Carbon Abatement as a Strategic Variable: Implication for Energy Suppliers in a Carbon Constrained Environment

Professor Harry Bloch, Curtin University, Australia, (61) 0406793 996, Harry.Bloch@cbs.curtin.edu.au
Dr Jo Rao Voola, (61) 0400176527, jvoola@gmail.com

Overview

International agreements, such as the 2015 Paris Agreement, are in place to gain commitment from the global community for the purpose of redressing environmental concerns. Individual countries use various policies to achieve their commitments under these agreements, including a Pigouvian tax (carbon tax) or the Coase's cap and trade mechanism. Both these regulatory instruments can be used to provide economic incentives for the use of environmentally friendly technologies. However, the responses of firms to these incentives can differ depending on the market structure in which they operate to sell their outputs. We investigate the responses of firms to incentives for carbon abatement under the oligopoly market structure common to energy production industries. The premise of our arguments are supported by a corresponding study of agriculture sector with oligopoly market structures (Lee and Thornsbury, 2010) and as well explain why "command and control" systems do not work effectively in the uptake of abatement technologies (Tirole, 2012, Belas et al., 2013).

Methods

We outline a generalised Cournot model and examine the conditions under which firms use abatement technologies as a strategic variable to gain competitive advantage in terms of market share. The cost of technology is an exogenous factor, to the model, but the decision to deploy or not to deploy is determined within the model (endogenous decision) as well as the "tightness" or "looseness" of government policy. The payoffs are written as a profit function, the magnitude of which are determined endogenously by the demand and cost parameters. Using game theory equilibrium solution for varying magnitdues of abatement costs, we derive optimal strategies in the use of abatement technology.

The possibility of achieving market power through cost differentials between firms makes the decision to deploy abatement technology a potent strategic variable. Each firm faces uncertainty (and thereby risk) when confronted with the possibility that its competitor may use the technology ahead of itself, gaining market power. In these cases, deployment of abatement technology may exceed what is considered optimal according to competitive analysis. Firms may invest with the intention of creating barriers to entry, or to force firms with higher cost functions to exit. In a dynamic setting, first mover advantages may arise for firms who invest ahead of their competitor.

Results

The case when deployment of abatement technologies forms the dominant strategy with Nash equilibrium is of particular interest. Each firm in the industry "overinvests", in the use of abatement technology and is worse off in terms of payoffs. What is of great significance is that in the long run such dynamics such may result in industries which produce their output with minimum externalities. From a macroeconomics perspective, in aggregation, simultaneous economic growth without sacrificing environmental health can be achieved through technological investment. This paper provides in a limited and simplified manner provides insight into the various factors, both exogenous (policy measures) and endogenous (those determined within the industry) which could bring about desirable outcomes of economic growth without the corresponding environmental destruction.

Conclusions

Our analysis allows the following conclusions. Firstly, environment policies provide economic incentives for the use of abatement technologies. The deployment of these is not costless, and tightness or looseness of environmental policies influences the relative costs of the decision to deploy at the margins. Secondly, market structures of energy suppliers, effect decisions to deploy or otherwise. The possibility of gaining market power in oligopolies in particular, provides the impetus to use abatement technologies. Deploying abatement technologies can bring about changes in industry structure. Our framework lends itself to empirical application for determining optimal market structure of fossil fuel industries (size and numbers), so that abatement technologies are used optimally allowing for socially optimal levels of output with minimum environmental damage.

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Key Words

Energy Suppliers, Market structure, Oligopoly, Game Theory, Prisoner’s Dilemma, Abatement Technology, Strategic Variable