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Bayesian analysis of time-varying parameter vector autoregressive model for the Japanese economy and monetary policy

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A B S T R A C T

Nakajima, Jouchi, Kasuya, Munehisa, and Watanabe, Toshiaki—Bayesian analysis of time-varying parameter vector autoregressive model for the Japanese economy and monetary policy

This paper analyzes the time-varying parameter vector autoregressive (TVP–VAR) model for the Japanese economy and monetary policy. The parameters are allowed to follow a random walk process and estimated using the Markov chain Monte Carlo method. The empirical result reveals the time-varying structure of the Japanese economy and monetary policy during the period from 1981 to 2008. The marginal likelihoods of the TVP–VAR model and other fixed parameter VAR models are estimated for model comparison. The estimated marginal likelihoods indicate that the TVP–VAR model best fits the Japanese economic data. *J. Japanese Int. Economies* **25** (3) (2011) 225–245. Department of Statistical Science, Duke University, Box 90251, Durham, NC 27708-0251, United States; Research and Statistics Department, Bank of Japan, 2-1-1 Nihonbashi-Hongokucho, Chuo-ku, Tokyo 103-8660, Japan; Institute of Economic Research, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo 186-8603, Japan.

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1. Introduction

The Japanese economy has experienced several distinct periods of macroeconomic activity in recent decades and many Japan's macroeconomic variables exhibit changing behaviors over time. Since Miyao (2000, 2002a) analyzed the Japanese economy using a vector autoregressive (VAR) model, the time-varying relations among Japanese macroeconomic variables have been investigated in several studies (e.g., Fujiwara, 2006; Inoue and Okimoto, 2008 using a Markov-switching VAR model, and Kimura et al., 2003 using a VAR model with time-varying coefficients). In these studies, the changes in the coefficients in the VAR system are well studied, although the variance of the structural shocks is assumed constant over the sample period or subsample periods. This paper estimates a time-varying parameter vector autoregressive (TVP–VAR) model for the Japanese economy and monetary policy, which allows both the coefficients and the variance of structural shock to vary over time.

The TVP–VAR model has recently become increasingly popular in macroeconomics literature following the introduction of this estimation technique by Primiceri (2005) for the US economy. Benati and Mumtaz (2005) provide empirical results for the TVP–VAR model for the UK economy, and Baumeister et al. (2008) for the Euro economy. D'Agostino et al. (2009) show the superior forecasting performance of the TVP–VAR model compared to other VAR models using US macroeconomic data. In these articles, the TVP–VAR model is estimated using the Markov chain Monte Carlo (MCMC) method. In the case of Japanese economy, Yano and Yoshino (2007) estimate the TVP–VAR model using a Monte Carlo particle filtering approach.

In our empirical analysis using Japanese data, a four-variable VAR system is estimated. The model includes the inflation rate, industrial production, nominal short-term interest rate, and money supply. The stochastic volatilities and time-varying impulse responses of the macroeconomic variables are shown over time. The marginal likelihoods of the TVP–VAR specification and other VAR models are also estimated under different estimation conditions. The estimated marginal likelihood indicates the good performance of the TVP–VAR model.

The original estimation scheme of the TVP–VAR model uses the mixture sampler for stochastic volatility in disturbances. The mixture sampler, originally developed by Kim et al. (1998) in the context of financial econometrics, draws sample from the approximated posterior density. As discussed by Kim et al. (1998) and Omori et al. (2007), its approximation error is small enough to make an inference. Instead, the multi-move sampler proposed by Shephard and Pitt (1997) and modified by Watanabe and Omori (2004) can draw sample from the exact posterior density of the stochastic volatility. In this paper, we utilize the multi-move sampler for the estimation of the TVP–VAR model. The MCMC algorithm is illustrated in detail.

The paper is organized as follows. In Section 2, we introduce the TVP–VAR model. Section 3 illustrates the estimation procedure for the TVP–VAR model. Section 4 presents the empirical results. Finally, Section 5 concludes.

2. Structural VAR models

2.1. Preliminary

We begin with a basic structural VAR model defined as

$$Ay_t = F_1 y_{t-1} + \cdots + F_s y_{t-s} + u_t, \quad t = s+1, \ldots, n, \tag{1}$$

where y_t is a $k \times 1$ vector of observed variables, $A, F_1, \ldots, F_s$ are $k \times k$ matrices of coefficients, and u_t is a $k \times 1$ structural shock. We specify the simultaneous relations of the structural shock by recursive identification, assuming that A is lower-triangular,

$$A = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1} & \cdots & a_{k,k-1} & 1 \end{pmatrix}.$$