Problem Set 6
Graduate Macro II, Spring 2015
The University of Notre Dame
Professor Sims

Instructions: You may consult with other members of the class, but please make sure to turn in your own work. Where applicable, please print out figures and codes. This problem set is due in class on Tuesday, April 14, 2015.

(1) News Shocks: This problem asks you to work out a business cycle model where there are anticipated shocks to productivity, which the literature has called “news shocks.” In particular, suppose that the process for exogenous productivity, $A_t$, obeys the following stochastic process:

$$\ln A_t = \rho \ln A_{t-1} + \varepsilon_{t-4}$$

This is the standard AR(1) in the log, but the shock is observed 4 periods in advance of when productivity changes. In this way, a positive (or negative) realization of $\varepsilon_t$ provides “news” about the level of $A_t$ in 4 periods.

The model that we will consider is a variant of Jaimovich and Rebelo (2009, American Economic Review): “Can News About the Future Drive the Business Cycle?” It is a real model (nothing nominal) with three main twists relative to a standard RBC model: investment adjustment costs, variable capital utilization, and GHH type preferences. For now, let’s assume a generic preference specification, where flow utility is $U = U(C_t, N_t)$ and is increasing in consumption and decreasing in labor hours. A representative household owns the capital stock, makes investment decisions, and also makes utilization decisions. It leases capital services (the product of utilization and the physical capital stock) to a representative firm. The household problem can be written:

$$\max_{C_t, K_{t+1}, I_t, N_t, u_t} E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

s.t.

$$C_t + I_t \leq w_t N_t + R_t u_t K_t + \Pi_t$$

$$K_{t+1} = \left[ 1 - \frac{\kappa}{2} \left( \frac{I_t}{I_{t-1}} - 1 \right)^2 \right] I_t + (1 - \delta(u_t)) K_t$$

$$\delta(u_t) = \delta_0 + \delta_1 (u_t - 1) + \frac{\delta_2}{2} (u_t - 1)^2$$

(a) Derive the first order conditions for the household problem. It is best to write a Lagrangian with two constraints; e.g. let $\lambda_t$ be the multiplier on the flow budget constraint and $\mu_t$ the multiplier on the capital accumulation equation.

The firm problem is standard, where it picks capital services, $\widehat{K}_t = u_t K_t$, not capital or utilization individually:

$$\max_{N_t, K_t} \Pi_t = A_t \widehat{K}_t^\alpha N_t^{1-\alpha} - w_t N_t - R_t \widehat{K}_t$$
(b) Derive the first order conditions for the firm problem.

(c) Write down the definition of a competitive equilibrium and derive the aggregate resource constraint.

(d) Derive a restriction on the parameter $\delta_2$ necessary to ensure that steady state utilization equals 1 (you do not need to know the specific form of preferences to do this).

Suppose that preferences are given by the standard additively separable form:

$$U(C_t, N_t) = \ln C_t - \theta \frac{N_t^{1+\chi}}{1+\chi}$$

(e) Write a Dynare file to solve this model using a first order log-linear approximation. Use parameter values $\alpha = 1/3$, $\beta = 0.99$, $\delta_0 = 0.025$, $\chi = 1$, the value of $\delta_1$ you derived above, and a value of $\theta$ consistent with steady state labor hours of 1/3. Use values of $\rho = 0.95$ and the standard deviation of the shock of 0.01. It is straightforward to include the news shock in Dynare – just write “e(-4)” where you would normally write “e” in the shock process. For now, assume that $\delta_2 = 1000$ (effectively, no variable utilization) and $\kappa = 0$ (no investment adjustment costs). Produce and print out impulse responses of output, consumption, hours, and investment to the news shock. What happens to these variables in the period between the news hits (on “impact”) and when the shock translates into higher productivity four periods later? Can you provide some intuition for this?

(f) Re-do the exercise in (e), but this time set $\delta_2 = 0.01$, effectively “turning on” variable utilization (but keep $\kappa = 0$). Comment on how the impulse responses are different, and try to provide some intuition.

(g) Repeat the exercise in (e), but instead “turn” on investment adjustment costs, setting $\kappa = 3$ (but set $\delta_2 = 1000$). Comment on how the impulse responses differ from the baseline, and try to provide some intuition.

(h) Now turn both of these features on simultaneously, setting $\delta_2 = 0.01$ and $\kappa = 3$. Produce the impulse responses to the news shock. Knowing what you know about co-movements among aggregate variables in the actual time series data, can news shocks be an important driving force of the business cycle in this model?

Now instead consider the GHH preference specification, where:

$$U(C_t, N_t) = \ln \left( C_t - \theta \frac{N_t^{1+\chi}}{1+\chi} \right)$$

(i) Use the same parameter values you did in part (e) (e.g. “turn off” variable utilization and the investment adjustment cost), compute impulse responses to the news shock when the household has these preferences. Use a value of $\theta$ consistent with steady state labor hours of 1/3 (note, this value of $\theta$ will be different than what you found above). Comment on how the impulse responses look different from what you found in part (e), and try to provide some intuition.

(j) Continue to use GHH preferences, but now “turn on” both variable utilization and the investment adjustment cost ($\delta_2 = 0.01$ and $\kappa = 3$). Produce impulse response to the news shock, and compare them what you found for the base RBC model with separable preferences, no utilization, and no adjustment costs. Comment on the differences, and try to provide some intuition for how each of the three different changes relative to the baseline (preferences, utilization, and adjustment costs) help account for the differences.