Phase-Plane Plots of the Nondurable Goods Index

Annotated Analyses in S-PLUS

The Data

The nondurable goods production index is calculated by the United States Department of Commerce each month, and is published by the Federal Reserve Board on the web site http://www.federalreserve.gov . The data that we will work with in these notes start in January 1919, and end in November 1999.

These commands input the data. Note that there are values for each year that we do not need to use, so we first set up the data as a matrix tempmat with a row for each year, and then drop the unneeded columns.

```
tempmat <- matrix(scan("nondurprod.dat",0), 18, 81)
tempmat <- tempmat[2:13,]
tempmat[12,81] <- 0

nondurables <- matrix(tempmat, 12*81, 1)
ndur        <- 971
nondurables <- nondurables[1:ndur]
```

We will fill in the missing December 1999 observation with the December 1998 value, and also contruct a January 2000 value by using its 1999 counterpart.

```
nondurables <- c(nondurables,
                 nondurables[961],
                 nondurables[962])
ndur <- 973
```

Now define time values for each month, and also a vector of densely spaced time values for plotting purposes.

```
durtime  <- (0:(ndur-1))/12 + 1919
durtimefine <- seq(1919,2000-0.01,0.01)
ndurfine <- length(durtimefine)
```

We also want the log-transformed index, using base 10 logarithms.

```
lognondur <- log10(nondurables)
```

Plotting the Index

The following code plots the raw untransformed index and the log index. For the log index, a straight line fit by least squares is also added to the plot.

```
par(mfrow=c(1,1), pty="s", mar=c(5,5,4,2))

plot(durtime, nondurables, type='l', cex=1.2,
     xlab='Year', ylab='Index')

plot(durtime, lognondur,   type='l', cex=1.2,
     xlab='Year', ylab='Log10 Index')
abline(lsfit(durtime,lognondur),lty=2)
```

Smoothing the Index

Since we need to work with a smooth curve which also has also smooth derivatives, this smoothing step is very important. We use the `smooth.Pspline` function, which permits us to penalize the size of the order of derivative that we specify. Because we want smooth second derivative or acceleration curves, we penalize the fourth derivative, which in effect controls the curvature of the second derivative.

First, however, S-PLUS needs to load the Fortran subroutine used in `smooth.Pspline`, and the following two commands are what works on my system.

```
dyn.load("c:\\Program Files\\sp2000\\Pspline.dir\\Pspline.obj")
source(  "c:\\Program Files\\sp2000\\Pspline.dir\\Pspline.q")
```

The smoothing parameter, called here spar, was chosen after looking closely at how the smooth curve fit the data, and at the same time how smooth the second derivative was. In general, if one wants a smooth derivative, one has to apply more smoothing than if the sole consideration is to fit the data adequately. In other words, some fit has to be sacrificed to get good information about derivatives, and the higher the derivative, the more that this is true. This code reflects our final choice, and puts the smoothing function to work. Note that setting the method parameter to 1 simply requests that the function use the smoothing parameter value that is provided, rather than attempting to optimize it.

```
Psplobj <- smooth.Pspline(durtime, lognondur,
                          spar=10^(-9.5, norder=4,  method=1)
```

Now let's zoom in on the years 1964 to 1967 to see how the fit looks for some typical and stable years. This code sets up the values to be plotted, and plots them.

```
index    <- 541:577
durrange <- range(durtime[index])
durfine  <- seq(durrange[1],durrange[2],len=201)
D06467   <- predict.smooth.Pspline(Psplobj, durfine, nderiv = 0)
```

```
plot (durtime[index], lognondur[index], type='p', cex=1.2,
      xlab="Year", ylab="Log10 Nondurables")
lines(durfine,D06467)
abline(v=durtime[c(553,565)], lty=3)
```

Phase-Plane Plots

Now we construct the phase-plane plots. Here we just do this for the three years from 1964 through 1966.

First we set up the number of years to plot and the starting year, as well as some single letter labels for months.

```
labs <- c('j','F','m','A','M','J','J','A','S','O','N','D')

nyr       <- 3   #  number of years to plot
years     <- 64  #  startingyear
yearindex <- years + 1900 - 1919  # indices of year
```

This is the code that carries out the phase-plane plotting.

```
par(mfrow=c(1,1), pty="s", mar=c(5,5,4,2))
for (i in yearindex) {
  index    <- (1:(nyr*12+1)) + i*12
  durrange <- range(durtime[index])
  durfine  <- seq(durrange[1],durrange[2],len=401)
  D1 <- predict.smooth.Pspline(Psplobj, durfine, nderiv = 1)
  D2 <- predict.smooth.Pspline(Psplobj, durfine, nderiv = 2)
  plot (D1, D2, type='n', cex=1.2, col=1,
        xlim=c(-.75,.75), ylim=c(-12,12),
        xlab="Velocity", ylab="Acceleration")
  if (nyr==1) {
        title(paste('Year',durrange[1]))
  } else {
        title(paste('Years',durrange[1],' to',durrange[2]))
  }
  abline(v=0, lty=2, col=2)
  abline(h=0, lty=2, col=2)
  x0 <- durrange[1]
  for (j in 1:nyr) {
    indj <- durfine>=x0+j-1 & durfine <=x0+j
    lines(D1[indj], D2[indj], lty=j,col=1)
  }
  durcrse <- seq(durrange[1],durrange[2],len=nyr*12+1)
  D1 <- predict.smooth.Pspline(Psplobj, durcrse, nderiv = 1)
  D2 <- predict.smooth.Pspline(Psplobj, durcrse, nderiv = 2)
  text(D1, D2, rep(labs,nyr), col=1)
}
```