# Macroeconomic regimes ☆

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## ARTICLE INFO

## ABSTRACT

A New-Keynesian macro-model is estimated accommodating regime-switching behavior in monetary policy and macro-shocks. A key to our estimation strategy is the use of survey-based expectations for inflation and output. Output and inflation shocks shift to the low volatility regime around 1985 and 1990, respectively. Monetary policy experiences multiple shifts with an important role in shaping macro-volatility. New estimates of the onset and demise of the Great Moderation are provided and the relative role played by macro-shocks and monetary policy is quantified. The estimated rational expectations model exhibits indeterminacy in the mean-square stability sense, mainly due to passive monetary policy.

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## 1. Introduction

The Great Moderation, the reduction in volatility (standard deviation) is observed in most macro-variables since the mid-1980s, makes it difficult to explain macroeconomic dynamics in the US over the last 40 years within a linear homoskedastic framework. There is still no consensus on whether the Great Moderation represents a structural break or rather a persistent but temporary change in the regime. The causes also remain the subject of much debate. Was the Great Moderation the result of a reduction in the volatility of economic shocks, or was it brought about by a change in the propagation of shocks, for instance through a more aggressive monetary policy? Articles in favor of the "shock explanation" include McConnell and Pérez-Quirós (2000), Sims and Zha (2006), Liu et al. (2011); articles in favor of the policy channel include Clarida et al. (1999) and Galí and Gambetti (2008). Nevertheless, there is empirical evidence of both changes in the variance of economic shocks (Sims and Zha, 2006) and persistent changes in monetary policy (see Cogley and Sargent, 2005; Boivin, 2006; Lubik and Schorfheide, 2004), necessitating an empirical framework that can accommodate both.

In this paper, we estimate a standard New-Keynesian model accommodating regime changes in systematic monetary policy, in the variance of discretionary monetary policy shocks and in the variance of economic shocks. Whereas the model implies the presence of recurring regimes, it can also produce near permanent changes in the regime. With the structural model, the timing of the onset of the Great Moderation, and it so happens, also its demise, is revisited. Moreover, the sources of changes in the volatility of macroeconomic outcomes are traced to changes in the volatility of demand, supply and discretionary monetary policy shocks, and to changes in systematic monetary policy. Output and inflation shocks moved to a lower variability regime in 1985 and 1990, respectively, but moved back to the higher variability regime towards the end of 2008. Systematic monetary policy became more active after 1980, whereas discretionary monetary policy shocks were much less frequent after 1985.[1] The aggressive lowering of interest rates in the 2000–2005 period preceding the recent financial crisis is characterized as an activist regime. Put together, the 1980–2007 period is identified as a period with substantially lower output and inflation variability. From several perspectives, including counterfactual analysis, monetary policy was a critical driver of the Great Moderation.

While our model is a Rational Expectations model, survey forecasts for inflation and GDP are used in its estimation. Ang et al. (2007) show that survey expectations beat any other model in forecasting future inflation out of sample. The use of survey forecasts not only brings additional information to bear on a complex estimation problem, but also simplifies the identification of the regimes under certain assumptions. In the extant literature, survey forecasts have mostly been used to provide alternative estimates of the Phillips curve (see Roberts, 1995; Adam and Padula, 2011). Instead, we study the role of survey expectations in shaping macroeconomic dynamics in the context of a standard New Keynesian (NK) model, accommodating regime switches.

While current medium-scale Dynamic Stochastic General Equilibrium (DSGE) models typically feature more variables and richer dynamics (see, for instance, Smets and Wouters, 2007; DelNegro et al., 2007), this paper deliberately focuses on a small scale New-Keynesian model with an output gap, inflation, and interest rate equation for several reasons. First of all, this is the first attempt to estimate a small-scale DSGE model with survey-based expectations, which by themselves comprise very valuable information about a large set of variables. As a result, it is both instructive and relevant to focus on a relatively simple benchmark which also facilitates comparing estimation results with previous studies. Second, the model is rich enough to capture the time-varying role of both monetary policy and the key shocks shaping the Great Moderation in terms of output and inflation. Medium-scale models incorporating capital and labor explicitly may account for output fluctuations better than our model, but we conjecture that the identification of inflation dynamics, monetary policy, and the Great Moderation would not be greatly affected. Third, the estimation of even a stylized model with a realistic number of regimes remains actually very complex. Part of our contribution is to embed survey forecasts in the estimation and to obtain a Markov-Switching Rational Expectations (MSRE) Equilibrium, applying recent results in Cho (2014).

Recent progress in DSGE models incorporating regime-switching and time variation of structural parameters includes Bikbov and Chernov (2013) and Fernández-Villaverde et al. (2010). These articles use very different identification strategies, and do not make use of survey expectations. Modeling differences are discussed further in the model section. Our analysis of the rational expectations equilibrium in a Markov-switching New-Keynesian model extends (Davig and Leeper, 2007) to an empirically more realistic setting, and is therefore closely related to Bianchi (2013). His model is a medium-scale DSGE model which differentiates the effects of macro-shocks on consumption and investment. In his model, all macro-shocks switch simultaneously, whereas in our model shocks are allowed to switch independently. As a result, our model displays many more different regimes (16) than his (4). Because the origin of supply, demand, and monetary policy shocks is by definition very different, our specification is likely more realistic. As in Bianchi (2013), our model produces a stabilizing switch towards active monetary policy in the early 1980s; but afterwards our model identifies several MP switches whereas in Bianchi (2013) there is only one more switch in monetary policy towards the end of the sample. Liu et al. (2011) also estimate a New-Keynesian model with switches in shocks and the inflation target, but do not accommodate switches in policy response coefficients, which we identify as key to explain historical U.S. macro dynamics.

None of the aforementioned studies analyzes determinacy, an important characteristic of rational expectations models. For example, Lubik and Schorfheide (2004) document indeterminacy in the pre-Volcker period and discuss the estimation biases arising when indeterminate equilibria are excluded. Applying the methodology developed by Farmer et al. (2011), the estimated New-Keynesian model is found to be indeterminate in the mean-square stability sense. Davig and Leeper (2007) and Farmer et al. (2009) have previously shown that a temporarily passive monetary policy can be admissible as a part of a determinate equilibrium in simple calibrated MSRE models. However, in our more complex model featuring endogenous persistence, the actual policy stance in the passive regime for the U.S. economy during the 1968–2008 period is estimated to be excessively passive relative to the active regime, thereby causing indeterminacy. The recent return to a passive regime also contributed to the end of the Great Moderation. Policy parameter configurations that ensure a determinate equilibrium are characterized.

Section 2 describes the New-Keynesian model, detailing the role of regime-switching and expectations formation. Section 3 discusses the data and estimation method. Section 4 presents the empirical results, emphasizing the parameter estimates and the identified regimes. Section 5 concludes.

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[1] Throughout the article we use active or activist policy to indicate the monetary policy regime where the interest rate reacts to expected inflation more than one to one, in contrast to passive monetary policy.