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Problem Set 1
Macroeconomics I
Due Monday, November 4, 2024

Recall the single-sector neoclassical model with search from class. In this first problem set, we solve this model using a linear approximation to the model around its non-stochastic steady state.

In later problem sets, we use a shooting algorithm to solve the model equations exactly under the assumption of perfect foresight, and then use a value function method and a projection method to solve the model globally under uncertainty.

The parameters you should use in this problem set are listed below. We'll call these the "baseline parameters" going forward.

Table 1: Numerical Parameter Values

Concept	Symbol	Value
Discount factor	β	0.99
Inverse IES	σ	2.00
Capital share	α	0.30
Capital Depreciation	δ_k	0.03
Labor separation	δ_n	0.10
Vacancy cost	ϕ_n	0.50
Matching Function Level	χ	1.00
Matching Function Elasticity	ε	0.25
log(A) persistence	ρ	0.95
log(A) disturbance	σ_a	0.01

Note: in building your code, you are free to use and modify the example programs on the course website.

1. **Solution to linearized model:**

   (a) Using the model equations above, create a function called `model_ss` that takes as an input a data structure called `param` of parameters values, and returns as an output a vector containing the steady-state values of the the variables $[X^{ss}, Y^{ss}] \equiv [[A, K, N], [Y, C, I, N, V]]$. Using the parameters in Table 1, your program should return the values in Table 2.

Table 2: Steady-state values

Variable	Value
A	1.0000
K	348.5424
N	19.6668
Y	46.5897
C	28.6534
I	10.4563
N	19.6668
V	14.9600

(b) Create a second function, called `model`, which takes as inputs the data structure called `param` and returns the first order derivatives of $F(x, y)$ evaluated at the steady-state F_x, F_y, F_{xp}, F_{yp}, where $y = log(Y)$, $x = log(X)$, etc. The function `model` should call the function `model_ss` you wrote above.

(c) Using the code `gx_hx`, generate the model "solution matrices" g_x, h_x, and η. Below, I provide my solution for h_x, please report corresponding values of g_x and η.

$$h_x = \begin{bmatrix} 0.9500 & 0 & 0 \\ 0.0812 & 0.9643 & 0.0707 \\ 0.0220 & 0.0128 & 0.8962 \end{bmatrix}$$

(d) Using your solution to 1(c) above, compute impulse responses to a one standard deviation disturbance to technology for each of the eight variables listed above. Generate a 4x2 figure in Matlab. In each subplot, plot the impulse response of one the eight main model variables according to the approximate solution of the model. You plot should include the impact through 20 periods after the shock. Plot the variables in the order they appear in part(a) of the problem set, and label each subplot in the figure withe variable name.

(e) Initialize the random number generator using Matlab's command `rng(0)` and draw 5000 random normal scalar shocks $\{\epsilon_t\}$. Using your solution from 1(c) above and the generated shocks, simulate 5001 periods of data from the model. Initialize all states variables in the first period of your simulation to be zero. Report the first 5 realizations of log productivity in your simulations, and complete the table of moments below.

(f) *One common criticism of labor search models is that they cannot match the relative volatility of output and employment in the data. What is the ratio of the two standard deviations $std(N)/std(Y)$ in the model and and the data? Find a parameterization that make this ratio substantially closer to the data. What are the key features of this parameterization?

Table 3: Moments from simulated linear model

Moment	model value	data value
Std log(Y)	0.0522	0.0149
Std log(C)		0.0082
Std log(I)	0.0975	0.0318
Std log(N)		0.0131
Autocorr log(Y)		0.85
Autocorr log(C)		0.85
Autocorr log(I)		0.84
Autocorr log(N)		0.93