Econ 808   Prof. Kasa

Macroeconomic Theory   Fall 2020

MIDTERM EXAM - Due, November 16, 6pm

Answer the following questions True, False, or Uncertain. Briefly explain your answers. (10 points each).

1. In the Mortensen-Pissarides model, the equilibrium unemployment rate is inefficient.

2. In the McCall model, the equilibrium unemployment rate increases when the variance of the wage distribution increases.

3. The Arrow-Debreu general equilibrium model cannot explain recent data on wealth inequality, since it implies that inequality is time- and state-invariant.

4. The Arrow-Debreu general equilibrium model rules out heterogeneous beliefs.

   When answering the following two questions, you may find it useful to first read pages 72-80 in the Ljungqvist-Sargent text. (See also ch. 8 (on Consumption) in Romer's text *Advanced Macroeconomics*).

5. (30 points). **The Linear-Quadratic/Permanent Income Model**. Consider an agent that can borrow or lend all he/she wants at a fixed world interest rate, $R = 1 + r$. Preferences are given by

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t) \qquad U(C) = -\frac{1}{2} \left(C_t - \bar{C}\right)^2$$

where $R\beta = 1$. The intertemporal budget constraint is

$$C_t + D_t = Y_t + R^{-1} D_{t+1} \qquad D_0 = 0 \qquad (1)$$

where D_t is the agent's debt at the beginning of period-t, and Y_t is an exogenous output sequence, which follows the autogressive process, $Y_t = \rho Y_{t-1} + \varepsilon_t$, with $0 < \rho < 1$.

   (a) Write down the Euler equation characterizing the optimal consumption path. Show that it implies $C_t = E_t C_{t+1}$

   (b) Substitute your answer to part (a) into the budget constraint and derive an expression for C_t in terms of the expected present discounted value of $\{Y_{t+j}\}$. (What is the transversality on D_{t+T}?)

   (c) Use the autoregressive process for Y_t to evaluate the present value in part (b) and derive an expression for C_t in terms of Y_t and D_t.

   (d) Substitute the expression for C_t into the budget constraint in eq. (1) and derive the equilibrium debt process, $\{D_{t+j}\}$. Does the agent ever 'pay back' his/her debt? Prove that debt is nonstationary, and does not possess a long-run mean.

   (e) Using your previous answers, illustrate how Output, Consumption, and Debt respond over time to a one-time shock in ε_t (i.e., trace out their 'impluse response functions'). Put t on the horizontal axis, and (Y_t, C_t, D_t) on the vertical axes.

6. (30 points). **Estimating the LQ/PI Model**. Now let's try to estimate and test the above LQ/PI model using quarterly US data. Test the model by: (1) comparing the innovation variance of ΔC_t with the innovation variance of an AR(1) fit to Y_t, and (2) By checking the implied orthogonality conditions associated with the martingale prediction. Is there 'excess smoothness' and 'excess sensitivity'? (Before doing anything, plot your data on consumption and labor income).

The data is posted on the class webpage, in the excel file 'LQPIData.xls'. It contains 5 series, running from 1947:1 to 2019:2 - (1) Disposable Personal Income (DPI), (2) Personal Income on Assets (DPIA), (3) Personal Consumption Expenditures (PCEC), (4) Personal Consumption Expenditures on Durables (PCDG), and (5) the GDP deflator (GDPDEF). Form a proxy for labor income by subtracting asset income from disposable income ($DPI - DPIA$). Form a proxy for consumption of nondurables and services by subtracting durables from total expenditures ($PCEC - PCDG$). Convert to real terms by dividing by the GDP deflator. Although the data should be per capita, the quarterly working age population series doesn't begin until 1960. So just detrend real consumption and labor income by dividing by $(1 + g)^t$, where g is the average quarterly growth rate of each series.

To import an excel spreadsheet into Python just type

import pandas as pd
from pandas import ExcelFile
df = pd.read_excel('File name, including path', sheet_name='Quarterly')

df is called a 'dataframe'. Columns correspond to different time series.

To run regressions in Python you can use the statsmodels package. Just type

import statsmodels.api as sm
model = sm.OLS(df['Y'], df['X']   (where Y and X are column names in the spreadsheet)
results = model.fit()
print(results.summary())

Warning: Python does not include an intercept by default. To include one, just type

df['const'] = 1

which adds a column vector of ones to your dataframe. You can then define a list of exogenous variables, including 'const', to pass to the OLS method. For more info, see the python lecture *Linear Regression in Python* on QuantEcon. Since this example involves running autoregressions, you could also use the tsa subpackage of statsmodels. For example, **from statsmodels.tsa.ar_model import AR**.

Note: If you prefer, feel free to use Matlab, Stata, R, or any other software that you want when answering this question.