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Environmental Economics: The 50th Anniversary of the Birth of this Field around the First Earth Day

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The term 'environmental economics' may sound like an oxymoron to those who believe that saving the environment must be based on a moral imperative that ignores financial costs. Yet, when viewed through an economic lens, pollution is ultimately a market failure that can be corrected. Economics can help achieve the *most* environmental protection for any particular amount that society is willing to spend. By identifying market failures that create pollution and helping to design policy proposals that maximize cost-effectiveness, economics can be a powerful tool for environmental protection.

Prior to the first Earth Day in 1970, mainstream economics had well-defined disciplines studying labor markets, international trade and public sector finance (i.e. government tax and spending policy). In contrast, the field of 'environmental economics' did not yet exist, *per se*, although individual economists had certainly explored pollution issues. An early pioneer, Arthur Pigou, pointed out in 1920 that government could impose a tax per unit of pollution (and to this day, economists still refer to a Pigouvian tax on pollution).[1] But Pigou's idea was subsequently challenged by Ronald Coase in 1960, who argued that private interactions could solve pollution problems when property rights are well defined and transactions costs are low.[2] In Coase's scenario, no government regulation meant that polluters could pollute, but victims downstream could simply pay the polluter to cut back emissions to a mutually agreeable level. If, instead, nobody had the right to pollute, then a polluter could pay the victims not to complain — a perfect market! Most often, however, the

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reality is not that simple. With many victims downstream, large numbers could 'free-ride' the system, claiming that they don't care about pollution and thus declining to contribute toward the costs of pollution reduction. This outcome is a classic market failure, which can be fixed by government intervention.

Despite these early debates around pollution pricing and other controls, most economists before 1968 largely ignored the study of the environment. But then a remarkable flurry of intellectual activity occurred in the brief period from 1968 to 1974 — the dawning of 'environmental economics'. Many crucial ideas converged within those few years, ending with the 1974 founding of the *Journal of Environmental Economics and Management*. Perhaps ironically, it was a non-economist who wrote the most-cited paper in what was to become environmental economics. In 1968, a biologist named Garrett Hardin published an article in *Science* called 'The tragedy of the commons'.[3] Hardin argued that unregulated use of a commons — a place that everybody can use, with no real owner — could lead to unsustainable exploitation and environmental degradation of the oceans, land and atmosphere. With a growing human population and free access to fishing grounds, for example, each boat takes as many fish as possible — before the others get to it. The ensuing 'tragedy' is the annihilation of the fish stock, or slaughter of the buffalo, or deforestation on a grand scale, or the extinction of many species.

While Hardin's arguments were largely based on biology and demography, to many economists the fundamental problem was a lack of ownership. If some people simply took possession of the resource, then owners could protect their property in the ocean or on land. Under this view, pharmaceutical companies could acquire vast portions of the Brazilian Amazon to protect the rainforest, ensuring preservation of the rich biodiversity necessary to discover and develop valuable life-saving drugs. Such a scheme could work under some circumstances, but history has shown the limits of this approach. Economists had already explained why private markets fail to provide 'public goods' such as roads, law and order, or military defense. A lighthouse is the quintessential example, with two key attributes. First, once the lighthouse is built, its light can provide navigational benefits to many boats in the area who use the resource without ever depleting it — the light is available to additional boats at the same time and at no additional cost. Second, no business could recover the cost of building the lighthouse, because boaters would realize they can see the light whether they pay or not. These free riders cause the private market to fail, even though the social benefits may greatly exceed the costs of building the lighthouse.

In 1968, Hardin didn't use economic terminology, but his reasoning was impeccable: a clean environment represents a public good that provides health and aesthetic benefits to millions of people simultaneously. Once provided, clean air is available to others to breathe at the same time and at no additional cost. Moreover, consumers will not buy clean air, because they can breathe whether they pay or not. With this free-riding behavior, no business would voluntarily pay the costs associated with cleaning up the air. Other firms who do not clean up will be able to charge a lower price for their goods or services, thus gaining a market advantage. Once again, we see the failure of a private market, even though the social benefits of clean air greatly exceed the costs.

