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Meetup to discuss 'R' code for linear programming analysis of fisheries

Jeff Shrader <jgshrade@ucsd.edu> Mon, Oct 21, 2013 at 4:05 PM
To: Stephen Stohs - NOAA Federal <stephen.stohs@noaa.gov>
Cc: Jordan Schafer <jinsca@gmail.com>

Steve and Jordan,

Attached, please find my code and some background papers. The code is in two files. The first, dea_package.R, contains everything you need to run DEA and industry model estimates. The second file contains a bunch of randomly generated examples I created to make sure that the code worked. I include the second file because it might be helpful to see examples. The third file contains the code "in the wild", on a project I am doing with Dale looking at global purse-seine capacity. This file has lots of stuff around the basic estimation, but it shows you (if you go to the loop where I call `f.dea`) how I am using these commands in practice. I loop over years, building matrices of inputs and outputs. Then I feed these matrices into `f.dea`. I then calculate optimal input and output values for the whole fishery for that year using `optimal.in.out`, and observed total values using `industry.observed`, a pair of helper functions. Finally, I run `f.jim` to calculate the industry wide efficient inputs.

I based lots of my syntax on FEAR, so if you use that package, things should be somewhat similar.

The papers attached are, in order, the one on which I based my coding of the Industry Model, the paper on which I based the DEA code, and the paper Dale and I wrote on the EPO.

I don't have an official help file, so here is a quick run-down of the four commands and syntax you need:

f.dea:

This command calculates efficient frontiers from an input or output oriented perspective for fixed or variable (or both) inputs. To calculate technical efficiency, include your variable inputs as if they were fixed. To calculate capacity utilization, include your variable inputs as variable inputs. See me and Dale's paper for more details.

Syntax: `output <- f.dea(f.inputs, <v.inputs>, outputs, tech='V', orientation='OUT', report.z='NO', slack='NO', convex='YES')`

Variables:
`f.inputs` = an *(n x k_f)* matrix of fixed inputs (e.g. grt) where *n* is the number of vessels and *k* is the number of fixed inputs.
`v.inputs` (optional) = an *(n x k_v)* matrix of variable inputs (e.g. days).
`outputs` = an *(n x j)* matrix of outputs where *j* is the number of outputs.
`tech` = 'V', 'N', or 'C' for variable, non-increasing, or constant technology. To my mind, there is no reason in practice to run anything other than 'V'. If you want to run 'C', use FEAR because my code will probably break.
orientation = 'OUT' or 'IN' for output or input orientation. Output orientation will maximize outputs while input orientation minimizes inputs. To run the industry model, this must be 'OUT'.
`report.z` = Set this to 'YES' for all runs! I don't know why I was silly and set the default to 'NO'
`slack, and convex` should be left at their defaults for your analysis.

`output` = a list containing theta and lambda. Theta gives the relative efficiency of the vessel (on a scale between 0 and 1) and lambda gives the weights on each efficient vessel that the vessel in question should place in order to reach the frontier. Another way of saying this is that an inefficient vessel should strive to be a convex combination of some efficient vessels, and lambda tells you the weights in that convex combination. An efficient vessel should always have a lambda equal to 1 for themselves. This is actually the scaling of the variable outputs...ok, I am actually forgetting exactly what lambda tells us, so I might get back to you on this.

Example:

```
# Specify fixed inputs
x.m.f <- matrix(c(10, 5, 3, 4, 5), ncol=1, nrow=5)
# Specify variable inputs
x.m.v <- matrix(c(2, 50, 3, 2, 2, 1, 3, 5, 2, 1), ncol=2, nrow=5)
# Specify outputs
y.m <- matrix(c(5, 0, 6, 1, 1,
                1, 4, 2, 0, 0), ncol=2, nrow=5)
# Run
cu <- f.dea(f.inputs = x.m.f, v.inputs=x.m.v,
            outputs=y.m,
            tech="V", orientation="OUT", report.z="NO", slack="NO", convex="YES")
```

f.jim:

This command calculates the Johansen industry model based optimal input values for the whole fleet. You need to run f.dea, industry.observed, and optimal.in.out before running f.jim. Almost all of the inputs are provided by the helper functions.

