Sustainability on Energy Planning of China

Yan Yuan, PhD; Toshiyuki Sueyoshi, PhD
New Mexico Tech

Abstract

In order to reinforce the environment protection, China needs to promote sustainable energy plan. This study compares the Returns to Damage (RTD) under Undesirable Congestion (UC) in natural disposability and Damages to Return (DTR) under Desirable Congestion (DC) in managerial disposability. After applying the methodology to Chinese provinces on energy planning for sustainable development, two facts are found. Environment protection has been historically ignored in China and Chinese government focused on large cities especially municipalities in terms of energy policy concerns. But China tries to improve the economy and environment at the same time. Therefore, Chinese government should proceed the privatization so that the linkage between government and energy firms will be broken. It will reinforce the power of energy management and GDP can be increased due to increased economic efficiency.

Introduction

In order to avoid the irreversible outcome from rapid economic development and duplication of UK's development mistake, China should seek social sustainability on economy and environment before the air quality goes worse. And the energy planning plays an important role in controlling air pollutions.

DEA environmental assessment is used to overcome the difficulty on global warming and climate change by combining the technology development with managerial challenges.

After finding the serious environmental pollution and imbalanced economy in China, Chinese government should proceed privatization in near future to reinforce the monitoring power.

Methods and Materials

$$\begin{aligned} \textit{Minimize} \quad & \sum_{i=1}^{m} v_i x_{ik} - \sum_{r=1}^{s} u_r g_{rk} + \sum_{f=1}^{h} w_f b_{fk} + \sigma \\ s.t. \quad & \sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r g_{rj} + \sum_{f=1}^{h} w_f b_{fj} + \sigma \geq 0 \quad (j = 1, .., n), \\ & \sum_{r=1}^{s} u_r g_{rk} + \sum_{f=1}^{h} w_f b_{fk} = 1, \\ & v_i \geq \varepsilon_s R_i^x \quad (i = 1, .., m), \\ & u_r \geq \varepsilon_s R_r^g \quad (r = 1, .., s), \\ & w_f : URS \quad (f = 1, .., h), \\ & \sigma : URS, \\ & -1 \leq v_{i'}/v_i \leq 1 \quad (i' > i = 1, .., m), \\ & -1 \leq u_{r'}/u_r \leq 1 \quad (r' > r = 1, .., s) \ \& \\ & -1 \leq w_{f'}/w_f \leq 1 \quad (f' > f = 1, .., h). \end{aligned} \tag{1}$$

$$UEN(UC) = 1 - [\sum_{i=1}^{m} v_i^* x_{ik} - \sum_{r=1}^{s} u_r^* g_{rk} + \sum_{f=1}^{h} w_f^* b_{fk} + \sigma^*], \tag{2}$$

$$\begin{aligned} \textit{Minimize} \quad & -\sum_{i=1}^{m} v_i x_{ik} - \sum_{r=1}^{s} u_r g_{rk} + \sum_{f=1}^{h} w_f b_{fk} + \sigma \\ s.t. \quad & -\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r g_{rj} + \sum_{f=1}^{h} w_f b_{fj} + \sigma \geq 0 \quad (j = 1, .., n), \\ & \sum_{r=1}^{s} u_r g_{rk} + \sum_{f=1}^{h} w_f b_{fk} = 1, \\ & v_i \geq \varepsilon_s R_i^x \quad (i = 1, .., m), \\ & u_r : URS \quad (r = 1, .., s), \\ & w_f \geq \varepsilon_s R_f^b \quad (f = 1, .., h), \\ & \sigma : URS, \\ & -1 \leq v_{i'}/v_i \leq 1 \quad (i' > i = 1, .., m), \\ & -1 \leq u_{r'}/u_r \leq 1 \quad (r' > r = 1, .., s) \ \& \\ & -1 \leq w_{f'}/w_f \leq 1 \quad (f' > f = 1, .., h). \end{aligned} \tag{3}$$

$$UEM(DC) = 1 - [-\sum_{i=1}^{m} v_i^* x_{ik} - \sum_{r=1}^{s} u_r^* g_{rk} + \sum_{f=1}^{h} w_f^* b_{fk} + \sigma^*], \tag{4}$$

where all the dual variables are identified on the optimality of Original Model.