In the absence of viable private markets, government can increase social welfare by providing a clean environment; it can regulate firms, require scrubbers, tax pollution and prohibit improper disposal of waste. These clean-up activities certainly have costs, especially for generation of electricity or transportation of goods, and industries may have to cover their costs by increasing product prices. But, *if environmental protection is done wisely*, then collective health benefits can greatly exceed the additional costs to businesses and consumers.

As a thought experiment, consider a particular environmental protection proposal where total health and aesthetic benefits exceed total costs. Suppose also that the benefits and costs are distributed equally across all voters. In this scenario, the proposal would provide a net benefit to everyone, and support for the proposal should be unanimous. Most often, however, the benefits and costs of environmental protection are not shared equally. And therein lies one of the major economic problems of enacting environmental protection. Even for policies with positive net benefits overall, some segments of society receive disproportionate benefits, while others bear disproportionate costs. Critically, economic analysis can be used to measure the distribution of these gains and losses resulting from any proposed policy. It can also help design a policy package that simultaneously achieves pollution reduction *and* desired objectives regarding the distribution of gains and losses.

When it was first established in 1970, the US Environmental Protection Agency (EPA) focused on technological and legal frameworks to control pollution, with little consideration of economic implications. Engineers were employed to determine the 'best' ways to cut pollution, and lawyers wrote regulations requiring the adoption of those recommended technologies. Under this approach, as it developed in the immediate aftermath of the first Earth Day, environmental protection was viewed as a moral imperative, and costs were not taken into account. In contrast, the early pioneers in environmental economics devoted significant attention to analyzing both the costs and the benefits of different environmental protection schemes. They often found that costs of actual legislative and regulatory changes were more than three times as high as those for alternative policies that would achieve the same degree of environmental protection. In other words, more economically efficient approaches could lead to greater environmental protection for the same level of financial investment.

Enter the ideas of John Harkness Dales. In 1968, Dales published a brilliant idea for minimizing the cost of achieving any given degree of environmental protection.[4] Government could limit the total amount of pollution at an appropriate low level, print a fixed number of permits or licenses, and let polluters bid for the permits or trade with each other. The key innovation of Dales' idea was to recognize that a particular required mitigation technology cannot logically be 'best' in all different circumstances. Policymakers in the nation's capital cannot possibly know as much about production technologies as the engineers inside each firm, especially when those technologies vary across firms. The same pollution reduction could be achieved by letting each firm determine their own 'best' method.

As an example, regulators might require the most advanced (and likely most expensive) flue-gas scrubber to remove sulfur dioxide from emissions of coal-fired electricity generating plants, but cost-minimizing engineers within the firm might be able to cut pollution the same amount at lower cost. They could switch from high-sulfur coal to low-sulfur coal, or from coal to natural gas, or change the dispatch order between coal plants and gas plants, or use renewable power like wind and solar. If the goal is a target pollution reduction, then the method of reduction should not matter. Moreover, not all of those strategies need to be available to every firm. With permit *trading*, a firm with limited options can essentially pay a different firm to do their required pollution reduction, through a so-called ‘cap-and-trade’ approach. Imagine ten firms that each hold 1,000 one-metric-ton permits for sulfur dioxide emissions. Together, these firms are collectively limited to 10,000 metric tons of emissions, but they do not all have to cut by the same amount. A firm with only fossil-fuel-fired power plants could switch some output from coal to gas plants, while also buying additional permits from some other firm in sunny Arizona with abundant solar power.

With a single market price, say $100 per metric ton of sulfur dioxide emissions, a tradeable permit system provides incentive for any firm to develop emission reduction strategies that cost less than $100 per metric ton. Firms would bypass any technology costing more than $100 to reduce emissions per metric ton, choosing the more economical approach of simply buying an emissions permit instead. The exact same argument can be applied to an emission tax of $100 per ton. Both emissions taxes and permits represent pollution-pricing policy; in either case, only the cheapest pollution abatement methods are chosen, minimizing the total cost of achieving any given target pollution reduction. If a pricing policy could effectively reduce pollution by the same amount at lower cost, it would allow policymakers to choose a more ambitious target for the same overall expenditure. In other words, the same dollar cost could be used more efficiently to achieve greater pollution reduction.

