Homework 14: Stationary Time Series

Exercise 1: Stationary Models in Lag Operator Form

- This exercise is basically a rehash of class notes to make sure that you can do the algebra yourself. Consider the following models with a single independent variable X.
  - Simple static model with iid errors.
  - Simple static model with AR1 error process.
  - Finite distributed lag model
  - Lagged dependent variable model
  - Autoregressive distributed lag model
  - Error correction model

  Write each of these models using lag operators, Solve each of them i.e. get Y in terms of X's and errors, no lagged Y's. Show the interrelationship among the various models, which are subsets of which, etc.

Exercise 2: OLS, Lagged Dependent Variables, and Serially Correlated Errors

- You are going to use simar1errorldv (the simulation program included with the homework online) to experiment with what happens if you do OLS with a lagged dependent and serially correlated errors? You will also find a textfile describing the simulation program called sim.stata.txt. You will start with the following basic model:

$$Y_t = \beta X_t + \mu Y_{t-1} + \epsilon_t \tag{1}$$

  where $\epsilon_t = \nu_t + \rho\epsilon_{t-1}$. ρ determines the degree of serial correlation in the error term. In the simulation, $\epsilon \sim SN(0, \delta)$ i.e. it has a mean of zero and a variance of δ. We will allow there to be a trend in the X variable i.e. let

$$X_{t+1} = X_t + \gamma X_{t-1}. \tag{2}$$

  γ determines the extent to which there is a trend in X. Sample size for simulation is n. The simulation program allows us to see what happens if we change n, β, δ, ρ, γ, μ.

  To get the simulation program to work, you will need to post it in STATA's do-file editor and run it. You will then experiment with it by changing various parameters to see what happens. Specifically, after running the ado file, you will have to type

  - simar1errorldv 100 2 1 0 0 0

  In other words, we are looking at a situation where $n = 100$, $\beta = 2$, $\delta = 1$, $\rho = 0$, $\gamma = 0$, $\mu = 0$ i.e. no trend in X, no serial correlation in the error term, and a coefficient of 0 on the lagged dependent variable. Once the program has run, you should type

  - use sim, clear
  - sum

  The summarize command should give you the estimated coefficients from a straightforward OLS model and from a Prais-Winsten model. The PW model coefficients end in 'p'. Since you know the true value of the coefficients, you can see how far off the two procedures are.

- Keeping $n = 100$, $\beta = 2$, $\delta = 1$, and $\gamma = 0$, run the simulation program over and over again as you increase the serial correlation (ρ) in the error term and the coefficient on the lagged dependent variable (μ). Fill in the following two tables - Table 1 for OLS and Table 2 for PW-GLS. Explain what you would expect to find theoretically and what you actually did find.

Table 1: Simulation Results for OLS (True Values $\beta = 2$)

μ		ρ 0.2	0.4	0.6	0.8	1
0.2	β					
	se_{beta}					
	μ					
	se_{μ}					
0.4	β					
	se_{beta}					
	μ					
	se_{μ}					
0.6	β					
	se_{beta}					
	μ					
	se_{μ}					
0.8	β					
	se_{beta}					
	μ					
	se_{μ}					
1.0	β					
	se_{beta}					
	μ					
	se_{μ}					

Table 2: Simulation Results for PW-GLS (True Values $\beta = 2$)

μ		ρ 0.2	0.4	0.6	0.8	1
0.2	β					
	se_{beta}					
	μ					
	se_{μ}					
0.4	β					
	se_{beta}					
	μ					
	se_{μ}					
0.6	β					
	se_{beta}					
	μ					
	se_{μ}					
0.8	β					
	se_{beta}					
	μ					
	se_{μ}					
1.0	β					
	se_{beta}					
	μ					
	se_{μ}					

Exercise 3: Models for Stationary Time Series

We are now going to estimate a variety of different stationary time series models using brneal.dta. These data are Harold Clarke's British approval data for the Thatcher-Major period. The data are described in his 2000 Electoral Studies piece cited in the syllabus. The dependent variable is PMSAT i.e. satisfaction with the prime minister. All data are as described in their article, but some variables are missing. We are going to assume that prime minister satisfaction (PMSAT) is determined by personal evaluation of the economy (ECONPT) and the falklands war (FALKMX).

