VAR EXERCISE

The course web site has, in the same directory with this file describing the exercise, monthly data on three components of the produce price index: raw materials, intermediate goods, and final goods. The file pdat.RData has the three series already logged and stored as an R multiple time series object. There are also three .xls files containing the raw data for the three series. The files VARpack2019.zip and optimize.1.zip contain R packages that you can install "locally" in R and then load with the R **library**() function. You don't have to use these packages or R.

(1) Plot the data. (e.g. **plot**(pdat) in R). Note that the materials index is the least smooth and the final goods index the most smooth of the three series.

(2) Estimate a VAR for these three series. Use 6 lags. This can be done easily with the `rfvar3()` function in the VARpack2019 package. That function uses the persistence dummy observations from the Minnesota prior. You can use it with the default weights on the prior. If you use other software, it is not essential that you use a prior.

(3) Check the roots of the system, which is most easily done by setting up the coefficient matrix for the stacked system and calculating its eigenvalues. The `sysmat()` function constructs the stacked-system coefficient matrix from the `rfvar3()` output. Observe whether the rule of thumb that suggests treating roots within $1/T$ of 1.0 as 1 suggests 1 unit root. (If you use `rfvar3()` with the default prior weights, you will probably see this.)

(4) Plot impulse responses for the system, with the default Cholesky ordering, for example with

```
resp <- impulsdtrf(vout,nstep=48)
plotir(resp))
```

Do the results suggest an approximate Granger causal ordering?

(5) Estimate a VECM model for these data, imposing the assumption that there are two cointegrating vectors. First try setting the cointegrating vectors to be [1, 0, -1] and [0, 1, -1], then use a nonlinear optimizer to start from these guessed cointegrating vectors and search for the optimal cointegrating coefficients. The ([1, 0, -1], [0, 1, -1]) pair has an economic interpretation: it implies that the relative prices are stationary, while the individual price time series are not.

Note that the cointegrating vectors have to be normalized; use the normalization that the 3 x 2 cointegrating vector matrix has the identity in its top 2 x 2 submatrix (leaving just two free coefficients to be estimated).

The program `vecmlh()`, available as a text file on the course web site, calculates the integrated posterior density under a flat prior as a function of the two free coefficients in the cointegrating vectors, and returns minus the log marginal data density. The program's **beta** argument must be a dimensioned matrix, representing the part

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of the cointegrating vector matrix that is below the normalized identity matrix — that is, in our case, a 1 x 2 matrix. (The program is more complex than necessary for this exercise. The only part of the calculated return value that depends on the cointegrating vectors is the degrees of freedom times the log of the determinant of the crossproducts of residuals. The other terms are useful only if one is making comparisons across models with different numbers of lags or cointegrating vectors.) You can use `vecmlh()` as an argument to an optimization function — `csminwelNew()` from the optimize.1 package or R's built-in **`nlm`**`()`. Note that the arguments `veclm()` beyond the first, have to be passed through to it as named arguments to the optimization function. Also note that if you start the optimization far from the optimum, it is possible to get stuck at a local peak of the likelihood (i.e. local minimum of minus the likelihood).

By looking at what happens to the integrated posterior density (or just log of the determinant of the residual crossproduct matrix, times degrees of freedom), assess whether the cointegrating vectors are sharply determined. Differences in logged integrated posterior densities are logs of odds ratios. They are usually thought of as small if the differences in log odds are smaller than 2 to 4.