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Data Envelopment Analysis using R

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- DEA provides a mathematical programming method for estimating optimal production frontiers and evaluating the relative efciency of different entities.
- "Benchmarking" package contains all of the main DEA and SFA methods.
- Commands to estimate production frontiers using "Benchmarking" package.

Get the data ready

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- To use the Benchmarking commands always: *library*(*Benchmarking*)
- firms-countries on rows, and inputs and output in the columns
- **define data**

1.inputs

$x <- matrix(c(data\$x1, data\$x2), nrow = 127, ncol = 2)$

2.outputs

$y <- matrix(c(data\$y), nrow = 127, ncol = 1)$

Plot Commands

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$dea.plot(x, y, RTS = "crs", ORIENTATION = "in - out", txt = rownames(x), main = "CRS, in - out")$

- For other models add the respective RTS and the ORIENTATION

Examples

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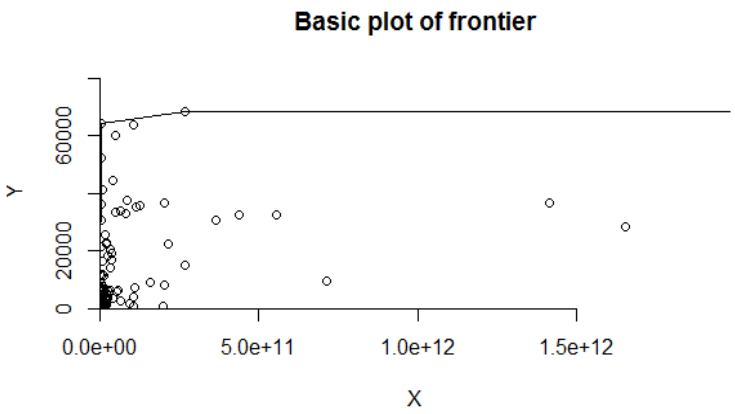

