

Economics 513: Economic Forecast and Analysis  
Department of Economics, Finance and Legal Studies  
University of Alabama

Problem Set #1 (Linear Regression)

1. The file entitled MONEYDEM.XLS contains quarterly values of seasonally adjusted U.S.3-month ( $TB3mo$ ) and 1-year ( $TB1yr$ ) treasury bill rates. Each series is measured over the period 1959:Q3 to 2001:Q1.

- (a) Plot the time series of each series separately. Does each series appear to have a constant mean and variance over time?
- (b) Plot each time series on the same figure. What can you say about the relationship between the two series?
- (c) Use Ordinary Least Squares (OLS) to estimate the relationship between long-term and short-term interest rates as

$$TB1yr_t = \alpha + \beta TB3mo_t + \varepsilon_t$$

- (d) What does the estimate of  $\beta$  tell you about the relationship between long-run and short-run interest rates?
- (e) Test the null that  $\beta = 1$ . Is this result in accordance with macroeconomic theory?
- (f) Plot the residuals from the regression in part (c) versus  $TB3mo$ . Do you observe any pattern?
- (g) Use the White Test to test for the presence of heteroskedasticity.
- (h) Estimate the model again, but calculate the robust (White) standard errors.
- (i) What happens to the coefficients of the model in part (h) relative to part (c)? What happens to the standard errors of the model in part (h) relative to part (c)? Why?
- (j) Create a dummy variable that is equal to 1 when  $TB3mo$  is in excess of 10.00 and zero otherwise. Include this variable in the regression model as

$$TB1yr_t = \alpha + \beta TB3mo_t + \delta D_t + \varepsilon_t$$

and run OLS.

- (k) Test the null that the dummy variable is relevant in part (j).
- (l) What happens to the fit of the model in part (j) relative to part (c)?

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Problem Set #2 (ARMA models)

1. The file entitled SIM\_2.XLS contains simulated data sets. The series Y1, contains ( $T =$ ) 100 values of a simulated AR(1) process. Use this series to perform the following tasks.
  - (a) Plot the sequence against time. Does the series appear to be stationary?
  - (b) Plot the ACF and PACF.
  - (c) Estimate the AR(1), AR(2), ARMA(1,1), ARMA(1,4), and ARMA(2,1) models with intercepts.
  - (d) Estimate the series as both an AR(2) and ARMA(1,1) process without an intercept.
  - (e) Use  $\bar{R}^2$ , AIC and SC to choose the best single model over parts (c) and (d).
  - (f) Are you surprised by the result from part (e)? Why or why not?
  - (g) Using your ideal model, plot the ACF and PACF of the residuals. Do they appear to be white noise?
  
2. The file QUARTERLY.XLS contains the quarterly values of the Consumer Price Index (excluding food and fuel) that have not been seasonally adjusted ( $CPINSA$ ). The series is over the period 1960:Q1 to 2008:Q1.
  - (a) Plot the  $CPINSA$  sequence against time. Does the series appear to be stationary?
  - (b) Plot the ACF and PACF of  $CPINSA$ .
  - (c) Create the growth rate series  $\log(CPINSA_t/CPINSA_{t-1})$  and plot this series against time. Does the series appear to be stationary?
  - (d) Plot the ACF and PACF of  $\log(CPINSA_t/CPINSA_{t-1})$ .
  - (e) Seasonally difference CPI using  $\log(CPINSA_t/CPINSA_{t-4})$ . Does this series appear to be stationary?
  - (f) Plot the ACF and PACF of  $\log(CPINSA_t/CPINSA_{t-4})$ .
  - (g) Use the ACF and PACF from part (f) and estimate a tentative model. Try several other alternative models.
  - (h) Use  $\bar{R}^2$ , AIC and SC to choose the best model from part (g).
  - (i) Instead of seasonally differencing the series, regress  $\log(CPINSA_t/CPINSA_{t-1})$  on (three) dummy variables to control for seasonality.
  - (j) Plot the residuals in part (i) versus time. Does this series appear to be stationary?
  - (k) Plot the ACF and PACF for the residuals in part (i). What do you conclude here?

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Problem Set #3 (Forecasting)

1. The file QUARTERLY.XLS contains U.S. interest rate data over the period 1960:Q1 to 2008:Q1. Our goal here is to estimate a quarterly model of spread between a long-term and a short-term interest rate. Specifically, the interest rate spread ( $s$ ) can be formed as the difference between the interest rate on a 10-year U.S. government bonds ( $r10$ ) and the rate on a three-month treasury bills ( $Tbill$ ) as

$$s_t = r10_t - Tbill_t$$

- (a) Plot  $s_t$  against time. Does the series appear to be stationary?
- (b) Plot the ACF and PACF of the time series. What do you conclude?
- (c) Estimate an AR(2) model for  $s_t$ .
- (d) Look at the ACF and PACF of the residuals from the regression in part (c). What do the Ljung-Box  $Q$ -statistics say about autocorrelation in the residuals?
- (e) Estimate an AR(7) model for  $s_t$ .
- (f) Look at the ACF and PACF of the residuals from the regression in part (e). What do the Ljung-Box  $Q$ -statistics say about autocorrelation in the residuals?
- (g) Which model appears to perform better in terms of goodness-of-fit measures and diagnostic checks?
- (h) Estimate both the AR(2) and AR(7) models over the period 1960:Q1 to 2005:Q3. Obtain the one-step-ahead forecast and the one-step-ahead forecast error