Syntax:

```
output <- f.jim(f.in.total, <v.in.total>, out.total, f.in.opt, <v.in.opt>,
out.opt, tac=0, fd.max=0, ivq=NULL, ivq.var=NULL, convex='YES')
```

Variables:

`f.in.total` = provided by `industry.observed`
`v.in.total` = provided by `industry.observed`
`out.total` = provided by `industry.observed`
`f.in.opt` = provided by `optimal.in.out`
`v.in.opt` = provided by `optimal.in.out`
`out.opt` = provided by `optimal.in.out`
`tac =` A total allowable catch for the fishery for each output (if set to 0 or the observed value, then no constraint)
`fd.max` = Fishing day maximum. To use, you must specify days as your first variable output.
`ivq` = Individual vessel quota
`ivq.var` = Column number of the species on which the IVQ applies (could be all).
`convex` = Leave this alone

`output` = a list containing theta, W, and Xv. Theta is the industry-wide input efficiency. W is the scaling that should be applied to each vessel in order to reach industry efficiency. Thus, the sum of W is the number of vessels you would want in the optimal fishery. Xv is the variable input scaling. I think it is the average of W.

Example:

```
# Call the package
source("C:/Users/jgs/Documents/research/bin/dea/bin/working/dea_package.R")
# Generate random data
set.seed(2982)
J <- 100
nv <- 1
nf <- 2
nu <- 2
x.m.f <- matrix(runif(nf*J, 0, 50), ncol=nf, nrow=J)
```

```
x.m.v <- matrix(runif(nv*J, 0, 50), ncol=nv, nrow=J)
y.m <- matrix(runif(nu*J, 0, 50), ncol=nu, nrow=J)
l <- length(y.m)

# Get the total inputs and outputs for the fishery
act <- industry.observed(f.inputs=x.m.f, v.inputs=x.m.v, outputs=y.m)

# Calculate the DEA estimates
testf <- f.dea(f.inputs = x.m.f, v.inputs=x.m.v, outputs=y.m, tech="V",
orientation="OUT",
                 report.z="YES", slack="NO")

# Calculate optimal inputs and outputs for the fishery based on the DEA step
outf <- optimal.in.out(f.inputs=x.m.f, v.inputs=x.m.v, outputs=y.m,
theta=testf$theta, z=testf$z)

# Run the industry model
jim.c <- f.jim(f.in.total=act$x.f.a, v.in.total=act$x.v.a, out.total=act$u.a,
                 f.in.opt=outf$x.f.s, v.in.opt=outf$x.v.s, out.opt=outf$u.s,
                 convex='YES')
```

optimal.in.out:
A helper function for f.jim.

Syntax:
`output <- optimal.in.out(f.inputs, <v.inputs>, outputs, theta, z, <flow>, <flow.var>)`

Variables:
`f.inputs` = same as for f.dea
`v.inputs` (optional) = same as for f.dea
`outputs` = same as for f.dea
`theta` = Just provide the value from f.dea output
`z` = Same as theta
`flow and flow.var` = Just ignore these

`output` = Look at how the f.jim example runs to see how to use the output from this command. It just links f.dea with f.jim to save a little repetitious coding.

industry.observed:
A helper function for f.jim.

Syntax:
`output <- industry.observed(f.inputs, <v.inputs>, outputs, <flow>, <flow.var>)`

Variables:
`f.inputs` = same as for f.dea
`v.inputs` (optional) = same as for f.dea
`outputs` = same as for f.dea
`flow and flow.var` = Just ignore these

`output` = Look at how the f.jim example runs to see how to use the output from this command. It just links f.dea with f.jim to save a little repetitious coding.

On Thu, Oct 17, 2013 at 12:28 PM, Stephen Stohs - NOAA Federal <stephen.stohs@noaa.gov> wrote:
[Quoted text hidden]

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6 attachments

dea_package.R
29K

dea_sandbox.R
6K

io_cu.R
10K

Kerstens, Squires, Vestergaard - 2005 - Methodological reflections on the short-run Johansen industry model in relation to capacity management.pdf
215K

Reid et al. - 2003 - An analysis of fishing capacity in the western and central Pacific Ocean tuna fishery and management implications.pdf
983K

Capacity & Fleet Size EPO 2013-02-19.pdf
1517K