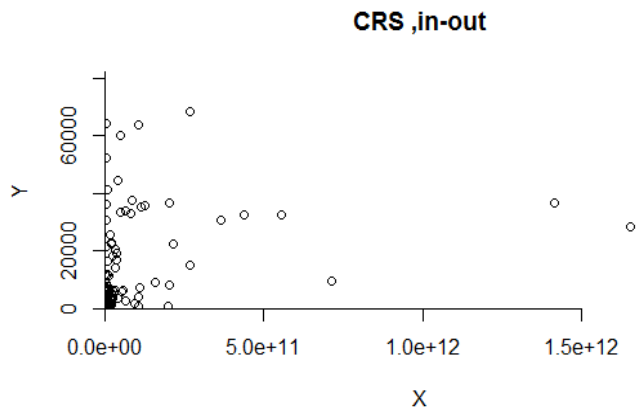

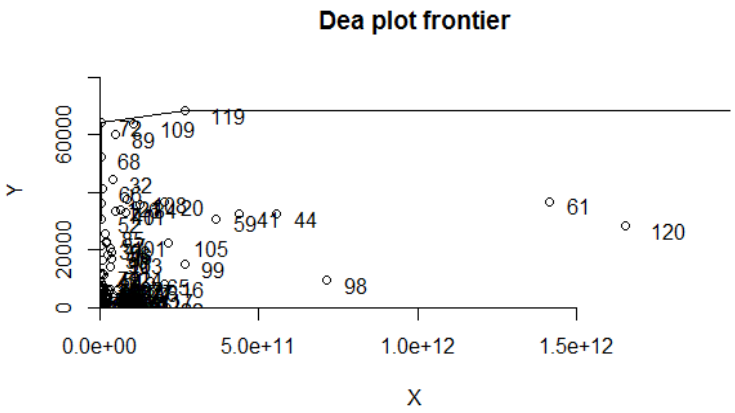

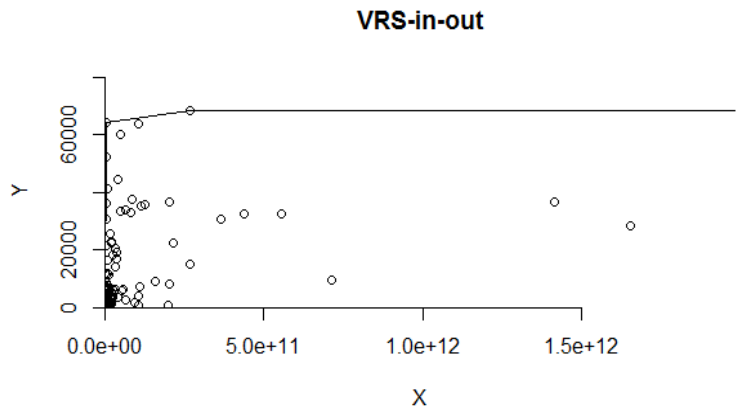

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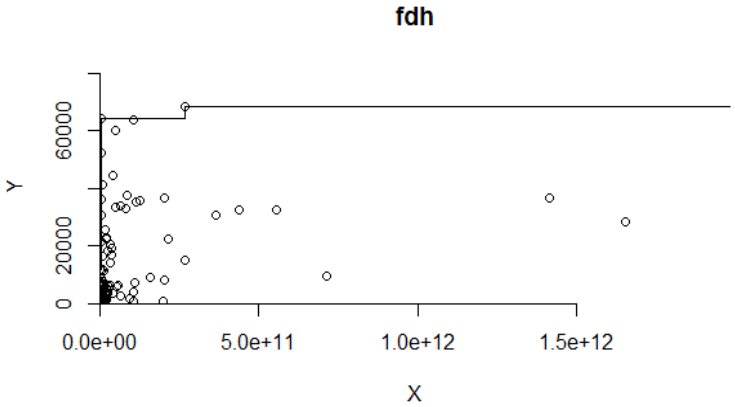

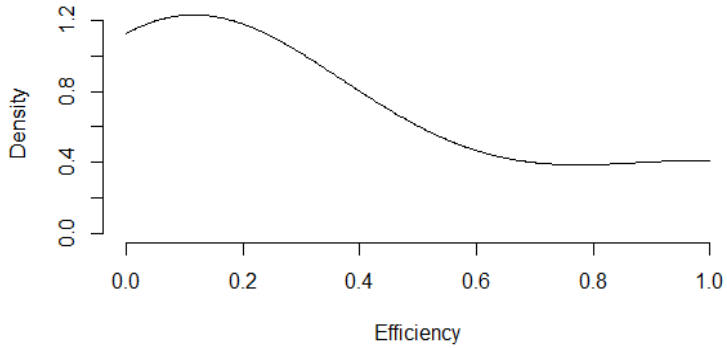

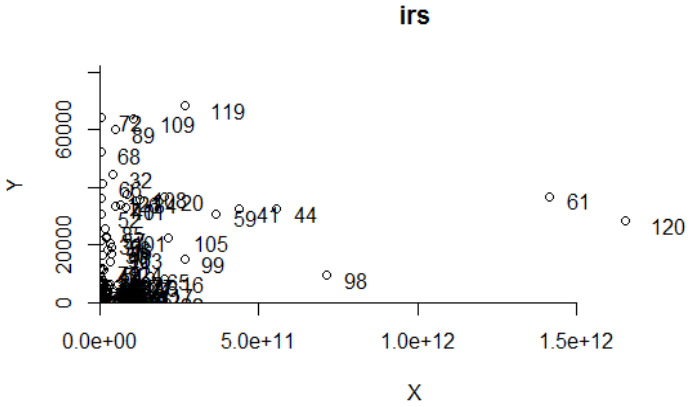

$dea(x, y, RTS = "crs", ORIENTATION = "in")$

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- **RTS:**
  change the value in order to examine the different kind of models i.e crs for constant return to scale, vrs for variable return to scale , irs , drs.
- **ORIENTATION:**
  change the value for the orientation that model has i.e in for input, out for output.
- **FRS:**
  easily can be calculated efciency under alternative assumptions about the technology as well, using the RTS option with values drs, irs, fdh and add.

Calculations

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1. $e1 < -dea(x, y)$
2. $eff(e1)$
3. $print(e1)$
4. $summary(e1)$
5. $peers(e1)$
6. $lambda(e1)$
7. $get.number.peers(e1)$

1. solve LP problem and insert DEA results in a matrix
2.select efficiency scores from the results
3.print the matrix with the efficient combinations
4.Summary of efficiencies: number of firm with efficiency=1 and the mean efficiency
5. determine the peers
6.weight information
7.gives the number of peers for every entity that have efficiency=1