Model (1), (2) are under natural disposability and Model (3), (4) are under managerial disposability. a. if $W_f^*<0/U_r^*<0$ for some (at least one) f, then "strong UC"/"Strong DC" occurs on the k-th DMU, b. if $W_f^*>0/U_r^*>0$ for all f, then "no UC"/"no DC" occurs on the k-th DMU, and c. In the others, including $W_f^*=0/U_r^*=0$ for some (at least one) f, then "weak UC"/"Weak DC" occurs on the k-th DMU.

$$\begin{aligned} DgRTD(UC) &= (\sum_{f=1}^{h} w_f^* b_f) / (\sum_{r=1}^{s} u_r^* g_r) \\ &= (\sum_{f=1}^{h} w_f^* b_f) / (\sum_{i=1}^{m} v_i^* x_i + \sum_{f=1}^{h} w_f^* b_f + \sigma^*) \quad (5) \\ &= 1/[1 + (\sigma^* + \sum_{i=1}^{m} v_i^* x_i) / (\sum_{f=1}^{h} w_f^* b_f)] \end{aligned}$$

$$\sigma^* + \sum_{i=1}^{m} v_i^* x_i \qquad E(7)$$

$$\begin{aligned} DgDTR &= (\sum_{r=1}^{s} u_r^* g_r) / (\sum_{f=1}^{h} w_f^* b_f) \\ &= (\sum_{r=1}^{s} u_r^* g_r) / (\sum_{i=1}^{m} v_i^* x_i + \sum_{r=1}^{s} u_r^* g_r - \sigma^*) \quad (6) \\ &= 1/[1 - (\sigma^* - \sum_{i=1}^{m} v_i^* x_i) / (\sum_{r=1}^{s} u_r^* g_r)] \end{aligned}$$

$$\sigma^* - \sum_{i=1}^{m} v_i^* x_i \qquad E(8)$$

Equation (5) & (6) are degrees of RTD and DTR. They are classified by rules below:

a. Increasing RTD/DTR-$W_f^*>0/U_r^*>0$ and E(7)<0/E(8)>0
b. Constant RTD/DTR-$W_f^*>0/U_r^*>0$ and E(7)=0/E(8)=0
c. Decreasing RTD/DTR-$W_f^*>0/U_r^*>0$ and E(7)>0/E(8)<0
d. Negative RTD/DTR-$W_f^*<0/U_r^*<0$
e. No RTD/DTR-All other cases excluding a-d.