$$\hat{e}_{t+1} = y_{t+1} - \hat{y}_{t+1|t}$$

for 2005:Q4. In other words, estimate the model from 1960:Q1 to 2005:Q3, create a forecast for 2005:Q4 ( $\hat{y}_{t+1|t}$ ) and compare that to the true value of  $s_t$  in 2005:Q4 ( $y_{t+1}$ ). Which model has the smaller forecast error? Hint: this may be easier to compute in Excel (after estimation).

- (i) Estimate a ten-step-ahead forecast for each model as in part (h). Which model has the smallest mean square forecast error

$$\begin{aligned} MSE &= \frac{1}{10} \sum_{i=1}^{10} \hat{e}_{t+i}^2 \\ &= \frac{1}{10} \sum_{i=1}^{10} (y_{t+i} - \hat{y}_{t+i|t})^2 \end{aligned}$$

Which model performs better? Is this surprising? Hint: this may be easier to compute in Excel (after estimation).

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Problem Set #4 (Univariate Nonstationary Time Series)

1. The file GDP.XLS contains real GDP data ( $GDP$ ). The series is measured over the period 1960:Q1 to 2002:Q1.
  - (a) Plot the  $GDP$  sequence against time. Does the series appear to be stationary?
  - (b) Regress the series on an intercept and a third-order polynomial of time ( $t$ ,  $t^2$ , and  $t^3$ ). Hint: use the Trend command in R to create  $t$ .
  - (c) Plot the ACF and PACF of the residuals from the model estimated in (b). What can be said about the residuals?
  - (d) Perform the Dickey-Fuller test on the  $GDP$  sequence.
  - (e) Construct the rate of growth of GDP as  $dlrgdp_t = \log(GDP_t/GDP_{t-1})$ . Plot the  $dlrgdp$  sequence against time. Does the series appear to be stationary?
  - (f) Model  $dlrgdp$  as an AR(2) process.
  - (g) Plot the ACF and PACF of the residuals from the model estimated in (f). What can be said about the residuals?
  - (h) Perform the Dickey-Fuller test on the  $dlrgdp$  sequence.
  - (i) It is often argued that the oil price shock in 1973 reduced the trend growth rate of real U.S. GDP ( $dlrgdp_t$ ). Perform the Chow test to determine whether the series is trend stationary with a break occurring in 1973:Q1.
  - (j) Create a dummy variable which is equal to one for 1973:Q1 to 2002:Q1 and zero otherwise. Model  $dlrgdp$  as an AR(2) process, but also include this dummy variable in the regression.
  - (k) Plot the ACF and PACF of the residuals from the model estimated in part (j). What can be said about the residuals?

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Problem Set #5 (Multivariate Nonstationary Time Series)

1. The file QUARTERLY.XLS contains the index of industrial production (*indpro*), the money supply as measured by *M1* (*M1NSA*), and the unemployment rate (*urate*) over the period 1960:Q1 to 2008:Q1.
  - (a) Plot the time series of each series. Does each series appear to be stationary?
  - (b) Test that *indpro* is  $I(1)$  using the DF test.
  - (c) Test that *M1NSA* is  $I(1)$  using the DF test.
  - (d) Regress *indpro* on *M1NSA*.
  - (e) Examine the ACF and PACF of the residuals from part (d). Do they appear to be stationary?
  - (f) Test that the residuals from part (d) are  $I(1)$  using the DF test.
  - (g) Create a scatter plot of *indpro* against *M1NSA*. How do you interpret the fact that  $R^2 = 0.924$  and the  $t$ -statistic on the money supply is 48.293?
  
2. The file COINT\_PPP.XLS contains quarterly values of Canadian wholesales prices and bilateral exchange rates with the United States. The file also contains the U.S. wholesale price level. *p\_US* is the U.S. price level, *p\_ca* is the Canadian price level, and *ex\_ca* is the Canadian exchange rate with the United States. All variables run from 1973:Q1 to 2008:Q2 and all have been normalized to equal 100 in 1973:Q1.
  - (a) Plot the log exchange rate series for the U.S. versus Canada  $\log(ex\_ca)$ , the log price level for the U.S. ( $\log(p\_us)$ ) and the log price level for Canada ( $\log(p\_ca)$ ). Do each of these series appear to be stationary?
  - (b) Perform a DF test on each series in part (a).
  - (c) Estimate the long-run relationship

$$\log(ex\_ca) = \alpha + \beta_1 \log(p\_ca) + \beta_2 \log(p\_us) + \varepsilon$$

- (d) Do the point estimates of the slope coefficients seem to be consistent with long-run purchasing power parity (PPP)?
- (e) Examine the ACF and the PACF of residuals from part (d). Do they appear to be white noise?