Econ 482

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PROBLEM SET 2

SUBMIT BY EMAIL BEFORE TUESDAY, NOVEMBER 15

In this problem set we will estimate a number of SVARs using the identification strategy of monetary policy shocks used in the work of Sims and Zha. The first exercise is methodological in nature, and it is about replicating their results (i.e. constructing impulse responses to monetary policy shocks with error bands). The second exercise aims at investigating whether these results are robust to the sample and the specific variables used for the estimation.

1. Exercise 1

Consider the first six variables of the dataset "SZdata.xlsx," which starts in 1959:1 and ends in 2003:3. This is the exact dataset used in Sims and Zha (2006, AER), and it includes (i) the logarithm of interpolated monthly real GDP (Y); (ii) the logarithm of the core personal consumption expenditure price index (P); (iii) the unemployment rate (U); (iv) the logarithm of a commodity price index (Pcom); (v) the logarithm of the M2 divisia monetary index (M2); (vi) the federal funds rate (R). The remaining three variables of the dataset are: (vii) the employment-population ratio; (viii) the logarithm of the industrial production index; and (ix) the logarithm of the M2 money stock.[1]

Using this dataset, we will estimate the following SVAR:

$$y_t = c + B_1 y_{t-1} + ... + B_p y_{t-p} + A_0^{-1} \varepsilon_t$$

$$\varepsilon_t \sim N(0, I_n),$$

[1]Make sure to load the dataset using the MATLAB function "xlsread."

where $p = 13$. As in Sims and Zha (2006, AER), the matrix A_0 has the following structure

$$A_0 = \begin{bmatrix} \text{x} & & & & & \\ \text{x} & \text{x} & & & & \\ \text{x} & \text{x} & \text{x} & & & \\ \text{x} & \text{x} & \text{x} & \text{x} & \text{x} & \text{x} \\ \text{x} & \text{x} & & & \text{x} & \text{x} \\ & & & & \text{x} & \text{x} \end{bmatrix},$$

where an "x" indicates a value possibly different from zero, and the blank spaces mean "zero." For the reasons that we have talked about in class, the structure of these restrictions suggests that the first three equations can be thought of as "private-sector" equations; the fourth equation as an "information-sector/financial-market" equation; the fifth equation as a "money-demand" equation; the last equation as a "monetary-policy" equation. Therefore, the monetary policy shock will be the sixth element of ε_t.

The model involves a high number of parameters, and we need to use priors to limit estimation uncertainty. In particular, we are going to estimate the model using the Minnesota prior ($\lambda = 0.2$), and the sum-of-coefficients prior ($\mu = 1$). More specifically, we will implement the sum-of-coefficient prior in the usual way that makes use of dummy observations. As for the Minnesota prior, we will use the following version of it:

$$\beta | A_0 \sim N\left(b, A_0^{-1} A_0^{-1\prime} \otimes \Omega\right),$$

where the vector b and the matrix Ω are constructed in the usual way.

With these priors, the posterior of the model parameters has the following form:

$$p\left(A_0 | Y\right) \propto |A_0|^{T-p+n} exp\left[-\frac{1}{2} tr\left(\left(\hat{S} + \left(\hat{B} - \hat{b}\right)' \Omega^{-1} \left(\hat{B} - \hat{b}\right)\right) A_0' A_0\right)\right]$$

$$\beta | Y, A_0 \sim N\left(\hat{\beta}, \left(A_0^{-1} A_0^{-1\prime}\right) \otimes \left(x'x + \Omega^{-1}\right)^{-1}\right),$$

where I am following the usual notation, except for the fact that the matrices y and x already include the artificial observations constructed to implement the sum-of-coefficients prior. In the previous expressions,

$$\hat{\beta} = \left(x'x + \Omega^{-1}\right)^{-1} \left(x'y + \Omega^{-1}\hat{b}\right),$$

and $\hat{S}$ is the sum of squared residuals computed using $\hat{\beta}$. Finally, T is the length of the original sample, so that $T-p$ is the number of observations used to construct the likelihood function (and $T-p+n$ is the number of actual observations used to construct the likelihood, plus the artificial observations added to implement the sum-of-coefficient prior).

(1) Compute the posterior mode of the model parameters $(c, B_1, ..., B_p, A_0)$. Report the mode of the free elements of A_0.
(2) Using the posterior mode of $(c, B_1, ..., B_p, A_0)$, construct the impulse responses of the six variables of the SVAR to a monetary policy shock.
(3) Use Monte Carlo methods (a Metropolis algorithm) to construct error bands for the impulse responses to the monetary policy shock. Plot the responses of the six variables with 90 percent error bands.
(4) Comment briefly on these responses, trying to assess whether the monetary policy shock has been well identified.
(5) How much of the variance in the 36-period ahead forecast error in GDP is due to the monetary policy shock?

2. Exercise 2

In this exercise, we will simply repeat the estimation of exercise 1 using the same sample period, but slightly different variables.

(1) Replace interpolated monthly real GDP with the employment-population ratio. Construct impulse responses (with error bands) to a monetary policy shock. Are the results approximately robust to these change?
(2) Replace interpolated monthly real GDP with industrial production. Construct impulse responses (with error bands) to a monetary policy shock. Are the results approximately robust to these change?
(3) Replace interpolated monthly real GDP with industrial production, and the M2 divisia monetary index with the M2 money stock. Construct impulse responses (with error bands) to a monetary policy shock. Are the results approximately robust to these changes?

3. Exercise 3

In this exercise, we will simply repeat the estimation of exercise 1 using an extended sample period. Since interpolated monthly real GDP is not available (I have written to Tao Zha and he told me that they do not have an updated series), we will work with industrial production as a measure of real activity. Since the M2 divisia monetary index has been discountinued (a new one is available, but only starts in 1967), we will work with the M2 money stock as a monetary aggregate. The six variables relevant for this exercise are in the dataset "SZdataExtended.xlsx," which covers the period from 1959:1 to 2014:12.

(1) Construct impulse responses (with error bands) to a monetary policy shock using data until 2008:12 (i.e. excluding the ZLB period). Are the results approximately robust to these change?
(2) Construct impulse responses (with error bands) to a monetary policy shock using the entire sample. Are the results approximately robust to these change?