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Are clean technology and environmental quality conflicting policy goals?☆

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ABSTRACT

We analyze the effects of an environmental policy on the diffusion of a clean technology. Compared to previous articles we consider that the polluting firms are competitors on the output market and we analyze the effects of the policy on the share of adopting firms in the economy. We show that this share is not monotonic with the stringency of the environmental policy. We also compare the effects of an emission tax and tradable pollution permits and we show that, depending again on the stringency of the policy, either the tax or the permits yields a higher degree of technology adoption.

1. Introduction

What does a clean technology look like? One would undoubtedly define it as a technology that lowers the pollution level. On that ground, clean technology adoption would justifiably be considered

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as a desirable policy objective. A relevant policy issue would thus be to identify the best way to promote the adoption of such clean technologies. In this paper we question both issues by analyzing the theoretical and policy implications of clean technology adoption at the firm and market levels. We show that promoting green (clean) technologies may well result in a brown (dirty) outcome, and we analyze the effectiveness of policy instruments (emission fee and tradable emission permits) to implement the socially optimal level of technology adoption. Thus, this paper contributes to the literature from both a theoretical and a policy perspective.

We extend and unify two strands of the literature. The first one deals with the interplay between the type of regulatory instrument and the adoption of a new pollution abatement technology (*e.g.* Milliman and Prince, 1989; Jung et al., 1996; Requate and Unold, 2003). The second one is a group of four articles published in 2008 that analyze the influence of the adoption of a clean technology on the marginal cost of pollution abatement when pollution results from production (Amir et al., 2008; Bauman et al., 2008; Baker et al., 2008; Bréchet and Jouvet, 2008).

Our contribution is twofold. Firstly, we adopt a primal modeling approach to compare regulatory instruments when a clean technology can be adopted. This is a key methodological issue because, as shown in the four 2008 articles, the adoption of a clean technology has a non-trivial effect on the marginal abatement costs. The papers that take a dual approach (abatement cost function) are silent about this issue. By so doing we can derive the MAC of the industry level and the (endogenous) associated share of adopters.

Secondly, the output market is explicitly modeled and the output price is endogenous in our analysis. That means that we capture the interplay between the output market, firms' adoption technology decisions, and the influence of the regulatory instrument (emission tax or tradable permits).[1] This is also key because equilibrium will endogenously drive all our results. In particular, we will make a distinction between micro and macro marginal abatement cost (MAC) functions and will provide micro-foundations for macro functions. We will show that the shape of macro-MAC curves not only depends on the technological choice, but also on the output market outcome in which firms interact through equilibrium. This is important as MAC curves are widely used in the literature, in particular in environmental economics, as a tool for economic analysis. The fact that MAC curves are policy dependent has recently been illustrated by Morris et al. (2012) with a computable general equilibrium model (the MIT EPPA model).

Our main results can be summarized as follows. We first show that there exist situations where only a subset of firms adopts the clean technology. At the equilibrium firms end up heterogeneous even though they are identical ex-ante. Then, we show that the proportion of clean firms is not monotonic with respect to the tax level or the emission cap. This proportion first increases, and then decreases with the tax level. So, setting the tax too high can discourage innovation. Similarly, strengthening the emission cap can lead to less innovation because the output level becomes too small to push out the innovation. This property has impacts on the output market. It may be the case that the output price decreases with the tax, because of the endogenous adoption of the clean technology. When the tax increases, a larger number of firms adopt the clean technology, thus increase their output level, and the overall effect can be positive on the aggregate output level.

As far as pollution is concerned, we show that aggregate pollution level can be higher with clean firms in the economy than with dirty firms only. This comes from the fact that a clean firm has a higher activity level than a dirty one, and this may well offset the reduction in pollution intensity. The result is obtained under an emission tax, but a corresponding result holds under tradable permits: the equilibrium permit price can be higher with clean firms than without.

Then, we compare the properties of the policy instruments in terms of pollution and incentive for adoption, *i.e.* their influence on the proportion of adopting firms in equilibrium. We take the usual assumption of a myopic regulator that does not anticipate firms' reaction in terms of technology adoption. Concerning emissions, we show that two situations can arise. In one case, the tax is better than permits for the environment, more precisely, there are too few emissions with a tax and too

[1] In the case of a market for tradable permits, we thus analyze two related market equilibria: output market and tradable permits market.