Exercise based on *NKmodelSimulations.ipynb*

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Guide for running the code on Google Colab: Go to your google drive (online). Under *My Drive*, there should be a folder called *Colab Notebooks* (if not, create one). Upload the two Python files to this folder. Open the Python file *NKmodelSimulations.ipynb* and run the first few cells under *SET PATH FOR TOOLKIT IN GOOGLE DRIVE.* See the README file in the github repository for more instructions.

Exercise

NKmodelSimulations.ipynb uses Chris Sims gensys algorithm to solve a three equation New Keynesian model with three (uncorrelated) shocks: productivity shock, cost shock, and monetary policy shock. The file also produces the variance-covariance matrix, the responses of macro variables to each of the three shocks, and historical decomposition for the simulated economy. Setup the files and do the following:

a. Import the libraries and run sections 1, 2 and 3. Section 3 reports the solution to the model. Which of the three shocks have a bigger effect on x_t, π_t, and i_t?

b. Run section 4. Which of the three variables - x_t, π_t, and i_t - is more volatile in our model economy?

c. The formula for correlation between any two variables, X and Y, is given by,

$$\rho_{XY} = \frac{Cov(X,Y)}{\sqrt{Var[X]Var[Y]}}$$

Use the information from the variance-covariance matrix from section 4 to find the correlation between x_t and π_t.

d. Run section 5. What is the difference in the responses to a cost shock and a productivity shock?

e. Increase the value for χ_π from 1.5 to 2.5. Does this make the economy less or more volatile? And, what happens to the correlation between x_t and π_t?

f. How do impulse responses change when χ_π increases from 1.5 to 2.5?

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Solution

a. The cost shock has the largest effect on all the three variables. The immediate effect equals -2.44 for x_t, 2.47 for π_t, and 2.48 for i_t. This is because we have assumed that the standard deviation for the cost shocks, $\sigma_{\hat{u}}$, equals 0.02. This is higher that what we have assume for both the monetary policy and the productivity shocks. We have also assumed cost shocks to be more persistent than monetary policy shocks but less persistent than productivity shocks. Therefore, cost shocks are not only bigger (higher $\sigma_{\hat{u}}$) but their effect also dies out relatively slowly.

b. Interest rate is the most volatilie in our model economy. Output gap and inflation are almost equally volatile even though inflation has a slightly higher variance (0.0081 compared to theh 0.0071 for output gap).

c. The covariance between x_t and π_t, Cov(x_t, π_t), equals -0.0059. The variance for x_t and π_t - Var[x_t] and Var[π_t] - equals 0.0071 and 0.0081, respectively. As a result,

$$\rho_{XY} = \frac{Cov(X,Y)}{\sqrt{Var[X]Var[Y]}} = -0.78$$

d. A positive cost shock increases inflation but decreases output gap. The decrease in output gap is due to the central bank increasing the interest rate to keep inflation closer to the target level. In contrast, a positive productivity shock decreases output gap (due to an increase in y_t^n) and, through the new keynesian phillips curve, also inflation. The central bank decreases the interest rate to stabilise both.

e. x_t becomes more volatile, whereas π_t becomes less volatile. The correlation between x_t and π_t becomes even more negative - from -0.78 to -0.93. This is because, since cost shocks are the key driver of business cycle fluctions in this economy, the central bank which is more concerned about stabilising inflation ends up making output gap more volatile.

f. **Cost shock:** Inflation increases by less but output gap deviates further away from zero. The intuition is straightforward. Since the central bank is more concerned about keeping inflation closer to the target level, it must decrease output gap by more to achieve its goal (through the new keyensian phillips curve).

Monetary policy and productivity shock: Both inflation and output gap fall by less. This is because both monetary policy and productivity shocks affect output gap and inflation in the same direction. Thus, stabilising one also means stabilising the other.