- You are going to estimate the following models. Errors are iid unless otherwise noted and you will have to add in constants.
  - Simple static model with iid errors: $Y_t = \beta X_t$
  - Simple static model with AR1 error process: $Y_t = \beta X_t$ with AR1 errors i.e. $\epsilon_t = \rho\epsilon_{t-1} + \nu_t$.
  - Finite distributed lag model: $Y_t = \beta_0 X_t + \beta_1 X_{t-1}$
  - Lagged dependent variable model: $Y_t = \beta_0 X_t + \phi Y_{t-1}$
  - Autoregressive distributed lag model: $Y_t = \beta_0 X_t + \beta_1 X_{t-1} + \phi Y_{t-1}$
  - Error correction model: $\Delta Y_t = \Delta X_t - \phi(Y_{t-1} - \gamma X_{t-1})$
- Estimate each model and put results in Table 3. Test for serial correlation in each of the model using the Durbin-Watson test (where appropriate) and the BG test. Do these tests by hand and with STATA's automatic commands.
- Which models are nested inside bigger models? For those that are nested, test the smaller against the bigger model.
- For each model (NOT the ECM - we'll do that next week), plot an impulse response function for the variable capturing the economic perceptions of the economy i.e. generate enough data points so that the model is in steady state, then shock ECONPT by one unit for one time period and plot the behavior of PMSAT. Use your own words to describe each of the plots. I'll give you an example for the static model where the shock occurs in period 5. You will have to type
  - gen t = _n-1; gen impulse = 0;
  - replace impulse = 1 in 5;
  - gen response_olsi = .;
  - replace response_olsi = 0;
  - replace response_olsi = beta in 5;
  - graph twoway spike response_olsi t in 1/10 ,blwidth(1) xtitle("Time") ytitle("PM Approval - Response") title("Impulse Response") subtitle("OLS model") legend(col(1) order(1) label(1 "Response Function after Impulse in Econ Evaluations")) ysize(10) xsize(12) name(irsols);
- Now repeat but plot a unit response function i.e. shock ECONPT by one unit and keep it at the new level until a new equilibrium is reached. Use your own words to describe each of the plots.

Table 3: Determinants of Political Views

Dependent Variable: Prime Minister Satisfaction

Regressor	OLS	AR1 Prais	AR1 C-O	FDL	LDV	ADL	Error Correction
Economy Perception							
Economy Perception (lagged)							
Falklands War							
Falklands War (lagged)							
PM Satisfaction (lagged)							
ρ							
Constant							
R^2							
Observations							

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (two-tailed); Standard errors are given in parentheses

Prais is Prais-Winsten, C-O is Cochrane-Orcutt

Exercise 4: Cochrane-Orcutt Procedure

- Estimate a simple static model with AR1 error process using the Cochrane-Orcutt procedure (Use STATA's automatic command). For this exercise, the dependent variable is PMSAT and the two independent variables are ECONPT FINANPT.
- Now make sure that you can repeat the first iteration of the CO procedure by hand i.e. do OLS, compute ρ, transform, and reestimate. How close are the results to the fully iterated CO procedure?

Exercise 5: Testing for Stationarity

We are now going to test for whether a series is stationary or not. We are going to use the mes.dta dataset from MacKuen, Erikson and Stimson (1989). The data is described in the article. MES are interested in (i) consumer sentiment (mics), (ii) presidential approval (prezapproval), and (iii) partisanship (gal).

- Start by relabeling the variables:
  - Relabel 'mics' as 'consumer_sentiment'
  - Relabel 'gal' as 'partisanship'
- Take a look at what the three series look like. To do this, you want to use an ado file called tsgraph.ado. You'll find it in the zip file for the homework. I think STATA has already adopted this file, but if it hasn't type the following command
  - run h:filenames\tsgraph.ado

  Then type:
  - tsgraph consumer_sentiment
  - tsgraph prezapproval
  - tsgraph partisanship

  Based on these figures, do any of the series appear non-stationary and how do you know?
- For all three series, manually estimate a Dickey-Fuller test for (i) a no constant model, (ii) a drift model, and (iii) a trend model. Now repeat using STATA's automatic commands. Put the results from these last tests in the following table of results. What conclusions do you draw about whether the series are stationary or non-stationary? If you find that the series are non-stationary, what is the cause of the non-stationarity - a unit root, drift, trend, some combination?

Table 4: Dickey-Fuller Tests

Dependent Variable: Δ in Y

Model	No Constant	Drift, No Trend	Trend
Y (lagged)			
Trend			
Constant			

t-statistics in parentheses.

- Pick one of the series and repeat using an augmented D-F test. Play around with the number of lags that you include. Do you reach the same conclusions?
- Using the same series as before, repeat using a Phillips-Perron test. Play around with the number of lags that you include. Do you reach the same conclusions?

Exercise 6: Testing for Cointegration and ECMs

- Are any of the three series co-integrated?
- If they are, estimate an error correction model
- Plot an impulse response and unit response function graph.