Resource and Energy Economics 53 (2018) 79–100

Contents lists available at ScienceDirect

Resource and Energy Economics

journal homepage: www.elsevier.com/locate/ree

Do differentiated performance standards help coal? CO_2 policy in the U.S. electricity sector

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ARTICLE INFO

Article history:
Received 28 November 2016
Received in revised form 2 February 2018
Accepted 12 February 2018
Available online 21 February 2018

JEL classification:
H23
Q48
Q54
Q58

Keywords:
Carbon regulation
Performance standards
Electricity markets
Distributional impacts

ABSTRACT

A salient feature of the Clean Power Plan is that it imposes higher emission rate standards on coal power plants than it does on their natural gas counterparts. In this paper, I examine the consequences of this design feature by modeling a series of tradable performance standard policies. I analyze how fuel-based standard differentiation affects compliance incentives and the regulatory burden on coal stakeholders through three key outcomes: coal usage, coal plant profits, and electricity prices. Analysis of a simple analytic model shows that differentiation, compared to a policy with a uniform standard for all fuel types, always increases coal usage, but price and profit impacts are ambiguous. To quantify these outcomes, I construct and implement a detailed simulation model of the U.S. wholesale electricity market. Simulation results suggest that differentiation increases coal usage modestly, increases coal plant profits well beyond the no-regulation level, and increases electricity prices in almost every region of the country.

1. Introduction

While academic economists have traditionally focused on the cost-effectiveness properties of environmental policy instruments, their distributional consequences are receiving increasing attention.[1] This research acknowledges the central role that equity concerns play in the policy debate, and their influence on political feasibility. In a recent example, the Clean Power Plan (CPP), promulgated by the United States Environmental Protection Agency (EPA) to regulate carbon dioxide (CO_2) emissions from existing power plants, has been heavily scrutinized for its potential impacts on key stakeholders, particularly the coal industry, owners of coal-fired generation assets, and downstream electricity consumers. Ultimately, these distributional impacts will depend on choices made by EPA in crafting the CPP and states in implementing it, which in turn will influence views of the CPP as well as other future policies to address climate change.

The options available for influencing distributional impacts depend on the type of policy under consideration. Under a cap-and-trade system, the allocation of permits can be manipulated to address equity concerns. However, while the CPP allows states to implement a cap-and-trade program to comply with the regulation, it also allows for rate-based compliance

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[1] For example, see Bovenberg et al. (2005), Bushnell and Chen (2012), and Rausch and Mowers (2014).

https://doi.org/10.1016/j.reseneeco.2018.02.002
0928-7655/

that caps emissions per unit of electricity generated (EPA, 2015).[2] Rate-based compliance can be operationalized through a tradable performance standard (TPS) policy, which allows low mitigation cost facilities that overcomply with the emissions rate standard to earn and sell credits to high mitigation cost facilities that undercomply. Under a TPS policy, the analogy to using permit allocation for redistribution is to manipulate the standard across facilities, yet the efficacy of this approach is not well understood. In the CPP context, the question is whether "differentiation" helps coal and its constituents when the standard for coal-fired generation is relaxed while the standard for natural gas generation is tightened.[3] Answering this question and quantifying the associated impacts is the central focus of this paper.

Does differentiation improve outcomes for various coal-oriented stakeholders under a tradable performance standard policy in the U.S. electricity sector? To answer this question, I assume that changes in aggregate coal usage, coal plant profits, and wholesale electricity prices represent the economic impacts on coal producers and laborers, coal-fired power plants, and electricity retailers and consumers, respectively. First, I develop and analyze a simple analytic model to understand how differentiation impacts compliance incentives, and in turn the outcomes for key stakeholders. Where the theory is ambiguous, I turn to a state-of-the-art simulation model of the U.S. wholesale electricity market, which also allows for detailed quantitative estimates of all outcomes.

