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Experimental tests of water quality trading markets

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ABSTRACT

Many watersheds in the U.S. have established water quality trading programs to help realize cost-effective reductions in water pollution; however, the success of these programs has been limited. This study highlights some of the unique features of water-based credit trading markets that may explain the lack of success, and uses laboratory experiments to isolate their effects. In particular, we compare two forms of a baseline-and-credit institution, a Pigouvian tax/subsidy regulation, and – characteristic of air quality programs – a textbook cap-and-trade regulation. Across these institutions we examine the effects of abatement technology adoption. We find that a baseline-and-credit program, when it requires firms to make upfront investments to generate tradable credits, is less efficient than cap-and-trade and tax/subsidy institutions. Furthermore, we find that when efficient trading requires costly technology adoption, institutions that involve inter-firm trading, including cap-and-trade, are less efficient than the tax/subsidy.

Introduction

Surface water pollution remains a prominent issue worldwide, including in many developed countries. Recent assessments indicate a substantial fraction of U.S. surface waters are still too impaired to support their designated uses (U.S. EPA, 2014). In order to meet water quality goals, policymakers have increasingly endorsed adoption, at the watershed level, of water quality trading (WQT) programs. This endorsement is no doubt related to the success of high-profile air quality trading programs such as the sulfur dioxide (SO_2) allowance trading component of the U.S. Acid Rain Program, and the EU Emissions Trading Scheme. As early as 2004, there were more than 70 WQT programs in some phase of development in the U.S., about twice as many as there were in 1999 (Breetz et al., 2004; Environomics, 1999).

Despite financial and political support, the numerous WQT initiatives established for U.S. watersheds have recognized little success. A recent report showed only 100 facilities had engaged in trade, with 80% coming from the Long Island Sound Trading Program (U.S. EPA, 2008).[1] In this study, we use laboratory experiments to investigate institutional and structural features of WQT markets that may help explain their lack of success. In particular, we look at the effects of using a "baseline-and-credit"

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[1] As we discuss below, the trading scheme associated with Long Island Sound differs substantially from the vast majority of credit trading markets in that "trades" are made with the regulator rather than through inter-firm trading.

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system of allocating permits, requiring firms to have already undertaken and verified abatement beyond their baseline to generate tradable credits, and the performance of institutions when costly abatement technology adoption is necessary to achieve efficiency.

The WQT institutions in practice differ markedly from the textbook cap-and-trade institution that typifies air quality markets. The majority of WQT programs involve baseline-and-credit trading institutions, wherein polluters have an emissions baseline and tradable credits are linked to emission reductions beyond this baseline (Breetz et al., 2004; Environomics, 1999).[2] That is to say, in contrast to cap-and-trade programs, there is no initial allocation of credits via free distribution, auction or otherwise. This approach is seemingly at odds with market fundamentals given inherent uncertainty over market prices and quantities, especially in the context of new markets. As highlighted by Cason and Plott (1996), the Clean Air Act Amendments governing the SO_2 market emphasize the importance of ensuring permit availability and providing clear price signals, and require the EPA to run annual auctions to help achieve this goal. This concern is exacerbated for WQT programs, which are often characterized by few (potential) buyers and sellers.

Regulators have discretion in defining how the generation of credits is determined. Some programs allow firms to receive credits based on proposed or estimated reductions. More common, however, are strict requirements that firms establish a reduction has occurred prior to receiving credits. Fundamental to this, firms face a risky financial decision as they must undertake costly activities (e.g. abatement, monitoring, and documentation) prior to the realization of credit demand. The theoretical analysis of Mailath et al. (2004) provides formal evidence that such investment activities are likely to be suboptimal whenever "people make current investment decisions whose returns depend upon future prices that are not currently contractible (p. 2)." Despite these potential concerns, the EPA guidelines (U.S. EPA, 2007) strongly endorse this approach:

> "A basic premise of water quality trading is that credits should not be used before the time frame in which they are generated. In general, a permitting authority should not allow for a pollutant reduction credit in a NPDES permit on the basis of the *proposed* treatment by another point source or an *unverified* commitment to install a BMP by a nonpoint source and their anticipated pollutant reduction (p. 34)."

In addition to baseline-and-credit institutional features, another potential impediment to the efficient operation of WQT markets are the upfront costs associated with abatement technology adoption. It is typical in WQT markets that in order to reduce emissions below baseline and realize abatement cost advantages, firms must make investments in abatement technology (e.g. install a filtration device). As discussed by a number of sources, these investments often involve large fixed costs and result in substantial increases in abatement capabilities (Sado et al., 2010; Caplan, 2008; Boisvert et al., 2007; EPA, 1996). Boisvert et al. (2007) and Sado et al. (2010) suggest that these fixed technology costs may lead to underinvestment in abatement technology and thus decrease WQT market performance.

Although baseline-and-credit WQT institutions are the most prevalent, some programs are fashioned instead after the Long Island Sound Trading Program – one of the few WQT success stories – which does not involve credit trading in a conventional sense.[3] In trading jargon, polluters that exceed their baseline "buy" credits and those with emissions below their baseline "sell" credits. However, the "trading" is with the regulator who automatically buys and sells credits at a pre-announced price at the end of a monitoring period. Further, there is no budget-balance condition: permits sold can exceed or fall short of permits purchased. Thus, this mechanism is more accurately described as a Pigouvian tax/subsidy than a market-trading institution.[4] As the tax/subsidy involves no financial risk due to market uncertainty, it provides an important yardstick from which to compare inter-firm trading mechanisms.

We use laboratory experiments to explore the effects of different institutional features and costly technology adoption in WQT markets, which have been a primary method of investigating the institutional features of cap-and-trade air pollution markets. Experiments are potentially informative for WQT program design, given (1) very few existing programs have recorded trades; and (2) identification issues arise from the many unobservable or difficult to measure factors in play (e.g. abatement costs; transaction costs; information; trading opportunities). In particular, our experiments allow us to compare tax/subsidy, baseline-and-credit (with and without binding abatement pre-commitment), and textbook cap-and-trade institutions, across treatments with and without fixed abatement technology costs.

It is worth noting that the primary inquiry in these experiments can be broadly characterized as an examination of how agents respond to risk that must be undertaken in order to trade efficiently in an emissions market, where the designed source of variation in this risk is the upfront investment required to generate (additional) credits. Upfront investment of this nature is introduced in our experiments when credit generation requires a binding, abatement pre-commitment and/or costly technology adoption, and is financially risky whenever uncertainty exists about credit demand. Hence, risky upfront costs for credit generation appear in the baseline-and-credit institution with abatement pre-commitment, and – when there are fixed abatement technology costs – in cap-and-trade and both baseline-and-credit

[2] A tradable right to emit an amount of a pollutant is typically referred to as a permit or allowance in the context of cap-and-trade, and is referred to as a credit when discussing baseline-and-credit institutions. For transparency, this paper uses the term "credit" regardless of the institution being discussed.

[3] As stated in U.S. EPA (2008), "[s]ome [WQT] program interviewees noted that their program lacks the defining features of trading (e.g., buyers and sellers, credits) and felt that EPA and others may apply the term too freely (p. 3-3)."

[4] Other examples of this include the Neuse River Basin Nutrient Sensitive Waters Management Strategy and Tar-Pamlico Nutrient Reduction Trading Program.