ECON 424 Homework 3

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Due: Tuesday, July 11 at 11:59pm via Canvas

Readings

- EZ chapters on matrix algebra review, time series concepts, and descriptive statistics for financial time series.
- Ruppert and Matteson, Chapter 4 (Exploratory Data Analysis) and Chapter 12 (Time Series Models: Basics)
- ZLM, chapters 5 and 7
- R Cookbook, chapter 5 (data structures)
- Introduction to R (pdf document on webpage), chapter 5 (Arrays and Matrices)
- Beginners Guide to R, chapter 3, section 5 (Manipulating objects)

Programs and Data

The following files are located on the class homework page:

- 424lab3.r (R commands/hints for lab3)
- matrixReview.Rmd (R markdown files used for in class examples)

- timeSeriesConcepts.Rmd
- descriptiveStatistics.Rmd

Programs and Data

In this lab you will use R to do

- simple matrix algebra computations
- simulate some simple time series models
- compute sample descriptive statistics for some example data

Exercises

The following questions require R. On the Canvas page are the R script files 424lab3.r, descriptiveStatistics.Rmd, timeSeriesConcepts.Rmd, and matrixReview.Rmd. The file 424lab3.r contains hints for completing the assignment and the latter files contain R code for replicating the in-class examples. Copy and paste all statistical results and graphs into a MS Word document (or your favorite word processor) while you work, and add any comments and answer all questions in this document. Alternatively, consider using Rmarkdown to integrate the R code and text. The Rmarkdown document can be compiled and saved to either a Word or .pdf file. Start MS Word and open a blank document. You will save all of your work in this document. Alternatively, create a new Rmarkdown document and copy the R code from 424lab3.r into the appropriate parts of your Rmarkdown document.

1. Matrix Algebra

(a) Create the matrices and vectors

$$A = \begin{bmatrix} 1 & 4 & 7 \\ 2 & 4 & 8 \\ 6 & 1 & 3 \end{bmatrix}, B = \begin{bmatrix} 4 & 4 & 0 \\ 5 & 9 & 1 \\ 2 & 2 & 5 \end{bmatrix}, x = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}, y = \begin{bmatrix} 5 \\ 2 \\ 7 \end{bmatrix}$$

(b) Compute the transposes of the matrices and vectors

(c) Compute A+B, A-B, 2*A, Ax, y 'Ax

(d) Consider the system of equations:

x + y = 1

2x + 4y = 2

Plot the two lines and note the solution to the system of equations (hint: use the R function abline()). Write the system using matrix notation as Az = b and solve for z.

(e) Consider creating a portfolio of three assets denoted A, B and C. Assume the following information

$$\mu = \begin{bmatrix} 0.01 \\ 0.04 \\ 0.02 \end{bmatrix}, \Sigma = \begin{bmatrix} 0.10 & 0.30 & 0.10 \\ 0.30 & 0.15 & -0.20 \\ 0.10 & -0.20 & 0.08 \end{bmatrix},$$

Compute the expected return and variance for an equally weighted portfolio (i.e., $x_A = x_B = x_C = 1/3$).

2. Simulating Time Series Data

Consider the MA(1) model:

$Y_t = 0.05 + \epsilon_t + \theta\epsilon_{t-1},\ |\theta| < 1$

$\epsilon_t \sim\ iid\ N(0, (0.10)^2)$

a) Simulate and plot 250 observations of the MA(1) with $\theta = 0.5, 0.9$. Briefly comment

on the behavior of the simulated data series. (Hint: you can do this in a “for loop" or use the R function arima.sim())

b) What is the mean value of Y_t for each process?

c) What is the variance of Y_t for each process?

d) Plot the theoretical ACF for each process.

Now consider the AR(1) model:
$Y_t - 0.05 = \phi(Y_{t-1} - 0.05) + \epsilon_t,\ |\phi| < 1$
$\epsilon_t \sim\ iid\ N(0, (0.10)^2)$

a) Using the R function arima.sim(), simulate and plot 250 observations of the AR(1) with $\phi = 0.5, 0.9$. Briefly comment on the behavior of the simulated data series.

b) What is the mean value of Y_t for each process?

c) What is the variance of Y_t for each process?

d) Plot the theoretical ACF for each process.

3. Ruppert and Matteson Exercises

Chapter 4, R Lab, Section 4.10.2 McDonald’s Prices and Returns, Problems 9, 10 and 11. Chapter 12 Exercises (section 16). Exercises 3 and 4.

4. Descriptive Statistics

In this part of the lab, you will analyze continuously compounded monthly return data on the Vanguard long term bond index fund (VBLTX), Fidelity Magellan stock mutual fund (FMAGX), and Starbucks stock (SBUX). I encourage you to go to finance.yahoo.com and research these assets. The script file econ424lab3.r walks you through all of the computations for the lab. You do not need to show the R commands in your lab write up. You will use the get.hist.quote() function from the **tseries** package to automatically load this data into R. You will also use several functions from the **PerformanceAnalytics** package. Remember to install packages before you load them into R.

I. Univariate Graphical Analysis

(a) Make time plots of the return data using the R command plot() as illustrated in the script file econ424lab3.r. Comment on any relationships between the returns suggested by the plots. Pay particular attention to the behavior of returns toward the end of 2008 at the beginning of the financial crisis.

(b) Make a cumulative return plot (future of $1 invested in each asset) and comment. Which assets gave the best and worst future values over the investment horizon?

(c) For each return series, make a four panel plot containing a histogram, density plot, boxplot and normal QQ-plot. Do the return series look normally distributed? Briefly compare the return distributions

II. Univariate Numerical Summary Statistics

(a) Compute numerical descriptive statistics for all assets using the R functions summary(), mean(), var(), stdev(), skewness() (in package **PerformanceAnalytics**) and kurtosis() (in package **PerformanceAnalytics**). Compare and contrast the descrip-

tive statistics for the three assets. Which asset appears to be the riskiest asset?

(b) Using the mean monthly return for each asset, compute an estimate of the annual continuously compounded return (i.e., recall the relationship between the expected monthly cc return and the expected annual cc return). Convert this annual continuously compounded return into a simple annual return. Are there any surprises?

(c) Using the estimate of the monthly return standard deviation for each asset, compute an estimate of the annual return standard deviation. Briefly comment on the magnitude of the annual standard deviations.