.g., Sims and Zha, 2006) explicitly models regime changes in monetary policy and in the volatility of exogenous shocks and finds that, most likely, the regimes affected the economy via the changing shocks to the private sector. More generally, it is of the utmost importance to describe the forces that shape fluctuations in the business cycle. Time-varying volatility of shocks and monetary policy are two plausible mechanisms that can generate the aggregate volatility. Thus, understanding their interaction transcends the specific task of explaining the great moderation.

This paper contributes to the debate on the sources of aggregate fluctuations by arguing that monetary policy regimes may not be estimated precisely if one uses information from the short interest rate only. We propose to incorporate the information from the cross-section of yields, which by its nature is forward-looking and thereby reflects market-based expectations of the monetary policy that will be implemented in the future. We incorporate this information by proposing a novel no-arbitrage term structure model, which allows for regime shifts in the monetary policy and in the shocks to the private sector. We show, via a Monte Carlo analysis, that the yields of several maturities can be helpful in identifying monetary policy. We find that US monetary policy can be characterized as switching between active and passive regimes, judging by the differential response of the interest rate to expected inflation.

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The finance literature has produced a number of important contributions on yield curve modeling with regime shifts.[1] However, all of the existing finance models are reduced-form models. This means that one cannot isolate the regime switches in the structural shocks to the economy from the regime switches in the monetary policy. For this reason, we complement the traditional no-arbitrage setup with structural assumptions.

We impose these assumptions in the spirit of the structural VAR literature. That is, we explicitly posit a monetary policy reaction function and the dynamics of the macro economy. However, our specification is silent about investors' preferences and how they are connected to the model's parameters. The advantage of this approach is that the model is less restrictive than explicit structural models and thus allows for a greater degree of realism.

We dispense with the latent factors that are traditionally encountered in finance models and rely only on three observable variables: inflation, output, and the short interest rate. The economy's (inflation and output) behavior is driven by past, current, and expected future values of inflation and output. We assume that the short interest rate is the monetary policy instrument. Similar to forward-looking Taylor rules, the monetary policy responds to expected future inflation and current output. We also allow for some degree of policy inertia by positing a response to the past interest rate.

We allow for three regime variables in our model. The first shifts the volatilities of exogenous inflation and output shocks. The second switches the parameters in the systematic monetary policy reaction function modeled as a forward-looking interest rate rule. The third affects the volatility of the monetary policy shock.

We provide a numerical rational expectations solution of the model with regime shifts.[2] The solution helps by relating the cross-section of yields to the current values of the three observed variables using the tools of the of regime-switching affine models. Given the structural assumptions that we have made, we are not free to choose a convenient parameterization of the dynamics of the state vector that allows closed-form bond prices to be obtained.[3] We propose a new approximate solution, which we show to be more precise than the log-linearization that is typically used in the literature.[4]

Our estimation results indicate the presence of at least two regimes for the volatilities of inflation and output shocks, two for the systematic monetary policy, and two for the volatility of the monetary shock. Given that any combination of these regimes can be realized at any particular time, there are a total of eight possible regimes in the economy. The high-volatility regime for inflation and output shocks is associated mainly with oil shocks and recessions. In this regime both shocks are more volatile than in the low-volatility regime. The two monetary policy regimes are distinguished clearly from each other by how the Federal Reserve (the Fed hereafter) reacts to expected inflation. In the "active" regime, the Fed reacts aggressively to expected inflation in order to stabilize prices. This policy was implemented in the 1970s and throughout Volcker's disinflation period. It has also prevailed since 2002. In the other, "passive", regime the reaction to expected inflation is far less strong. The "passive" policy was implemented in the 1970s and prevailed during the monetary experiment and the internet bubble of 1995–2001. The high and low regimes for the volatility of monetary shock are interpreted as "discretion" and "commitment" respectively. These two regimes were each implemented at sporadic intervals in the sample.

When confronted with a dataset that does not include long-term bonds, our model yields similar results for regimes in volatility but very different estimates of monetary policy regimes. Intuitively, the yield curve contains information about expected future interest rates, which, in particular, reflect the probabilities that a particular policy is being implemented. A simulation study suggests that using the yield curve reduces the bias of the estimated monetary policy regime by a factor of 20. These findings indicate the importance of using the whole term structure for identifying policy regimes.

Because our model specification allows us to differentiate between monetary and private sector regimes, we can evaluate the effects of these different regimes on the economy and the yield curve. We do so by simulating counterfactual economies. These economies are driven by the shocks realized in our sample, but are contrary to fact in that only one of the eight possible regimes prevails throughout the full sample. By using these counterfactual economies, we can contrast active and passive monetary regimes by holding other regimes constant. For example, we can assume low volatility of output and inflation shocks, the commitment regime of monetary policy shocks, and then allow either passive or active policy to prevail throughout the full sample. Comparing the resulting output, inflation, and yields allows us to characterize the effect of a specific monetary policy.

Using the counterfactual analysis as a basis, we report that a nearly permanent transition from high to low volatility of exogenous shocks to output and inflation made a large contribution to the great moderation. However, this is an incomplete explanation of the real economy's improvement over the last two decades.

We show via impulse responses that output and inflation react asymmetrically in the two monetary regimes, depending on the type of exogenous shock (output or inflation). In the case of output shock, inflation declines much faster in the active regime, whereas output reacts in a similar fashion across all the regimes. In the case of inflation shock, there is a trade-off between active and passive regimes, in that each of the two objectives of monetary policy — stable inflation and output — are easier to achieve in different policy regimes. Inflation declines fast (a desirable outcome) in response to either a shock in inflation or output in the active regime. Output does not decline (a desirable outcome) in response to an inflation shock in the passive regime and has a similar response to output shock across the regimes. Building on this observation, we show, using the mean and volatility of macro variables and yields as a basis, that the realized shocks were such that the Fed had to face the noted trade-off between active and passive policies, because no single regime uniformly dominated the others in our sample. Due to the fact that the inflation realized during the post-1982 sample is, on average, lower and less volatile than inflation in any of the individual regimes, the changing monetary policy contributed to the great moderation in addition to the "lucky" low-volatility exogenous shocks.

The topic of our paper bridges two strands of the macro literature. One strand is concerned with understanding the role of the time-varying volatility of exogenous shocks vis-a-vis time-varying monetary policy in generating fluctuations in the business cycle. Researchers of this topic allow for time-varying volatility of shocks, use macro data only, and estimate models in which structural restrictions are imposed with varying degrees of severity. The conclusions vary. Cogley and Sargent (2005) find evidence of varying persistence of inflation and conclude that monetary policy was

[1] Latent factor regime-switching no-arbitrage models of term structure are represented by the works of Bansal and Zhou (2002), Bansal et al. (2004) and Dai et al. (2007), among others. Ang et al. (2008) and Evans (2003) develop regime-switching models to study the term structure of real interest rates and inflation risk premia by combining the latent and macroeconomic factors.

[2] This solution is consistent with the view that if policy had changed in the past, rational economic agents would form expectations about future changes in policy and act accordingly.

[3] See, e.g., Ang et al. (2008) and Dai et al. (2007) for examples of parameterizations that lead to analytical expressions for bond prices.

[4] See, e.g., Bansal and Zhou (2002) for an example of an approximate solution based on log-linearization.