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Structural evolution of the postwar U.S. economy

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ABSTRACT

We consider a time-varying parameter vector autoregressive model with stochastic volatility and mixture innovations to study the empirical relevance of the Lucas critique for the postwar U.S. economy. The model allows blocks of parameters to change at endogenously estimated points of time. Contrary to the Lucas critique, there are large changes at certain points of time in the parameters associated with monetary policy that do not correspond to changes in "reduced-form" parameters for inflation or the unemployment rate. However, the structure of the U.S. economy has evolved considerably over the postwar period, with an apparent reduction in the late 1980s in the impact of monetary policy shocks on inflation, though not on the unemployment rate. Related, we find changes in the Phillips curve tradeoff between inflation and cyclical unemployment (measured as the deviation from the time-varying steady-state unemployment rate implied by the model) in the 1970s and especially since the mid-1990s.

1. Introduction

> "*[T]he question of whether a particular model is structural is an empirical, not theoretical, one.*" – Lucas and Sargent (1981)

The U.S. economy has experienced large shifts in monetary policy regimes since World War II, as discussed by Lucas (1976) and Sargent (1999), amongst many others. Therefore, econometric models designed to study this phenomenon should allow at least some parameters to change over time. In addition, a substantial decline in the volatility of macroeconomic variables, often referred to as "the Great Moderation", has occurred since the mid-1980s. Together, these changes imply that a conventional vector autoregressive (VAR) model with constant parameters and homoskedastic shocks is inadequate for the postwar U.S. data.

In order to allow for changes in model parameters most of the literature has focused on two different approaches: Markov-switching (MS) models and time-varying parameter (TVP) models. MS-VAR models assume that the economy switches abruptly between a few (possibly recurrent) regimes for conditional mean and/or variance parameters, where the magnitude of change across regimes can be large (see, for example, Sims and Zha, 2006). By contrast, TVP-VAR models assume gradual changes (every period of time corresponds to a distinct regime) in conditional mean and/or variance parameters (see, for example, Cogley and Sargent, 2001, 2005; Primiceri, 2005; Cogley et al., 2010).

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Recently, a few models that bridge the MS and TVP approaches have been proposed. Koop and Potter (2007) develop a non-reversible change-point model with unknown number of regime shifts and Poison-distributed regime durations, while Giordani and Kohn (2008) introduce an alternative flexible framework called a 'dynamic mixture model' or 'mixture innovation model' in which the timing of regime shifts is determined by a latent variable and subgroups of model parameters are allowed to vary independently.[1] Building on these studies, Koop et al. (2009) apply the mixture innovations framework to extend the standard TVP-VAR of Primiceri (2005). They do so by introducing independent binary latent variables for three blocks of parameters corresponding to conditional mean parameters, variances, and the contemporaneous cross-equation impacts of shocks, allowing the data to determine the occurrence of a regime shift for each block in each period of time. However, principal components analysis of the variance–covariance matrix governing the magnitude of changes in TVP-VAR parameters conducted by Cogley and Sargent (2005) shows that conditional mean parameters appear to vary in a highly structured way that does not correspond to uniform changes across these parameters. Specifically, a small number of principal components explain most of the time variation in conditional mean parameters, with loadings varying considerably across parameters. Cogley and Sargent (2005) speculate that this pattern could be due to cross-equation restrictions associated with private agents' optimization and foresight in the context of adaptive learning by the policymaker, as considered in Sargent (1999). Meanwhile, if some parameters vary more frequently and more strongly, while others are approximately time-invariant, then estimation of a standard TVP-VAR model will tend to overstate variation in some parameters and understate variation in others, which could distort our understanding of the structural evolution of the U.S. economy.

Motivated by the possibility that not all conditional mean parameters need to change together, we extend Koop et al.'s (2009) analysis to allow for variation at different points of time in subgroups of VAR parameters, including different blocks of the conditional mean parameters. Because changes in each block of parameters are controlled by a Bernoulli distributed latent variable, the posterior density of the probability parameter for the Bernoulli distribution reflects the frequency of occurrence of breaks in a given block. Then, if the true model is the stochastic volatility TVP-VAR model, as in Primiceri (2005), the data will push the probability parameter for each block to one. Otherwise, if the true model is a MS-VAR model, the probability parameters will be much smaller than one, with differences in probability parameters across blocks suggesting different economic forces driving the structural changes. This approach is related to Inoue and Rossi (2011), who allow for a structural break at an unknown break date in subgroups of VAR parameters. However, our model is more flexible in that it allows for multiple stochastic shifts in the different blocks of parameters, which appear to be relevant in practice according to our results.

Building on Koop et al.'s (2009) modeling strategy, our paper makes three contributions: First, because we divide the VAR parameters into "policy" and "non-policy" blocks, the frequency of changes in the non-policy blocks relative to that of the policy block can be used to test the empirical relevance of Lucas (1976) critique, which states that a shift in systematic policy should induce a change in the "reduced-form" parameters describing the time series behaviour of the macroeconomic variables affected by policy. This test is different than simulation-based approaches to testing the Lucas critique often considered in the literature; see, for example, Estrella and Fuhrer (2003), Lindé (2001), Rudebusch (2005) and Lubik and Surico (2010). Our approach reveals the extent to which the Lucas critique is empirically relevant for the time-varying VAR parameters, including the variances of error terms. Notably, we find that Lucas critique is often not relevant. Second, based on standard short-run restrictions, we identify monetary policy shocks and study their effects on inflation and unemployment over time. Our findings can be compared with those in Primiceri (2005) and Koop et al. (2009), who find that there are no statistically significant changes in impulse responses for monetary policy shocks over the postwar period, and Kuttner and Mosser (2002) and Boivin and Giannoni (2006), who find that the effects of monetary policy on the U.S. economy have weakened since 1980s. Based on our model, we find that the effects of monetary policy on inflation have only changed over time at the 3–9 quarter horizon, while the effects on the unemployment rate appear not to have changed at any horizon. Third, we estimate the natural rate of unemployment as the time-varying steady-state of the unemployment rate, as in Phelps (1994) and King and Morley (2007). Based on the estimated natural rate, we test for the existence of a Phillips curve tradeoff between inflation and cyclical unemployment. We find evidence of a short-run tradeoff, with some support for a nonlinear relationship that is stronger for higher levels of lagged inflation. However, the tradeoff has clearly weakened since the late 1970s and has even disappeared since the mid-1990s, coinciding with the anchoring of inflation expectations at relatively low levels in recent years.

The rest of this paper is organized as follows. Section 2 presents our model. Section 3 describes the data and elicitation of priors. Section 4 provides model fit and robustness analysis. Section 5 considers the empirical relevance of the Lucas critique. Section 6 reports on the evolution of impulse response functions for a monetary policy shock on inflation and the unemployment rate. Section 7 examines the natural rate of unemployment and the short-run tradeoff between inflation and cyclical unemployment. Section 8 concludes.

[1] Notably, models with mixture innovations often have improved forecasting performance relative to simpler models, supporting their usefulness in describing the time series properties of the macroeconomic data. For example, Giordani and Villani (2010) forecast nine quarterly macroeconomic series from the United States, Sweden, and Australia using a mixture innovation model and find it outperforms related models with restrictions such as homoskedastic errors or smooth, continuous changes in parameters. Likewise, Groen et al. (2013) find very accurate real-time point and density forecasts for a multivariate model of U.S. inflation with mixture innovations.