

Natural Rates and Filtering Problems in Reduced-Form and Structural Models

Course at the National Institute of Public Finance and Policy, Delhi

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Objectives: This course provides an introduction to the use of the Kalman filter in linear macroeconomic models. Several applications to the estimation of unobserved natural rates are considered, with an emphasis on the quantification of uncertainty around the estimates. The Kalman filter is then related to alternative models of expectations formation. Finally, we discuss examples of signal extraction problems in dynamic general equilibrium models and let agents use the Kalman filter to form expectations.

Logistics: The course will consist of five lectures, held on December 1, 2, 7, 8 and 9, 2011. Matlab code that implements the techniques will be made available.

1. Derivation of the Kalman filter and maximum likelihood estimation

Kim, Chang-Jin, and Charles R. Nelson (1999). *State-Space Models with Regime Switching* (MIT Press), Ch. 3.

Hamilton, James (1994). *Time Series Analysis* (Princeton University Press), Ch. 13.

Stock, James, and Mark Watson (1998). "Median unbiased estimation of coefficient variance in a time-varying parameter model," *Journal of the American Statistical Association* 93, 349-368.

2. Estimating trend growth and natural rates of unemployment and interest in linear macro models

Staiger, Douglas, James Stock, and Mark Watson (1997). "How precise are estimates of the natural rate of unemployment?" in Christina Romer and David Romer (eds), *Reducing Inflation: Motivation and Strategy* (Chicago: University of Chicago Press), 195-246.

Kuttner, Kenneth (1994). "Estimating potential output as a latent variable," *Journal of Business and Economic Statistics* 12 (3), 361-368.

Laubach, Thomas (2001). "Measuring the NAIRU: Evidence from seven economies," *Review of Economics and Statistics* 83 (1), 218-231.

Laubach, Thomas, and John C. Williams (2003). "Measuring the natural rate of interest," *Review of Economics and Statistics* 85 (4), 1063-1070.

3. Expectations, learning and the Kalman filter

Cuthbertson, Keith (1988). "Expectations, learning and the Kalman filter," *The Manchester School* 56 (3), 223-246.

Branch, William and George W. Evans (2006). "A simple recursive forecasting model," *Economics Letters* 91, 158-166.

4. Partial information in DSGE models

Pearlman, Joseph, David Currie, and Paul Levine (1986). "Rational expectations models with partial information," *Economic Modelling* 3 (2), 90-105.

Gürkaynak, Refet, Andrew Levin, Andrew Marder and Eric Swanson (2007). "Inflation targeting and the anchoring of inflation expectations in the western hemisphere," Federal Reserve Bank of San Francisco *Economic Review*, available at <http://www.frbsf.org/publications/economics/review/2007/er25-47.pdf>

Edge, Rochelle, Thomas Laubach and John C. Williams (2007). "Learning and shifts in long-run productivity growth," *Journal of Monetary Economics* 54 (8), 2421-2438.