Theory of Pollution Control
A short overview of C&C and MBI

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Views expressed are those of the authors alone.
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1. Introduction

At a much distilled level pollution control can be viewed as a choice between either a command-and-control or market-based approach. Economists are perhaps more likely to favour the ‘market-based’ approach, yet environmental regulators and policy makers have more often opted for traditional ‘command-and-control’ approaches such as the imposition of limits on permissible levels of emissions and the required use of specified abatement techniques. Arguably linked to this trend has been a greater reliance on technical measures (as part of the command-and-control approach) to achieve environmental goals.

However, with increasing pressure to curb emissions of greenhouse gases in a short time frame and constraints on the pace of development and deployment for technological solutions, the use of non-technical or behavioural measures is gaining increased recognition as part of the solution. These measures are more commonly associated with the market-based approach.

This brief aims to provide a concise synopsis on the general theory of pollution control and the nature of both these types of intervention. Pollution control in this context encompasses both climate change and transboundary air pollution.

The brief is structured as follows. Section 2 provides the theory on pollution and the need for intervention. This is then followed in section 3 by classification of both the command and control and market-based approaches. Section 4 provides a summary and conclusion.
2. Environmental Economics & Pollution Control

Feldman (1989) notes that welfare or quality of life is maximised in a market economy when there is a perfectly competitive market, full information to make informed choices as citizens and consumers, large numbers of profit maximising firms, clearly assigned property rights and no externalities. However, not unsurprisingly markets rarely enjoy such an appropriate arrangement and therefore on occasion they experience ‘market failure’. Mankiw (1998) defines this concept of market failure as a situation in which a market left on its own fails to allocate resources efficiently. Arguably implicit in this definition is a degree of support for market intervention as a solution.

Related to this issue of market failures is the specific concept of externalities. Externalities can be either positive or negative. A positive externality occurs when one person’s actions improve the well being of others, whereas a negative externality will result in a reduction of the welfare of others. Negative environmental externalities occur when the polluter does not fully bear the costs of the damage for which they are responsible.\(^1\) Instead others in society bear the cost of the negative externalities through a reduction in economic welfare.

Such environmental externalities generally arise when environmental resources possess the characteristics of a public good. Environmental resources such as air and water are, by and large, non-market public goods with open-access characteristics and therefore do not generally ‘belong’ to anyone (Eggertsson, 2003). Clinch and Convery (1999) define the environment as “those parts of our physical and psychological endowment which we somehow share, which are open access”. It is this shared, non-proprietary nature of environmental endowments that threatens their quality and opens them to abuse and misuse. A long tradition of economic theory suggests that treating resources as a commons shared jointly by many users can lead to overexploitation in the absence of some kind of access rationing (Ostrom et al. 2002). Without clear property rights, no incentives exist for careful use or improvement of environmental

\(^1\) The classic example of a negative externality involves two firms, a waste emitting factory on the banks of a river and a fish hatchery. The fish hatchery is downstream of the factory. The factory discharges its waste into the river, but since the fish hatchery is downstream it is forced to clean up the polluted water. In this case the pollution costs are borne not by the polluter but by the victim, the hatchery.
resources because capturing private gains proves impossible. Thus externalities are produced and the market fails to allocate the resources efficiently (Ayres and Kneese, 1969).

Figure 2.1 illustrates the market failure resulting from negative externalities. The market failure in this example is simply that the polluter is imposing additional costs on others but has no incentive to reduce pollution and produce the socially optimum level of output. Under such circumstances the producer only considers his own private costs and benefits. From figure 2.1 it is seen that the private equilibrium – point A – of supply and demand is not the same as the social equilibrium (which captures all costs, including those for pollution control) – point B – thus resulting in a deadweight loss of economic welfare equivalent to the area ABC.

However, the environmental regulator through the use of pollution control policies, which at least internalise the external social damage, can attempt to correct the sub-optimality of the unregulated market that allows for the existence of these negative externalities.

