



ANALYSIS

A tale of two market failures: Technology and environmental policy

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Abstract

Market failures associated with environmental pollution interact with market failures associated with the innovation and diffusion of new technologies. These combined market failures provide a strong rationale for a portfolio of public policies that foster emissions reduction as well as the development and adoption of environmentally beneficial technology. Both theory and empirical evidence suggest that the rate and direction of technological advance is influenced by market and regulatory incentives, and can be cost-effectively harnessed through the use of economic-incentive based policy. In the presence of weak or nonexistent environmental policies, investments in the development and diffusion of new environmentally beneficial technologies are very likely to be less than would be socially desirable. Positive knowledge and adoption spillovers and information problems can further weaken innovation incentives. While environmental technology policy is fraught with difficulties, a long-term view suggests a strategy of experimenting with policy approaches and systematically evaluating their success.

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1. Introduction

The influence of technological development on energy and environmental systems permeates discussions of energy and environmental policy. New technology has been credited with solving environ-

mental problems by mitigating the effects of pollutants, and has been maligned as a source of increased pollution. For modeling long-term environmental problems such as global climate changes, the effects of technological change compounded over long time horizons will likely be large. Thus, the single largest source of difference among modelers' predictions of the cost of climate policy is often differences in assumptions about the future rate and

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direction of technological change (Clarke and Weyant, 2002; Carraro et al., 2003; *Energy Modeling Forum*, 1996).

But technological change does not exist in a vacuum. Environmental policy interventions, such as carbon cap and trade systems and carbon taxes, generate incentives that will affect which new technologies will be developed and how rapidly and deeply they will diffuse. The induced effects of environmental policy on technology can therefore have substantial implications for the normative analysis of policy. While researchers dispute the extent to which environmental policy-induced technological change reduces the social cost of environmental compliance, there is little dispute among economists that flexible, incentive-oriented policy approaches are more likely to foster low-cost compliance paths than prescriptive regulatory approaches.¹

The realization that the process of technological change is itself characterized by market failures complicates policy analysis, and increases the likelihood that a portfolio of policies, rather than policy directed at emissions reduction alone, will offer a more complete response to environmental problems. The seeming intractability of some energy and environmental problems, such as global climate change, combined with considerable uncertainties and the long time frame over which their ultimate consequences will play out, may make the development and deployment of new technologies attractive as a major policy response. That is, policies whose purpose is generating technological change are likely to be important parts of the policy portfolio for addressing certain environmental problems, in addition to the rules and regulations we normally think of as environmental policies. Technology policy can be a costly approach, however, if it is used as a substitute for, rather than complement, to environmental policy. Environmental policy targeted directly at emissions (for example through an emissions tax or cap-and-trade system) will still typically provide the most important single element of a cost-effective environmental policy strategy.

This paper provides background for consideration of these issues. We begin by discussing the key analytic issues that permeate policy discussions occurring at the nexus between technology and environmental policy. Section 3 discusses the possibilities for policies designed to operate directly on technology to improve our ability to cope with environmental problems. We offer concluding observations in Section 4.

2. Key analytical issues

2.1. *Fundamentals of environmental economics*

Economic analysis of environmental policy is based on the idea that the potentially harmful consequences of economic activities on the environment constitute an “externality,” an economically significant effect of an activity, the consequences of which are borne (at least in part) by a party or parties other than the party that controls the externality-producing activity. A factory that pollutes the air, water, or land imposes a cost on society. The firm that owns the factory has an economic incentive to use only as much labor or steel as it can productively employ, because those inputs are costly to the firm. The cost to society of having some of its labor and steel used up in a given factory is “internalized” by the firm, because it has to pay for those inputs. But the firm does not have an economic incentive to minimize the “external” costs of pollution.

Environmental policies attempt to equalize this imbalance by raising the incentive for a firm to minimize these externalities. Policy choices accomplish this in one of two general ways—either by internalizing the environmental costs so polluters make their own decisions regarding their consumption of environmental inputs, or by imposing a limit on the level of environmental pollution.

The cost of environmental policies could be in the form of decreased output of desired products (for example, a scrubber on an electric power plant reduces its electricity production from a given quantity of fuel), increased use of other variable inputs (for example, eliminating certain gases from the waste stream in a smokestack may require more fuel to be burned), purchase of specialized pollution

¹ For a detailed survey of the influence of environmental policies on innovation and diffusion see Jaffe et al. (2003).

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