Environmental Efficiency Analysis of Biodiesel from Waste Cooking Oil

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Abstract
This study presents an assessment of the productive and environmental efficiency of an advanced biodiesel plant in Japan using Slack-adjusted Data Envelopment Analysis (S-DEA). The empirical analysis uses monthly input data (waste cooking oil, methanol, potassium hydroxide, power consumption, and the truck diesel fuel used for the procurement of waste cooking oil) and output data (biodiesel, glycerin, and life-cycle CO2 emissions derived from producing biodiesel) of the biodiesel plant for August 2010-March 2013. Based on the environmental input-output database, we estimated life-cycle CO2 emissions associated with the biodiesel productions with and without the life-cycle emissions as an environmental externality in the S-DEA framework. The results show that of the 32 months, there are 12 whose productive efficiency scores as estimated by the S-DEA without environmental externalities are unity (maximum) and the lowest score is 0.83 (February 2011). In addition, the environmental efficiency scores were estimated by the S-DEA including environmental externalities and it was found that the productively efficient 12 months are also environmentally efficient. The unit production cost in the month with the lowest productive efficiency was \13 yen/L. As a result, the highest unit production cost was \19 yen/L in December 2012, while the lowest unit production cost was \10 yen/L in March 2011. Comparing the efficient production cost to the mean unit production cost on the production possibility frontier at \4 yen/L revealed that the cost of producing the average amount of biodiesel during the study period could be reduced by as much as \120,000 yen. This study goes on to discuss how the biodiesel plant could improve its production activities, regarding the enterprise input-output structure.