Journal of Environmental Economics and Management 67 (2014) 20–38

Contents lists available at ScienceDirect

Journal of Environmental Economics and Management

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

Enforcement and price controls in emissions trading ☆

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ARTICLE INFO

Article history:
Received 4 July 2011
Available online 29 October 2013

Keywords:
Emissions trading
Emissions taxes
Cap-and-trade
Uncertainty
Price controls
Hybrid policies
Enforcement
Monitoring
Penalties
Prices vs. quantities

ABSTRACT

This paper examines how enforcement affects the structure and performance of emissions trading programs with price controls under uncertainty about firms' abatement costs. The analysis highlights how an enforcement strategy can cause abatement-cost risk to be transmitted to enforcement costs via the price of permits. When this occurs, accommodating the effect of abatement-cost risk with an optimal policy results in higher expected emissions and lower expected permit price than their second-best optimal values. However, it is possible to design an enforcement strategy that shields enforcement costs from abatement-cost risk by tying sanctions directly to permit prices. This enforcement strategy stabilizes enforcement effort, the optimal permit supply and price controls are independent of enforcement costs, and the policy produces the second-best optimal outcome.

1. Introduction

Much attention has been devoted recently to adding price controls (i.e., permit price ceilings and floors) to cap-and-trade policies to control uncertainty in aggregate abatement costs. The theoretical motivation for placing price controls on emissions markets originated with Roberts and Spence (1976). Following Weitzman's (1974) seminal analysis of the comparative optimality of price-based and quantity-based regulations, Roberts and Spence showed that policies that combine price and quantity controls, so-called hybrid policies, cannot be less efficient than either a pure price or a pure trading scheme. The reason is that pure tax and trading policies are special cases of hybrid programs. Price controls for emissions trading policies limit the risk associated with uncertain abatement costs in exchange for additional variation in aggregate emissions.

The current debate about hybrid emissions control policies has been driven by their proposed use in cap-and-trade policies to contain the highly uncertain costs of controlling greenhouse gases. Some analyses of price controls only involve price ceilings, so-called safety valves (Pizer, 2002; Jacoby and Ellerman, 2004), but several simulation studies have

☆ This research has been supported by a Grant from the U.S. Environmental Protection Agency's National Center for Environmental Research (NCER) Science to Achieve Results (STAR) program. Although the research described in the article has been funded wholly or in part by the U.S. EPA through Grant number RD-83367201-0, it has not been subjected to the EPA's peer and policy review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred. Additional funding for this research was provided by the Cooperative State Research Extension, Education Service, U.S. Department of Agriculture, Massachusetts Agricultural Experiment Station under Project no. MAS00964. We are grateful to Nikolaos Zirogiannis for his valuable research assistance. We are also grateful to Andrew Yates and two anonymous referees for their constructive guidance.

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0095-0696/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jeem.2013.10.001

demonstrated the cost-effectiveness of combining price ceilings and price floors (Burtraw et al., 2010; Fell and Morgenstern, 2010; Philibert, 2008). In addition, a very recent theoretical literature has emerged that examines cap-and-trade policies with price controls and other cost-containment measures (Weber and Neuhoff, 2010; Webster et al., 2010; Grull and Taschini, 2011).[1] At the same time, several emissions trading programs with various forms of price control have been proposed, and some implemented, to control greenhouse gas emissions (Hood, 2010; U.S. Congressional Budget Office, 2010).

We contribute to the theoretical literature on price controls for emissions trading by adding the enforcement component to the determination of optimal hybrid policies.[2] All regulations have to be enforced and it is well-known that enforcement costs can have important impacts on the design of environmental policies. This is demonstrated in the design of emissions markets by Malik (1992), Stranlund (2007), and Caffera and Chávez (2011). Understanding the joint determination of the supply of emissions permits, permit price controls, and enforcement is a new contribution to the theoretical literature on designing market-based policies. The problem is particularly intriguing because the permit price in a competitive permit market is the marginal benefit of failing to hold enough permits to cover emissions. Higher permit prices produce a higher incentive toward noncompliance, causing regulators to respond with more vigorous monitoring or higher sanctions to maintain compliance. Thus, abatement-cost risk can be transmitted to enforcement costs via the permit price, and the optimal hybrid policy must account for this.[3]

