TS Module 21 Building an ARIMA process

(The attached PDF file has better formatting.)

- Model specification, fitting, and checking
- Tools for model building: Excel VBA macros and R functions

Modules 21-24 help you design and complete the student project. They have no homework assignments; study for the final exam and begin your student project. The time series on-line course has 19 homework assignments, of which you must complete 15.

Read the step-by-step guide to ARIMA modeling. Your student project builds an ARIMA process to model an actual time series. You specify an ARIMA process, fit parameters, and verify that the actual time series conforms to the process. Getting started is often hard, so we provide a step-by-step guide.

Excel does not have all the tools needed for ARIMA modeling.

- If you use Excel, review the illustrative worksheets on the NEAS web site.
- If you use R, review Appendix A in the Cryer and Chan textbook, which describes the time series modeling tools in their TSA package.

Excel has a *REGRESSION* add-in that can fit autoregressive processes. Moving average and mixed models need nonlinear regression, for which Excel does not have built-in functions.

- If you use Excel for your student project, fit AR(1), AR(2), and (perhaps) AR(3) models.
- If the sample autocorrelation function indicates an MA(1) or ARMA(1,1) model, use the Yule-Walker equations.

As the textbook explains, the Yule-Walker equations are not efficient for moving average and mixed models. The fitted parameters may be far from the true coefficients, and your results may not predict well.

ARIMA modeling is both art and science. A time series that follows an ARIMA process exactly is rare, since changes in the environment make the parameters unstable.

Illustration: Interest rates might follow an AR(1) process in 20X1 with $\mu = 5\%$ and $\phi = 40\%$. In 20X2, they might follow an AR(1) process in 20X1 with $\mu = 6\%$ and $\phi = 30\%$.

Statisticians speak of interventions: changes in the environment that cause the model to change. Part of time series modeling is judging whether an apparent change is a random fluctuation or a true change in the process.

Some candidates conclude that ARIMA modeling lacks the economic sophistication of real models. They say we should study the fiscal and monetary policies that affect interest rates to form realistic forecasts.

This perspective is correct, but it misses the point. We use structural (economic) factors when we have the information, but we don't always have these data.

Illustration: An actuary is forecasting claim severity trends. In theory, the actuary should examine inflation indices and other economic data that affect severities, such as gas prices, unemployment, legal trends, and business growth. But the actuary is pressed for time, and simply fits an exponential curve to average claim severities of the past 12 quarters.

Time series modeling says we can do better. The actuary should take logarithms and first differences and then fit an ARMA process. The ARMA process will probably fit better than the simple exponential curve. A sophisticated econometric model might do even better, but it takes too long to build and the added precision may be small.

For your student project, you may find that ARIMA models sometimes do quite well.