Carbon Policy Implication for the Greenhouse Industry

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Introduction

CO_2 emission has been a major concern in the greenhouse industry which heavily relies on energy use, particularly fossil fuels in production, to heat up greenhouses. Greenhouse growers are faced with volatile energy market and environmental concerns associated with greenhouse gas emissions. Growers are feeling a great need to reduce energy use and greenhouse gas emissions.

The objective of this research:

- Measure energy and CO_2 emission efficiency in the greenhouse industry
- Investigate the impact of potential carbon emission regulation on the industry.

Methodology

The directional distance functions (DDF) approach is used to measure greenhouse firms' economic and environmental efficiency. DDF provides a complete representation of the production technology and is particularly useful in modeling production process that involves joint production of "goods" and "bads", in this case the greenhouse products and CO_2 emissions. The method is illustrated in the following figure:

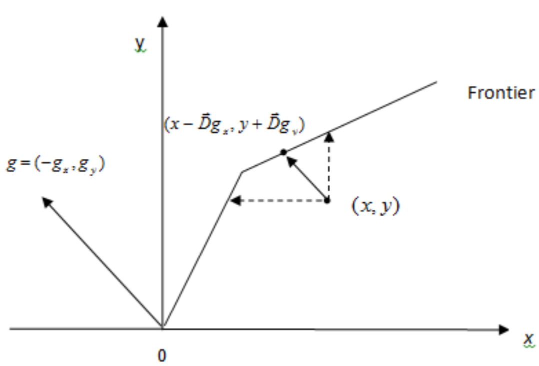

Figure 1. Illustration of Directional Distance Function

In Figure 1, moving in the direction of $g = (-g_x, g_y)$, firm at (x, y) expands its production of y while simultaneously decreases the use of input x.

In the special case where $g_y = 0$, the firm contracts in the input direction and the resulting measure is a form of input distance function.

When $g_x = 0$, the firm expands upward to the frontier in the output direction; the resulting measure is a form of output distance function.

This makes it possible to measure firm production efficiency in any input (e.g. energy) or output (e.g. CO_2 emission) direction.

In the output space in figure 2, the firm's CO_2 emission performance can be measured with its distance from A to A'' and the business performance can be measured in the direction of "goods" by its distance to A', assuming CO_2 is not freely disposable under a policy that restricts free emission.

However, when there is no emission restriction and CO_2 is freely disposable, the business performance of firm A is measured by its distance to A''', and distance from A' to A''' is lost revenue due to emission restriction.

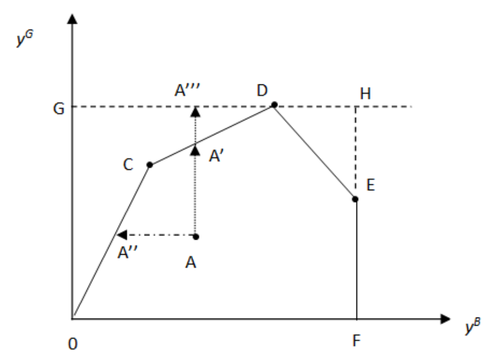

Figure 2: Output Frontier under Different Assumptions

Data

The empirical application uses data from the greenhouse industry of Michigan, an important state in greenhouse production in the United States where production is predominantly floriculture. The industry ranks third nationally in revenue, behind California and Florida. As a northern state, however, Michigan's cold weather in production season requires much more intensive energy use compared to the other two states, which makes it an ideal empirical application for the purpose of this study.

Greenhouse firms' sales, CO_2 emission, energy use, land, capital, and (non-energy) variable inputs are used in the study.

Results

- The greenhouse firms' average energy efficiency is 79%;
- Average CO_2 emission efficiency is 53%;
- If an emission restriction policy is imposed, the industry would lose approximately 9% of revenue.

Conclusions

- Emission can be nearly halved if efficient technology were used.
- Growers are more efficient in managing energy cost than in emission control.
- Restricting CO_2 emission can significantly reduce the profitability of the industry.

Note: References not provided due to space considerations but available upon request.

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