Results examples


```
Summary of efficiencies
The technology is vrs and input orientated efficiency
Number of firms with efficiency==1 are 12
Mean efficiency: 0.246
---
 Eff range     #    %
 0<= E <0.1    64 50.39
 0.1<= E <0.2  15 11.81
 0.2<= E <0.3  11 8.66
 0.3<= E <0.4  10 7.87
 0.4<= E <0.5   7 5.51
 0.5<= E <0.6   5 3.94
 0.6<= E <0.7   1 0.79
 0.7<= E <0.8   1 0.79
 0.8<= E <0.9   0 0.00
 0.9<= E <1     1 0.79
    E ==1      12 9.45
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.001115 0.034780 0.098050 0.246000 0.344100 1.000000
```

```
> dea(x,y, RTS="crs", ORIENTATION="in")
  [1] 4.012e-02 6.968e-03 7.912e-03 9.809e-03 1.346e-02 1.741e-02 3.291e-02 6.275e-02
  [9] 8.250e-04 1.213e-02 2.734e-02 1.976e-02 2.537e-02 6.255e-01 1.061e-01 1.774e-03
 [17] 2.347e-02 8.818e-03 1.174e-02 1.092e-02 2.207e-02 6.984e-05 1.481e-02 4.484e-03
 [25] 8.521e-02 6.891e-02 2.074e-01 7.042e-02 1.763e-02 3.166e-01 2.324e-02 6.843e-02
 [33] 2.139e-02 1.872e-02 2.496e-03 3.934e-02 2.708e-02 1.866e-01 7.010e-01 4.542e-02
 [41] 4.680e-03 2.747e-01 1.000e+00 3.560e-03 8.744e-03 3.018e-02 1.981e-02 1.000e+00
 [49] 2.659e-02 4.126e-02 3.882e-02 1.000e+00 1.040e-04 5.382e-04 4.031e-03 6.928e-01
 [57] 7.611e-02 4.068e-02 5.192e-03 1.014e-01 1.714e-03 4.583e-02 6.133e-03 7.570e-03
 [65] 3.131e-03 3.993e-01 2.003e-02 1.000e+00 4.044e-02 1.000e+00 6.651e-02 1.000e+00
 [73] 9.369e-02 9.156e-03 6.137e-01 1.455e-01 3.101e-03 6.178e-02 1.749e-01 5.280e-03
 [81] 3.810e-03 1.754e-01 3.762e-03 1.958e-02 1.013e-01 1.847e-02 8.320e-03 1.792e-03
 [89] 8.498e-02 1.033e-03 1.275e-01 3.799e-02 8.659e-03 1.814e-03 7.013e-03 2.631e-02
 [97] 1.071e-02 7.581e-04 7.293e-03 1.595e-02 7.297e-02 3.934e-02 1.582e-01 8.680e-03
[105] 6.333e-03 7.425e-03 9.274e-03 2.874e-02 4.215e-02 1.110e-02 2.939e-03 1.489e-03
[113] 2.472e-02 1.192e-01 1.991e-02 5.013e-03 7.072e-03 5.138e-03 1.870e-01 2.396e-03
[121] 4.183e-02 7.248e-02 2.284e-03 4.354e-02 7.335e-03 1.076e-01 1.330e-01
>
```

```
> peers(e)
      peer1 peer2 peer3
 [1,]    75    79    NA
 [2,]    75    79    NA
 [3,]    75    79    NA
 [4,]    75    79    NA
 [5,]    75    79    NA
 [6,]    52    68    72
 [7,]    52    72    NA
 [8,]    68    75    79
               .
               .
               .
               .
[125,]    14    70    NA
[126,]    14    70    NA
[127,]    14    70    NA
```

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8. $get.which.peers(e1, c(z1, z2))$
9. $(1 - eff(e1)) * x$
10. $e2 < -dea(x, y, SLACK = TRUE)$
11. $data.frame(eff(e2), e2\$slack, e2\$sx, e2\$sy, lambda(e2))$
12. $esuper < -sdea(x, y, RTS = "vrs", ORIENTATION = "in")$
$print(peers(esuper, NAMES = TRUE), quote = FALSE)$

8. Who are the firms that firm z1 and z2 is peers for
9. matrix with input savings for every firm-country
10. calculate slacks for every entity
11. data frame which has as columns :efficient slack from SS'and other results
12. which observations are on SS' curve

Scale and allocative efficiency

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- **Scale efciency**

  $> e_vrs < -dea(x, y, RTS =' vrs')$
  $> e_drs < -dea(x, y, RTS =' drs')$
  $> e_crs < -dea(x, y, RTS =' crs')$
  $> se < -eff(e_crs)/eff(e_vrs)$
  $> abs(eff(e_vrs) - eff(e_drs)) < 1e-4$ The last command check if DRS eff. is equal to VRS eff.

- **Allocative efficiency**

  $dea(x, y, RTS = "vrs")$
  $cost.opt(x, y, w, RTS = "vrs")$

References

- Benchmarking with DEA ,SFA, and R
  Peter Bogetoft, Lars Otto