**Figure 2.1 Welfare Loss of Negative Externalities**

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\begin{figure}
\centering
\includegraphics[width=\textwidth]{welfare_loss.png}
\caption{Welfare Loss of Negative Externalities}
\end{figure}
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When pollution control policies are introduced to combat the effects of a negative externality the ultimate goal of this intervention should be to achieve the optimal level of pollution. Welfare economics suggests that the polluter should pay the marginal cost of the environmental damages caused by its activity at the optimal level of pollution. This occurs when the marginal cost of pollution control is equal to the marginal cost of the damage caused by such pollution. Pollution control costs are defined as all monetary expenditure by society, direct or explicit, to reduce current pollution levels, whereas pollution damage costs refer to the monetary value of the damage caused by pollution (Hussen, 2004). The optimal level of pollution is found at the point of intersection of the marginal cost curve of pollution to society and the marginal benefit curve of pollution to the polluter. Figure 2.2 illustrates this concept of optimal pollution. The optimal level of pollution occurs at X* – the point of intersection of the marginal cost curve (MC) and the marginal benefit curve (MB).

Figure 2.2 The Optimal Level of Pollution

However, it is often extremely difficult to achieve a point estimate of pollution damage, let alone estimate how marginal external cost may vary with output and thereby identify an ‘optimal’ level of pollution. Identification of the efficient level of emissions requires extensive and often uncertain information about the benefits and costs. The huge informational requirements surrounding the definition of optimality has led to regulators instead looking to achieve some specified ambient level of pollution in the least expensive way. In this situation, what is known as the ‘second best approach’ is adopted. In this case the environmental regulator chooses the
emission level target or emissions standard, and employs an instrument or suite of instruments to achieve these standards at the lowest possible cost. This is commonly known as the ‘cost-minimisation’ or ‘two-step’ approach.

3. Command and Control – v – Market Based Instruments

Further considerations specific to command and control and market based instrument interventions are discussed in this section. Including a brief review of the design and operational distinctions of these two approaches.

3.1 Command-and-Control

The conventional approach to regulating the environment is frequently characterised as Command and Control policy and is generally seen as a legal approach to protecting the environment. According to Clinch (2001) command and control policies are essentially directives to individual decision makers requiring them to set one or more outputs or inputs at some predetermined standards [specified levels] or prohibiting them from exceeding (or falling short of) such standards [levels]. The most prevalent form of uniform command and control standards are technological standards and performance standards that specify uniform limits on the amount of pollution a firm can produce. The firm then adjusts its output or abatement so that the standard is achieved. In the event of firms not complying with these standards then such firms are considered lawbreakers and financial penalties or other sanctions are used to bring non-complying sources into compliance. Stavins (2001) argues that command and control regulation allows relatively little flexibility in compliance efforts since such regulation tends to force all firms to take on equal shares of the pollution control burden, regardless of the cost. Where there is a significant heterogeneity of abatement costs, command and control methods will not be cost-effective. Unless all polluters face the same pollution abatement costs, uniform emissions standards will not minimise the costs of reducing emissions.

In reality abatement costs vary significantly between firms due to production design, physical configuration, age of assets and other factors. A common criticism of the command and control
approach to environmental policy making is that costs of compliance may be considerably higher than under flexible mechanisms such as emissions trading or charges on emissions. This problem is exacerbated when regulation takes the form of technological prescription – mandatory use of a particular form of equipment.

In theory the command-and-control approach could achieve an environmental objective in the same least cost fashion as a market-based instrument. However, Stavins (2004) highlights that in order to achieve this the environmental regulator would need to define different standards for each pollution source taking into account the abatement costs that each firm faces. Since such information is not readily available and unlikely to be disclosed by firms, the command-and-control will generally prove to be more costly than the market-based approach.

### 3.2 Market Based Instruments

When trying to achieve an ambient standard of pollution, environmental regulators can choose to use market-based instruments to help them reach this standard. The OECD (1991, 1994) classify market-based instruments within five categories – emissions taxes, tradable permits, market friction reductions, government subsidy reductions and voluntary agreements. Such instruments could include interventions such as transport taxation or an emissions trading market. Regardless of the application, market based instruments generally operate to create incentives that encourage people acting more or less in their own best interests, simultaneously, to treat the environment in a way that is in the best interests of society. In general, market-based instruments reward people monetarily for producing environmental benefits (i.e. lower levels of pollution and emissions) and penalise those people who impose environmental costs on society.

