Econ 210C Final

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Due: 6/8/2023, 5:00PM PST, send answer pdf and code packet to Canvas.

0. General Instructions

- The final is open book, open notes, open internet.
- You are not allowed to communicate with anyone about the final. You are not allowed to share code or answers.
- Some questions are hard! If you cannot figure out the exact answer to one part, continue with what you have.
- For several questions I impose length limits ("Max X sentences"). This is for your benefit so you do not spend too much time writing a long answer.
  - We will penalize lengthy answers that try to "fish" for the solution.
- You will be asked to download data from FRED. You should do a test run of your preferred software (Stata, Python, R, etc) before the final.
- You will need to submit the following deliverables on Canvas:
  1. A pdf document or Jupyter notebook with your answers and figures.
  2. A zip file with your code (unless already contained in your Jupyter notebook).
     - The base directory of the code packet needs to contain "main" files that create all your figures with on click (e.g., main.do for Stata, main.m for Matlab).
     - We must be able to execute those main files on our computers without error messages.
       * To make sure it works on our computers you should **avoid absolute paths** such as C:/Myfiles/Mydata.xls. Import and save any data using relative paths such as Data/mydata.xls.
       * We will grade on whether the results are reproducible by us.
- To ensure fairness, the final is due at 4pm sharp! Late submissions will be graded out (100 - X)% where X solves the following formula:

$$X = (\exp(\text{minutes late}/100) - 1) * 100$$

1. Model Simulation:

Consider the new Keynesian model

$$\hat{y}_t = E_t \hat{y}_{t+1} - E_t(\hat{i}_t - \hat{\pi}_{t+1} - \hat{r}^n_t) \tag{1}$$

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{y}_t \tag{2}$$

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \bar{i}_t, \qquad \phi_\pi > 1 \tag{3}$$

$$\hat{r}^n_t = \epsilon^n_t, \qquad \epsilon^n_t \sim N(0, \sigma^2_n) \tag{4}$$

$$\bar{i}_t = \epsilon^i_t, \qquad \epsilon^i_t \sim N(0, \sigma^2_i) \tag{5}$$

where $\bar{i}_t$ is an exogenous monetary policy shock and $\hat{r}^n_t$ is a shock to the natural rate of interest.

(a) Using either the sequence space methods or the method of undetermined coefficients, plot IRFs for the following variables to a ϵ^n_t shock and to a ϵ^i_t shock:

- $\bar{i}_t$
- $\hat{y}_t$
- $\hat{\pi}_t$
- $\hat{i}_t$
- $\hat{r}_t = \hat{i}_t - E_t \hat{\pi}_{t+1}$
- $\hat{r}^n_t$

Use the following parameters:

$$\beta = 0.99, \kappa = 0.01, \phi_\pi = 2.5, \sigma_n = 0.01, \sigma_i = 0.001.$$

The suggested horizon is 5 quarters.

(b) Explain intuitively how the monetary policy shock affects output, inflation, the nominal interest rate, and the real interest rate in the model. (5 sentences should suffice.)

(c) Explain intuitively how the natural rate of interest shock affects output, inflation, the nominal interest rate, and the real interest rate in the model. (5 sentences should suffice.)

(d) Simulate a time series of length 10000 for $\hat{y}_t, \hat{\pi}_t, \hat{i}_t$. Plot each of the three time series.

Note that the values for σ_i and σ_r are different!

(e) Using your simulated time series, estimate the following regression by OLS and report your estimate for γ:

$$\hat{y}_t = \gamma \hat{i}_t + \eta_t$$

(f) Explain why your estimate for γ does not recover the causal effect of monetary policy on output in the model.

(g) Suppose you had data on $\bar{i}_t$. How would you use it to identify the causal effect of monetary policy on output in the model? **Describe in words, do not implement yet.**

(h) Suppose you had data on $\hat{r}_t^n$. How would you use it to identify the causal effect of monetary policy on output in the model? **Describe in words, do not implement yet.**

(i) How would you use a Cholesky decomposition to identify the causal effect of monetary policy on output in the model? **Describe in words, do not implement yet.**

(j) Explain which of these approaches do you expect to be the most reliable in the data.

(k) Implement your preferred approach in the model and show that it recovers the causal effect of monetary policy on output from the model.

2. Data Analysis

(a) Download data for the Federal Funds rate (FEDFUNDS), the level of output (GDPC1), the level of potential output (GDPPOT), and the CPI index (CPIAUCSL) from FRED.

- The frequency should be quarterly.
- Your code should pull these data automatically from the FRED server.
  - You will need an API key: https://fred.stlouisfed.org/docs/api/api_key.html
  - Stata: "import fred".
  - Python: use the module "pandas_datareader.data"

(b) Merge the Romer-Romer (2004) shocks with your dataset. (They are on Canvas along with this pdf.)

(c) Transform the CPI into an annualized 4-quarter growth rate (CPI inflation).

$$\pi_t = 400 \times \ln\left(\frac{C_t}{C_{t-4}}\right)$$

(d) Create a measure of the output gap as follows:

$$gap = 100 \times \ln\left(\frac{\text{level of output}}{\text{level of potential output}}\right)$$

(e) Keep only data from 1970Q1 to 2007Q4. Discard all other time periods.

(f) Plot each time series from 1970Q1 to 2007Q4. You should have no missing observations!

1. Federal Funds rate (i_t)
2. Output gap (gap_t)
3. CPI inflation rate annualized (π_t)
4. Romer-Romer shock (RR_t).

- Make sure all graphs are appropriately labelled.

(g) Construct the IRFs from the estimation equation

$$y_t = \alpha + \sum_{s=1}^{8} \beta_s y_{t-s} + \sum_{s=0}^{12} \gamma_s i_{t-s} + \epsilon_t$$

where $y_t \in [\pi_t, gap_t]$ are the outcome variables and i_t is the Federal Funds Rate.

This means you plot the response $\{y_s\}_{s=0}^{T}$ for an initial shock $i_0 = 1$ and $i_s = 0$ for all $s \geqslant 1$. A good value to start is $T = 16$.

(h) Now plot the IRFs from the estimation equation

$$y_t = \alpha + \sum_{s=1}^{8} \beta_s y_{t-s} + \sum_{s=0}^{12} \gamma_s RR_{t-s} + \epsilon_t$$

where $y_t \in [\pi_t, gap_t]$ are the outcome variables and RR_t are the Romer-Romer shocks.

(i) Explain why these impulse response functions look different.

(j) The output gap in our data measures the distance of output from full employment. How is this different from the output gap in our New Keynesian model?