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Technology choice and environmental regulation under asymmetric information

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ABSTRACT

We focus on the incentives of an industry with a continuum of small firms to invest in a cleaner technology under two environmental policy instruments: tradable emission permits and emission taxation. We assume asymmetric information, in that the firms' abatement costs with the new technology are either high or low. Environmental policy is set either before the firms invest (commitment) or after (time consistency). Under commitment, the welfare comparison follows a modified Weitzman rule, featuring reverse probability weighting for the slope of the marginal abatement cost curve. Both instruments can lead to under- or overinvestment ex post. Tradable permits lead to less than optimal expected new technology adoption. Under time consistency, the regulator infers the cost realization and implements the full-information social optimum.

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1. Introduction

Regulators often have to set environmental policy without being completely informed about the costs of new technology. The range of technologies that can be adopted in reaction to environmental

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(e.g. climate change) policy, might differ significantly, ranging from fuel substitution, to solar, wind or nuclear energy, up to carbon capture and storage (Krysiak, 2008). We can therefore expect that, at least for the less mature technologies, the regulator is able to only imperfectly observe their features and, therefore, to infer how good regulated firms are in using them. As Nentjes et al. (2007) point out, when environmental policy is made stricter (e.g. through stricter environmental standards) regulators might indeed face uncertainty concerning the capability of a regulated industry to develop and install the needed technology. Existing and past environmental policy choices have in several cases been based on imperfect anticipations of the related costs and impacts, most notably so when setting feed-in tariffs (FITs) for renewable energy generation.[1] On the basis of these considerations, we can expect the regulator's informational burden related to new technology deployment to be significant. We can also expect that the firms themselves know more about the cost of new technologies than the regulator.

We then focus on the incentives of an industry with a continuum of small firms to invest in a cleaner technology under two environmental policy instruments: tradable emission permits and emission taxation. We are thus comparing price and quantity instruments under uncertainty about abatement costs (that we model à la Weitzman, 1974) in a model of technology adoption and policy timing. Environmental policy is set either before the firms invest (commitment) or after (time consistency). We assume asymmetric information, in that the firms' abatement costs with the new technology are either high or low. In addition to this "aggregate" informational asymmetry, there is an idiosyncratic (i.e. firm-level) informational asymmetry about fixed adoption costs. This is close to several real-life policy problems where entire sectors are subject to regulation and are expected to implement the same clean technology (e.g. renewable energy).

The comparison of incentives towards cleaner technology adoption has been the subject of a substantial amount of literature, starting from the seminal papers by Downing and White (1986) and Milliman and Prince (1989).[2] This literature had the merit to bring to scholars' attention the need to explicitly include technological change in instruments comparisons. Requate and Unold (2001, 2003) build and comment upon earlier papers on the relative merits of different environmental policy instruments in terms of technology adoption. Through the lens of general models featuring heterogeneous (Requate and Unold, 2001) and homogeneous (Requate and Unold, 2003) firms, the authors compare emission taxes or abatement subsidies and tradable emission permits endogenizing the number of adopters of the new technology. They focus on two extreme cases: one in which the regulator sets the policy that was optimal without the new technology, and another, which is the most relevant for our purposes, where the regulator knows about the new technology. In the latter case, with commitment as well as with time consistency, the regulator can implement the social optimum.

Even with perfect information, commitment and time consistency do not usually implement the first best if there are additional market failures (other than pollution). If the number of firms is small, they can affect environmental policy under time consistency, which typically precludes attainment of the first best. However, this does not mean that commitment leads to higher welfare than time consistency. Amacher and Malik (2002) demonstrate these findings for emission taxation of a single firm choosing whether or not to adopt a new abatement technology, so that technology adoption is a discrete variable.

Our model is more specific than Requate and Unold's settings in order to keep it manageable with the added complexity of asymmetric information. In our setting, firms in the industry are symmetric in terms of abatement costs, as in Requate and Unold (2003), but asymmetric in terms of fixed adoption

[1] In the case of the UK FITs scheme to support photovoltaic (PV) electricity, due to complexities in the monitoring process and unexpected reduction in PV panels cost, installed plants overshot significantly with respect to forecasts, leading to the need for an early review of tariffs (UK National Audit Office, 2011). In other countries, such as Italy, the significant costs related to the FIT system have shown "...the inability of the regulator to directly control how much new capacity investors install in a given year, and the consequent inability to control costs." (OECD, 2013, p. 165). Similarly, in Germany, the costs related to FITs have increased far above government expectations (OECD, 2012). Finally, focusing on the diffusion impact of the first EU ETS phase in Italy, Borghesi et al. (2015) underline how specific sector-level features might lead to counterintuitive (and unexpected) outcomes.

[2] This literature has since been surveyed by Jaffe et al. (2003) and Requate (2005).

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