The underlying idea with market based instruments is closely related to the *polluter pays principle* which requires that environmental costs are internalised and reflected in the prices of the goods and services that cause pollution as a result of their production and consumption (EEA 2005). The OECD (1999) defines market-based instruments for environmental policy as “those policy instruments that may influence environmental outcomes by changing the cost and benefits of alternative actions open to economic agents. They aim to do so by making the environmentally preferred action financially more attractive”. Unlike command and control regulation, market-based instruments encourage abatement behaviour through price signals, as
opposed to explicit directives regarding pollution levels or methods. The nub of the economists’
prescription for the failing of the market is to create a set of surrogate prices e.g. through
taxation or a direct charge per unit of pollution, such that individuals and firms pay for their use
of the environment. In essence, those who pollute less are rewarded since they avoid the charge.
The price signal that emerges – indicated directly by the tax level or indirectly by the price of an
allowance that emerges in the allowance market of an emissions trading scheme – indicates that
the assimilative capacity of the environment in question is scarce and valuable and that money
can be saved in the case of a tax or made in the case of emissions trading by reducing emissions.

Hahn and Stavins (1992) note that well designed market based approaches provide incentives
for firms to equate abatement costs at the margin by encouraging firms that can reduce
emissions most cheaply to take on a greater share of the emissions reduction burden, thus
allowing for a desired level of pollution cleanup to be realised at least cost. In 1972 Montgomery
described this situation as one where market-based instruments, instead of equalising pollution
levels among firms, simply equalised their marginal abatement costs. In general, market based
instruments allow the polluter to choose the level of pollution but they have a cost imposed on
them for the pollution they produce.

In addition to being statically efficient (cost-effective) economists claim that market based
instruments have the potential to be dynamically efficient by providing incentives for firms to
invest in R&D and develop and adopt cheaper and more efficient pollution control technologies
as such investments will lead to the reduction of abatement costs over time. With market based
instruments, notably emissions taxes and tradable permits, it is in the firm’s interest to abate
more than is required of it if a sufficiently low cost method of doing so can be developed and
implemented (Downing and White, (1986); Malueg, (1989); Millman and Prince, (1989); Jaffe
and Stavins, (1995); Stavins, (2004)). Such incentives do not exist for firms under CAC
regulation on account of the fact that if firms develop or adopt more efficient pollution control
technologies and abate more than is required of them by the command and control regulation,
they then run the risk of being subject to stricter standards in the future.
4. Summary/Conclusion

All approaches to controlling the environment have strengths and weaknesses and their suitability can depend upon the situation, scope, political constraints, and environmental issue being addressed. The conventional approach to regulating the environment has been command-and-control, with such policies traditionally relying on technical measures to achieve environmental goals. A common criticism of this approach is that costs of compliance may be considerably higher than under other policy approaches such as market-based instruments. Where there is a significant heterogeneity of abatement costs, command and control methods will not be cost-effective. Unless all polluters face the same pollution abatement costs, uniform emissions standards will not minimise the costs of reducing emissions. More recently there has been a greater up-take in the use of market-based instruments (notably taxation, emissions trading, and voluntary agreements) amongst environmental regulators. Market-based instruments are often preferred by economists because they offer greater flexibility in complying with environmental policy through the simple acknowledgement and accommodation of the fact that not all polluters share the same abatement costs. The use of market-based instruments provides all those subject to an environmental policy the opportunity to comply in the most cost-effective manner. In addition, with many Member States facing significant challenges to meet climate targets in a short time frame and constraints on the pace and deployment of technical solutions, market based instruments have been thrust centre stage and now underpin a significant share of global climate ambitions. As a result market-based instruments are being increasingly integrated into the policy portfolios of Member State governments and warrant further ongoing research and assessment.
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