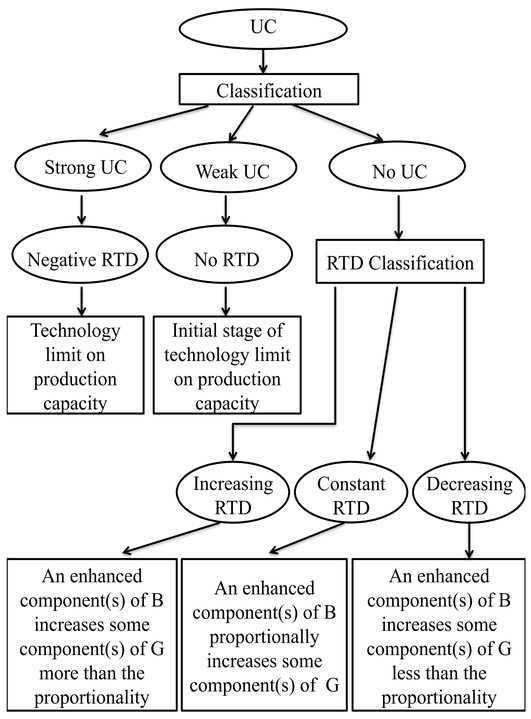

Figure 1. RTD under UC

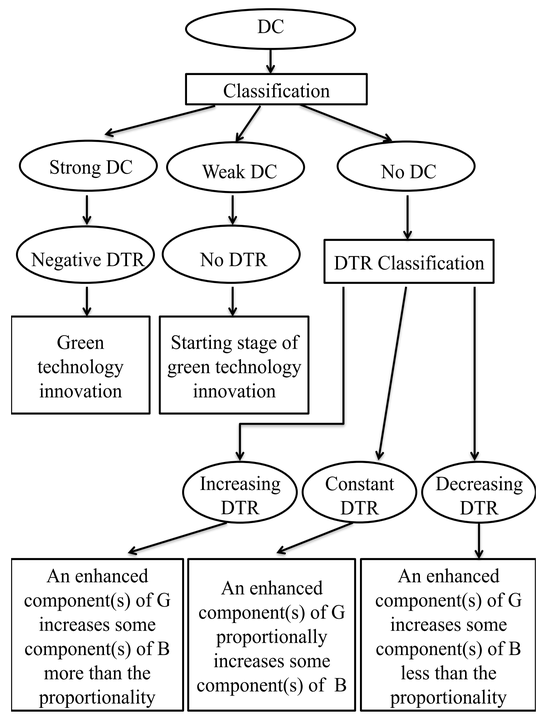

Figure 2 DTR under DC.

Results

- Most provinces in east coast China and four municipals belonged to no or weak in UC and decreasing or no in RTD and even though Hainan had weak or no UC, but increasing RTD in year 2006, 2010 and 2012. Therefore, the Chinese government should invest and develop Hainan in terms of economy.
- Most of the central provinces had weak or no UC with no or decreasing RTD except Hubei.
- Even though some of the northeast and north provinces had some no UC with increasing RTD before 2008, all of the provinces had weak or no UC with no or decreasing RTD.
- Even if the UC of all western provinces such as Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang is weak or no, all of them had no UC with increasing RTD. The Chinese government should reinforce the development of western China.
- Most provinces all over the China including east coast China, central China, northeast and north China have strong potential to reduce the pollutions with green technology innovation because they have strong DC with negative DTR The Chinese government should invest green technology to provinces in east coast, central China, northeast and north China, as well as Xinjiang in western China.
- There are two types of provinces having weak DC with no DTR, which indicates the low level of potential for pollution mitigation. One type is big municipals such as Beijing, Tianjin and Shanghai. The other type is western China.

Discussion

- The Chinese government has ignored environmental protect for a long time. As a result, the environment is not good to attain sustainability.
- The economic imbalance exists in China because the government always paid attention to big cities such as municipalities.
- The Chinese government tries to improve environment protection and economic growth at the same time. Previous studies talked about resource allocation from big cities to small cities, fuel mix shift from coal to renewable energies, this study focuses on energy planning and the role of government.

Conclusions

This study tries to find a way for China to deal with the environment pollutions. After analyzing the Chinese data in province level, this study finds out two facts. First, the Chinese government has been historically ignoring environment protection and paid attention to economic growth. Second, the Chinese government has focused on large cities such as municipalities so that the economic imbalance exists. China tries to improve both concerns. This study suggests privatization should be proceeded in China to reinforce the energy management and increase economic efficiency.

Contact

<Yan Yuan>
<New Mexico Tech>
Email:yan.yuan@nmt.edu
Phone: 575-835-5390

References

1. Cooper, W.W., Bisheng, G. & Shanlin L. (2001). Comparisons and evaluations of alternative approaches to the treatment of congestion in DEA. *European Journal of Operational Research, 132*, 62-74.
2. Sueyoshi, T. (1997). Measuring scale efficiencies and returns to scale of Nippon Telegraph & Telephone in production and cost analyses. *Management Science 43*, 779-796.
3. Sueyoshi, T. (1999). DEA duality on returns to scale (RTS) in production and cost analyses: An occurrence of multiple solutions and differences between production-based and cost-based RTS estimates. *Management Science 45*, 1593-1608.
4. Sueyoshi, T., & Yuan, Y. (2015). China's regional sustainability and diversity: DEA environmental assessment on economic development and air pollution. *Energy Economics 49*, 239-256.
5. Sueyoshi, T. & Yuan, Y. (2016). Returns to damage under undesirable congestion and damages to return under desirable congestion measured by DEA environmental assessment with multiplier restriction: Economic and energy planning for social sustainability in China. *Energy Economics 56*, 288-309