TECHNOLOGY DIFFUSION AND ENVIRONMENTAL REGULATION: THE CASE OF COAL-FIRED SCRUBBERS

Elaine Frey, George Washington University, Phone: (202)566-2359, E-mail: effrey@gwu.edu

Overview

Title IV of the 1990 Clean Air Act Amendments established a national pollution permit system to mitigate the negative effects of sulfur dioxide (SO_2) emissions and was enacted in two phases. Phase I began in 1995 and required the largest and dirtiest generating units to reduce emissions. Each year, units are allocated permits sufficient to achieve a target emission rate, where one permit allows the unit to emit one ton of SO_2. Allocated permits can then be used, banked, or traded. Phase II began in 2000 and includes most significant steam electric generating units in the country. Under Phase II, permits are allocated as in Phase I, but the target emission rate is more stringent. Prior to Title IV, newly constructed generating units had to follow the New Source Performance Standards (NSPS), which established rigid technology and emission restrictions. In addition, existing sources were subject to state level emission rate standards (or command-and-control regulations) as part of the National Ambient Air Quality Standards (NAAQS). These restrictions were essentially overridden under Title IV, although existing sources still have to comply with state regulations.

The purpose of this research is to determine how regulatory structure and stringency affects technology diffusion in the electric generating industry. Specifically, I examine the impact of Title IV on the diffusion of scrubbers by coal-fired generating units. A scrubber is an abatement technology designed to remove SO_2 from gases emitted by generating units. Within Title IV's unique regulatory environment, I test how technology diffusion responds to changes in regulatory structure and changes in regulatory stringency, controlling for the expected cost of installing a scrubber. Theory suggests that market-based policies, such as a permit system, give firms more incentives to adopt new technologies, relative to command-and-control regulations. But because there have been so few market-based regulations in place in the U.S., there is little empirical evidence to support this claim.

Methods

Several specifications of the Cox proportional hazards model are estimated, including a model which controls for unobserved heterogeneity among generating units owned by the same firm. This research utilizes the Energy Information Administration's publicly available survey: Steam Electric Plant Operation and Design Report (Form EIA-767) from 1985 to 2002. The covariates used to estimate the semi-parametric model include individual generating unit characteristics and regulatory variables. Unit characteristics include nameplate capacity, age of the unit, the distance from the plant to the Powder River Basin and expected scrubber installation costs. Regulatory variables include an indicator variable for those units that are regulated under Phase I and an indicator for those units that have very strict state regulations.

Results

Empirical results show that age, phase, state regulations and low expected installation costs are statistically significant and are the major factors that drive scrubber adoption. The effect of age and expected installation costs on the likelihood of scrubbing is negative, which are both expected results. The size of the unit does not have a statistically significant effect on the hazard but carries a positive coefficient. The distance to the Powder River Basin has a near zero effect on the hazard rate and is not statistically significant. Finally, units that are regulated under Phase I and those units with very strict state regulations are more likely to install scrubbers. Several diagnostic tests were performed to assess the model specifications and assumptions. Overall, I conclude that the Cox proportional hazards model is a reasonable specification for the data and parameter estimates are robust to changes in the model.

Conclusions

Regulations imposed on electric generating units are the most important determinants for installing scrubbers. Units in Phase I were more likely to install scrubbers than units regulated under Phase II. Also, units that faced strict state regulations were much more likely to install scrubbers than those that had less stringent regulations. Two unit characteristics were also important factors in the decision to install scrubbers. First, those units that faced relatively low expected installation costs were more likely to install scrubbers. Secondly, units in the sample that were relatively older were less likely to install a scrubber. Although the importance of other unit characteristics was tested, none had a statistically significant effect on the decision to install a scrubber.

Policies are often evaluated by the incentives they provide for the adoption of new technologies. In the case of scrubbers, although Title IV required units to reduce SO_2 emissions, having very strict state regulations is a strong determinant of whether or not a scrubber was actually installed. Evaluating programs such as Title IV, which implement flexible market-based policies, and understanding the resulting diffusion patterns will be particularly useful to policy makers when considering future climate change policy.