The flurry of important new ideas in the emerging field of environmental economics continued through the early 1970s. In 1971, William Baumol and Wallace Oates described various approaches to implementing pollution pricing policies.[5] And in 1972, David Montgomery showed exactly what conditions would be necessary for a permit policy to minimize the total social cost of pollution abatement.[6] These contributions culminated in the significant 1974 paper by Martin Weitzman that explored the difference between taxation and permit policy as a means of pollution pricing.[7] A tax on pollution fixes the price of pollution, but it does not necessarily limit the total quantity of emissions. Firms facing a fixed price will decide their quantity of pollution and thus the total amount they are willing to pay for it. If policymakers knew the total quantity of pollution that would result under a given taxation scheme, they could fix that quantity of pollution by printing a fixed number of tradable permits. Under this permit system, the market would be expected to produce an equivalent pollution price for the same quantity of emissions. But the critical difference, pointed out by Weitzman, relates to future *uncertainty* as market conditions evolve. Limiting the quantity of pollution through a permitting system is great for ensuring a clean environment, but firms cannot be sure what price they will have to pay in the future. That uncertainty can inhibit investment and reduce growth, raising costs. On the other hand, setting the price of pollution through taxation is great for ensuring a known cost of production (and thus certainty for investors), but this approach creates uncertainty about the total amount of resulting pollution.

Which policy, taxation or permitting, better maximizes total social welfare — accounting for all economic and environmental costs and benefits? The answer depends on the relative impacts of uncertain economic costs as compared to uncertain environmental costs. We face many environmental problems ranging from contaminated water, climate change, endangered species and local air pollution. At one end of the spectrum, where the quantity of pollution is not critical, pollution that reduces aesthetic amenities (like visibility) might best be handled by a tax that fixes the price of pollution and avoids the risk of very high costs on business and consumers. At the other end of the spectrum, some types of pollution have critical thresholds, like the 1952 Great Smog of London that caused thousands of deaths.[8] These pollutants might best be handled by a permit system that fixes the quantity of emissions *below* that critical threshold (even though the price per metric ton could end up quite high).

In the decades since the first environmental economics journal started in 1974, thousands of scholarly articles have been published examining multiple aspects of this field. New theoretical ideas have added to those described above, and the discipline has become more empirically driven by advances in 'big data'. For example, observations from satellite remote sensing have been used to estimate the deforestation effects of various land-use changes, from agricultural policy and mining to various attempts at reforestation. Large data sets have also been important to quantify the effects of environmental policy on industrial output, productivity, employment and growth, in an effort to maximize the cost-effectiveness of various environmental policy approaches.

Over the past half-century, environmental economics has earned its keep. Academic ideas like permit trading have been put to the test in many practical applications, starting in the US with the 1990 Clean Air Act Amendments that initiated sulfur dioxide permit trading and largely eliminated the acid rain problem. Permit policies for carbon dioxide emissions began in 2005 for the European Union, and in 2006 for California. Carbon taxes have now been enacted in a dozen countries and in three Canadian provinces. These policies are currently generating much data for further analysis by environmental economists trying to help design better polices that can help protect Earth's environment at lower cost. These economic approaches can play a huge role in aiding our transition to more sustainable societies.

Endnotes

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6. W. D. Montgomery, 'Markets in licenses and efficient pollution control programs', *Journal of Economic Theory*, 1972, 5, 395–418, https://doi.org/10.1016/0022-0531(72)90049-x
7. M. L. Weitzman, 'Prices vs. quantities', *Review of Economic Studies*, 1974, 41, 477–91, https://doi.org/10.2307/2296698
8. On the Great Smog of London, see also 'Air' by Jon Abbatt in this volume.