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Non-separable pollution control: Implications for a CO_2 emissions cap and trade system

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ABSTRACT

The federal government now confronts considerable political pressure to add CO_2 to the existing set of criteria air pollutants. As with current criteria pollutants, proposals call for control of CO_2, assuming that the control of each of the three criteria pollutants is separable from the others. However, control of CO_2, SO_2, and NO_X emissions is most appropriately viewed as joint rather than separable based on engineering relationships. Empirically, we also find considerable jointness. Using a 10-year panel for 77 U.S. electric utilities, which comprise the largest sector in terms of energy-related CO_2 emissions, we estimate a multiple-input, multiple-output directional distance function combining good inputs (production capital, pollution control capital, labor, and energy) and a bad input (sulfur burned) to produce good outputs (residential and industrial/commercial electricity production) and bad outputs (SO_2, NO_X, and CO_2). We find that while utilities do not directly control CO_2 emissions, considerable jointness exists across SO_2, NO_X, and CO_2 emissions. Failure to account for this jointness increases the cost of pollution control, making it less acceptable to the public and policymakers. We also compute the technical efficiency of our set of utilities and find that considerable cost savings can be achieved by adopting the best technology for production of electricity and reduction of pollutants.

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1. Introduction

Since the late 1960s, the U.S. federal government has regulated nationwide an ever-expanding set of air pollutant emissions from fossil-fueled electricity generating facilities. It has proceeded piecemeal, pollutant by pollutant, to control selected particulate and acidic (SO_2 and NO_X) atmospheric emissions. Designated as “criteria” pollutants, separate regulations for each have drastically ratcheted down their emission rates over time. Source-specific, technology-based emission standards initially dominated the regulatory tools employed. In the last two decades, emphasis has shifted to market approaches, mainly tradable emission permits, using “cap-and-trade” systems. However, the piecemeal approach endures. The assumption is maintained that controlling one pollutant will have no impact on the other two criteria pollutants. This assumption has been applied to existing emissions permit systems, where for example, a SO_2 permit provides no credit for NO_X removal, even if pollution removal is joint.

The federal government now confronts considerable political pressure to add CO_2 to the existing set of criteria air pollutants. In Massachusetts v. EPA, 127 Sp. Ct. 1438, 1460–1462, the U.S. Supreme Court ruled that the USEPA has the authority to add CO_2. Since 2000, Congress has considered, but not enacted, any one of numerous bills calling for the regulation of CO_2 (e.g., Waxman-Markey H.R. 2454, which calls for a tradable permit system with a cap of a 17% reduction by 2020 nationwide from 2005 CO_2 emissions). Several states or state coalitions have independently proposed or actually implemented one or another version of tradable permit programs to limit CO_2 emissions from fossil-fueled power plants within their jurisdictions. One example is California which implemented on January 1, 2013 the Global Warming Solutions Act, which will reduce CO_2 emissions from all sources to 1990 levels by 2020 using a cap-and-trade system. In all these settings, as with controlling current criteria pollutants, CO_2 control is treated as separable. However, this is unwarranted if the control of CO_2, SO_2, and NO_X emissions is joint rather than separable.

Most emission control measures employed by power plants affect more than one pollutant (National Research Council, 2004). Four major engineering relationships produce interactions among control measures.[1] The first results from switching to lower-sulfur, lower-Btu Western coal, which increases particulate, NO_X, and CO_2 emissions per kWh of electricity generated. Low-sulfur coal produces less heat per unit of coal, which implies more coal burned to produce a given kWh. A second type of interaction stems from inefficiently operated flue gas desulfurization (FGD) systems that may generate added CO_2 emissions via the chemical reactions that capture the SO_2.[2]

A third source of interaction would occur if CO_2 emissions are reduced using an amine-based technology, which is the currently favored technology to capture CO_2 at coal-fired power plants. Because these sorbents bind with all acid gases, not just CO_2, SO_2 will also be removed from the stack gas with the possible result that SO_2 emissions will be below their required level. This will cause CO_2 marginal control costs to be unnecessarily high.

The fourth source of pollutant control interaction stems from shutting down old, dirty plants to meet the SO_2 or NO_X standards. If the shift in generation is to new coal-fired plants, NO_X and SO_2 will be reduced per Btu. If the shift is to new gas-fired plants, CO_2 will be reduced in addition to NO_X and SO_2 per Btu.

A number of authors have examined the control of multiple pollutants when pollutant control is non-separable. Moslener and Requate (2007) consider optimal abatement strategies in a dynamic multi-pollutant framework when social damage is caused by multiple stocks of accumulating pollutants and pollutant emissions are either substitutes or complements. For the case of two pollutants with identical decay rates, they show that the optimal steady-state emission of the less harmful pollutant rises with the degree of emission substitutability. However, the effect of substitutability on emission of the more harmful pollutant is ambiguous. Burtraw et al. (2003) use the Haiku model to simulate

[1] Another interesting interaction not considered in this paper is that the performance of electrostatic precipitators used to capture particulates is enhanced by greater flue gas sulfur content.

[2] Additional inefficiencies may result from the use of CO_2 scrubbers. About 50% of states apply rate-of-return (ROR) regulation to electricity production and distribution. Fowlie (2009) finds that utilities in states with ROR regulation over-capitalize in NO_X pollution control equipment rather than fuel-switch. These concerns for CO_2 scrubbers are increased by an order of magnitude, since their costs are 10-fold or more than the costs of existing scrubbers.