Economic analyses of enforcement of emissions markets and price controls have been limited to suggestions that imperfect enforcement can be used to provide a price ceiling in emission markets to limit high-side abatement-cost risk. Imperfect enforcement in this context means that the expected marginal penalty for permit violations is set below the level that would guarantee full compliance under all circumstances. (We use perfect enforcement to refer to cases in which the enforcement strategy guarantees full compliance.) If marginal abatement costs turn out to be high enough, the permit price rises to the expected marginal penalty and firms escape a fixed permit supply by violating their permits. Some view the relatively high penalties in the U.S. SO_2 Allowance Trading and the E.U. Emissions Trading Scheme as safety valves because they place a ceiling on the price of permits (Jacoby and Ellerman, 2004; Stavins, 2008). More rigorously, Montero (2002) reexamined the prices vs. quantities debate to analyze the effect of imperfect enforcement on the choice between an emissions tax and emissions trading. He found that imperfect enforcement tends to favor emissions trading over emissions taxes precisely because the expected marginal penalty can provide the price ceiling that improves the efficiency of emissions trading. While the link between enforcement and price controls in emissions trading has been recognized, we believe that the discussion thus far is incomplete.

In fact, using the expected marginal penalty to provide a price ceiling is inefficient if explicit price controls are available. Relative to a trading program with imperfect enforcement (i.e., Montero's model and the suggestion of others), adopting a perfectly enforced tax that sources can pay to emit beyond their permit holdings can eliminate the expected costs of sanctioning noncompliant firms without changing the expected emissions and price of the policy. An additional efficiency gain can be obtained if a perfectly enforced subsidy for unused permits is available to provide a price floor that motivates additional emissions control when abatement costs turn out to be significantly lower than expected. Using imperfect enforcement to provide a price ceiling cannot address the possibility that abatement costs may be lower than expected. In this paper we examine the optimal trading policy with explicit price controls that is enforced so that firms are always compliant, because this policy will always be more efficient than one that uses imperfect compliance to provide a price ceiling.[4]

Given the goal of achieving full compliance, we determine optimal hybrid policies under two enforcement strategies that vary according to how penalties are set. Under one strategy the unit penalty is a fixed value that is high enough to allow the achievement of full compliance with imperfect monitoring. To achieve full compliance and conserve monitoring effort, monitoring is chosen so that the resulting expected marginal penalty is slightly above the going permit price. A problematic feature of this strategy is that abatement-cost risk can be transmitted to enforcement costs, because it makes monitoring effort an increasing function of the permit price. An alternative enforcement strategy is to make the penalty a constant multiple of the going permit price. This makes the required monitoring effort independent of price variation, which is absorbed by the penalty. There are examples of both kinds of penalties in actual and proposed emissions trading schemes.[5] In the U.S. SO_2 Allowance Trading program the penalty for failing to hold enough permits is a fixed penalty that was set at $2,000 per ton of excess emissions in 1990, and is adjusted for inflation every year (U.S. EPA 2010). Similarly, the E.U. Emissions Trading Scheme

[1] See Fell et al. (2011) for a review of the literature on alternative cost-containment approaches.

[2] We use standard terminology for enforcement efforts. Enforcement consists of two activities, monitoring firms to check whether they are complying with a regulation and sanctioning (or penalizing) incidences of noncompliance. Enforcement costs generally refer to the sum of monitoring costs and sanctioning costs. In cases in which enforcement is strong enough to induce full compliance, which is important in real trading programs and our model, there are no variable costs of applying sanctions.

[3] The RECLAIM program of Los Angeles provides a particularly dramatic example of how price volatility can be transmitted to compliance behavior and enforcement efforts. The California energy crisis of 2000 and 2001 produced high demand for NO_X permits by electric power producers. This led to a spike in the price of NO_X permits from about $2000 per ton in 2000 to over $120,000 per ton in early 2001 (Fowlie et al., 2012; South Coast Air Quality Management District, 2002). Consequently, some sources willingly violated their permits. In 2000, aggregate NO_X emissions exceeded the permit supply by nearly 20%. Authorities responded with negotiated settlements of sanctions for some violators and a special penalty policy for others (South Coast Air Quality Management District, 2007). We do not know if this event resulted in a significant increase in enforcement costs, but it is a good example about how price volatility can be transmitted to compliance choices and enforcement effort.

[4] We should be clear that Montero does not propose that trading programs be designed with imperfect enforcement. His motivation was to reconsider prices vs. quantities given imperfect enforcement, not that environmental policies should be designed to allow some noncompliance.

[5] It is possible to make both monitoring and the penalty vary with the permit price. Given perfect enforcement, this would allow abatement-cost risk to be transmitted to monitoring costs, but the effect would be reduced by the variation in the penalty. We do not explore this possibility in this paper.