Tools for Macroeconomists

The Essentials

Wednesday Assignment

Petr Sedláček

1 Objective

The objective of this assignment is to use the Kalman filter to estimate the aggregate matching function via Maximum Likelihood while allowing for time-variation in (unobserved) mismatch.

2 Motivation and background on the matching function

The unemployment rate in the U.S. increased to (almost) record high levels during and in the aftermath of the Great Recession. Moreover, it remained persistently high even after the number of job openings recovered which sparked a great deal of discussion about the sources of the observed unemployment rate dynamics both in academic but also in policy circles.

A popular way of parsing unemployment rate dynamics is through the lens of the so-called aggregate matching function. This function is a reduced-form relationship which connects the number of new jobs, hires (H_t), created in the economy to the number of (unemployed) job seekers (U_t) and the number of available jobs, vacancies (V_t). A common form of the matching function used in the macro-literature is a Cobb-Douglas specification with constant returns to scale:

$$H_t = MU_t^{1-\mu}V_t^{\mu},$$

where M is a constant level parameter and μ is the elasticity of matches with respect to the number of unemployed.[1] The parameter M is referred to as the degree of mismatch or matching efficiency because it affects the level of matches for a given number of vacancies and unemployed in the economy. A lower M reflects more "mismatch".

For policy it is important to distinguish whether unemployment is high because the economy is going through a large (but otherwise regular) recession or whether it is high because of greater "mismatch". In the former case short-term stimulus may be effective in boosting the economy as high unemployment is the result of a lack of jobs. In the latter case short-term stimulus may have little effect because unemployment is high not due to a lack of jobs, but due to a lack of *appropriate* jobs.

In this exercise we will investigate to what extent the unemployment rate increased during the Great Recession because of a rise in mismatch (decline in match efficiency)

[1] Look into Petrongolo, Pissarides (2001) for an excellent survey of the empirical literature about the (aggregate) matching function.

and to what extent it was "just" a large recession. Towards this end, we will estimate the aggregate matching function, but allowing match efficiency to fluctuate over time.

3 Part 1: Estimate the aggregate matching function

It is convenient to estimate the matching function using the job finding rate $F_t = H_t/U_t$. In this case, the state-space system being estimated is given by

$$f_t = m_t + \mu(v_t - u_t) + \epsilon_t \tag{1}$$
$$m_t = m_{t-1} + \eta_t, \tag{2}$$

where lower-case letters indicate logarithms of variables and where $\eta_t \sim N(0, Q)$ and $\epsilon_t \sim N(0, R)$ with $cov(\eta_t, \epsilon_t) = 0$ for all t. Notice that now the observation equation includes not only the unobserved state, but also observable regressors in the form of labor market tightness $(v_t - u_t)$. Look into the extension part of the slides to see how to deal with this within the Kalman filter. It turns out that it is extremely easy to include observable regressors into the recursions because they only enter the expression for the forecast error.

In the Part 1 of `MatchMain.m` set the initial values for the three estimated parameters (Q, R, μ). For instance, results from an OLS estimate of the matching function will do fine as a starting point.

Next, in `loglikelihood_match.m` specify the estimated parameters in terms of the notation used in the lecture. That is, determine the values of Q, R, C, F, H and A given the input of the minimization routine. Again make sure that variances remain positive during the estimation!

Finally, fill in the Kalman filter recursions in `Kalman_match.m`. Once you've done the above, you can run the program (commenting out the rest of the code) and see what happened to match efficiency during the crisis.

4 Part 2: Mismatch and unemployment during the Great Recession

Now that you have an estimate of the time-path of mismatch you can gauge to what extent it contributed to the unemployment rate increase during and in the aftermath of the crisis. In particular, ask yourself what would happen if the level of match efficiency remained fixed after November 2007, i.e. at its level just before the crisis.

First, at the beginning of Part 2 in `MatchMain.m` create the counterfactual job finding rate. That is, construct the predicted values for f_t based on your estimates, but fix m_t after November 2007.

Next, use this counterfactual job finding rate to construct a counterfactual unemployment rate. Towards this end we will use the law of motion for the unemployment rate:

$$Ur_{t+1} = (1 - F_t)Ur_t + S_t(1 - Ur_t), \tag{3}$$

where Ur_t is the unemployment rate, S_t is the separation rate and where the labor force has been normalized to 1. Equation 3 says that the unemployment rate in $t+1$ consists of all the unemployed who did not find jobs ($(1-F_t)Ur_t$) and those employed who lost their jobs ($S_t(1-Ur_t)$) in period t. In steady state this boils down to

$$Ur = \frac{S}{S+F}. \tag{4}$$

It turns out that for the U.S. labor market the above "steady state" expression for the unemployment rate tracks the actual unemployment rate very closely (indicating the flexibility of the labor market). We will use (4) to gauge the effect of the match efficiency decline on the unemployment rate.

In particular, in Part 2 of `MainMatch.m` use (4) to compute the separation rate implied by the data on the unemployment rate and your predicted values for the job finding rate.

Finally, use the above-computed separation rate together with your *counterfactual* job finding rate to construct a counterfactual unemployment rate (again using equation (4)). Plot the counterfactual and the actual unemployment rate. How much of the increase in the unemployment rate during the Great Recession can be attribute to the increase in mismatch?

References

Petrongolo, B. , C. Pissarides (2001). "Looking into the black box: A survey of the matching function", *Journal of Economic Literature*, 39, 390-431.