Using the analytic model, I demonstrate how, compared to a uniform standard policy, differentiation is expected to increase coal usage, but that the directions of price and profit changes depend on two competing effects. The coal usage result is driven by changes in emission reduction incentives: I show that differentiation provides stronger incentives for emission reductions through efficiency improvements at coal plants and generation shifts from coal plants with high emissions rates to those with low emissions rates, as opposed to fuel switching from coal to natural gas plants. The ambiguous impact of differentiation on prices and profits results from counteracting impacts on compliance credit prices and the amount of required credit purchases. Because differentiation causes credit prices to increase, relaxing the standard for coal-fired plants has the counteracting effects of requiring fewer credit purchases but raising the credit prices.[4] I explain how these competing cost effects are related to electricity price and plant profit outcomes, and how the net effects depend on the entire system of generating facilities and opportunities for various types of mitigation.

Using the simulation model, I calculate plausible quantitative short-run impacts of differentiation under a national tradable performance standard policy. Consistent with the analytic results, I find that differentiation increases coal usage through an increase in investments in coal plant efficiency and within-fuel switching; however, the extent is modest ($\approx$2% for the most extreme level of differentiation). I also find that, on average, differentiation increases electricity prices in almost every region in the country, including regions that rely heavily on coal-fired generation. Increasing electricity prices help to bolster coal plant profits. Additionally, more than half of the utilized coal plant capacity in the model observes decreasing per-unit costs under differentiation. In the extreme, the combination of these two effects results in aggregate coal-fired plant profits that actually exceed aggregate profits in the absence of regulation by almost 40%.

Taken together, the results imply that differentiation of a tradable performance standard on the basis of fuel-type does little to aid coal producers and laborers, and hurts electricity consumers in coal-heavy regions even more. Unless the goal is to assuage owners of coal-fired power plants, this type of policy design lever is an ineffective one, at least in a short-run analysis. However, the analytic results suggest that differentiation could be more effective in situations where switching between differentiated facilities (e.g., from coal to gas in this case) is not the overwhelming source of mitigation. For example, this might be the case for programs with differentiation based on geography rather than fuel or technology.

This paper contributes to two emerging literatures within environmental and resource economics. One literature pertains to second-best policy for CO_2 emissions mitigation, including tradable performance standards and cap-and-trade policies with output-based permit allocation. This literature includes theoretical studies of the efficiency properties of tradable performance standards, modeling both uniform (Helfand, 1991; Fischer, 2001; Holland et al., 2009) and, more recently, differentiated or attribute-based standards (Lemoine, 2014; Ito and Sallee, 2014), as well as simulation studies (Rubin et al., 2008; Burtraw et al., 2012b, 2016; Bushnell and Chen, 2012).[5] This paper also contributes to the literature on distributional effects of environmental policy, with particular focus on the profits of the industry being regulated (Bovenberg et al., 2005; Burtraw et al., 2013; Mignone et al., 2012).

My study differs on the previous literature by examining distributional impacts of differentiated performance standards. The most closely related paper is Bushnell and Chen (2012), which simulates a variety of alternative cap-and-trade program designs in the western United States. The study compares a few different permit allocation rules, including one that is a "fuel-based" such that the number of permits allocated per megawatt hour is higher for coal-fired plants than for natural

[2] For a brief discussion of the history of CO_2 policy in the United States, including an explanation as to why the CPP includes rate-based compliance options, see Appendix A.

[3] In fact, this is exactly the style of policy suggested by the CPP's technology-based rate standards compliance pathway, which provides coal and natural gas plants with different standards (EPA, 2015).

[4] The impacts of differentiated standards on credit prices is a variant of a result from Bohringer and Lange (2005), which studies bench-marking schemes for permit allocation in a cap-and-trade program. The authors show that if emission rates are identical within fuel categories, then allocating permits proportionally to emissions in a closed system will result in a proportionate rise in the credit price relative to a pure output-based allocation scheme.

[5] Other related theoretical contributions include Fischer (2003), which examines the environmental consequences of allowing permit trade across sectors subject to cap-and-trade and tradable performance policies; Fischer (2011), which examines the theoretical analysis of tradable performance standards to imperfectly competitive markets, and Fischer and Fox (2007), which considers the tax interaction effects of tradable performance standards.