

PROJECT TEMPLATE ON ARIMA MODELING OF RETAIL CAR SALES

The textbook for the on-line time series course has many illustrations of ARIMA modeling for industry sales. The NEAS discussion forum has numerous time series of retail sales by industry that can be used for student projects.

Each industry differs. The student project should examine trends, cycles, seasonality, and changes in market demand.

The Excel spread-sheet on retail auto sales has six time series. The six series are related:

- Total auto sales = new car sales + used car sales (#3 = #4 + #5).
- Auto + parts sales = auto sales + parts sales (#1 = #2 + #6).

Take heed: The attributes of the industry help you model sales. Auto manufacturers gave large rebates in some years, raising sales above their expected levels.

- Higher new car sales one year may reduce used car sales that year and new car sales the next year.
- The student project does not require special knowledge of the industry. But combining GDP, car sales, and inflation may help you interpret the results.

Inflation affects dollars sales. To convert sales to real dollars, divide by the CPI. It is easier to fit an ARIMA process to real dollar sales than to nominal dollar sales. If you use nominal dollars, you must take logarithms and first differences to create a stationary time series. But the first differences distort the moving average and autoregressive parameters, and make the ARIMA process harder to interpret.

Sales of durable goods (like autos) vary strongly with GDP. A 2% increase in real GDP may cause a 5% increase in auto sales, and a recession (a drop in real GDP) may cause a large decline in auto sales.

We may state this relation as demand build-up. New car sales show demand build-up. If sales are lower than expected in 20X7, demand builds up and sales may be higher than expected in 20X8.

Demand build-up causes a *moving average* ARIMA process, which does not occur in most industries and in single firm sales. Its effect on auto sales is unclear. Your student project may examine if sales of durable goods have a moving average component.

New car sales are seasonal, with new year models appearing in October. But auto manufacturers offer so many inducements (no cash down financing, rebates, special loan offers) that the seasonality can be hard to model. Graph the monthly new car sales, adjust for inflation and trends, isolate any apparent seasonality, and examine 12 month sample

autocorrelations. If the seasonality is material, de-seasonalize the data or use 12 month autoregressive parameters.

New car sales affects used car sales, but the relations are hard to isolate.

An increase in new car sales may cause a decline in used car sales. Convert nominal dollar sales to real dollar sales and then regress used car sales on new car sales. Fit an ARIMA process to the residuals.

A downturn in the economy may cause a decline in all car sales. Regress used car sales on new car sales and real GDP. Fit an ARIMA process to the residuals.

The combination of these items makes car sales an excellent student project. You may use lagged variables, such real GDP one month earlier.