Dear All,

I´m a student and wanted to make a research on the electric sector of CO_2 emission performance in Europe. So I employ a nonparametric data envelopment analysis to measure the relative CO_2 performance across states using the multiple-input and multiple-output prduction structure of electricity generation. As inputs I use fuel consumption and capacity and as desirable output produced electricity and undesirable output CO_2 emissions. For Benchmarking I use global Malmquist CO_2 emission performance index (GMCPI). I have the method and all equations, but no clue how to transfer it into R, because I never worked with it.

<u>Equations:</u>

$x = (x_1, \dots, x_N) \in \mathbb{R}_+^N$ denotes vector of inputs

$y = (y_1, \dots, y_M) \in \mathbb{R}_+^M$ denotes vector of desirable output

$b = (b_1, \dots, b_I) \in \mathbb{R}_+^I$ denotes vector of undesirable output

P(x) = {(y, b) : x can produce (y, b)} production technology

<u>Benchmark technology:</u>

$P^t(x) = \{(y^t, b^t): x^t \text{ can produce } (y^t, b^t)\}, \text{with } t = 1, \dots, T$ contemporaneous

$P^G(x) = conv\,\{P^1(x) \cup \dots \cup P^T(x)\}$ global

<u>GMCPI:</u>

$$\text{GMCPI} = \frac{D^G(t)}{D^G(t+1)}$$

where

$\mathrm{D}^{\mathrm{G}}(x^t, y^t, \mathrm{b}^{\mathrm{t}}) = D^G(t),$

$\mathrm{D}^{\mathrm{G}}(x^{t+1}, \mathrm{y}^{\mathrm{t+1}}, b^{t+1}) = D^G(\mathrm{t}+1),$

$\mathrm{D}^{\mathrm{t}}(\mathrm{x}^{\mathrm{t}}, y^t, \mathrm{b}^{\mathrm{t}}) = D^t(t)$

and $\mathrm{D}^{\mathrm{t}}(x^{t+1}, y^{t+1}, b^{t+1}) = \mathrm{D}^{\mathrm{t+1}}(t+1).$

$$\text{GMCPI} = \text{EC} \times \text{BPC}$$

where

$$\text{EC} = \frac{D^t(t)}{D^{t+1}(t+1)}$$

$$\text{BPC} = \frac{D^G(t)/D^t(t)}{D^G(t+1)/D^{t+1}(t+1)}$$

<u>Contemporaneous distance function in each period s (s = t, t + 1) for each observation k‘ (k = 1, … , K):</u>

$$[D^s(x^s, y^s, b^s)]^{-1} = \min_z \theta$$

s.t.

$$\sum_{k=1}^{K} Z_k^s y_{km}^s \geq y_{k'm}^s, \text{where } m = 1, \dots, M,$$

$$\sum_{k=1}^{K} z_k^s x_{kn}^s \leq x_{k'n}^s, \text{where } n = 1, \dots, N,$$

$\sum_{k=1}^{K} z_k^s b_{ki}^s = \theta b_{k'i}^s, \text{where } i = 1, \dots, I,$ weak disposability

$z_k^s \geq 0, \text{where } k = 1, \dots, K$ constant returns to scale

<u>Global distance function in each period s (s = t, t + 1) for each observation k‘ (k = 1, … , K):</u>

$$[D^G(x^s, y^s, b^s)]^{-1} = \min_z \theta.$$

s.t.

$$\sum_{t=1}^{T} \sum_{k=1}^{K} z_k^t y_{km}^t \geq y_{k'm}^s, \text{where } m = 1, \dots, M,$$

$$\sum_{t=1}^{T} \sum_{k=1}^{K} z_k^t x_{kn}^t \leq x_{k'n}^s, \text{where } n = 1, \dots, N,$$

$$\sum_{t=1}^{T}\sum_{k=1}^{K} z_k^t b_{ki}^t = \theta b_{k'i}^s, \text{where } i = 1, \ldots, I,$$

$$z_k^t \geq 0, \text{where k} = 1, \ldots, \text{K}.$$