

Extended Product Responsibility: An Economic Assessment of Alternative Policies

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Abstract

Extended Product Responsibility embodies the notion that agents along a product chain should share responsibility for the life-cycle environmental impacts of the product, including those associated with ultimate disposal. Extended Producer Responsibility is a narrower concept which places responsibility on producers and focuses primarily on post-consumer waste disposal. Manufacturer "take-back" requirements are the policy lever most often associated with Extended Producer Responsibility. In this paper, we discuss alternative incentive-based policies that are consistent with the objectives of Extended Product and Producer Responsibility. We argue that an upstream combined product tax and recycling subsidy (UCTS) is generally more cost-effective and imposes fewer transactions costs than the take-back approach. We also consider the strengths and weaknesses of a policy not targeted at producers: unit-based pricing of residential waste collection and disposal. We find that this option shows potential for achieving non-trivial reductions in solid waste. Widespread application in the U.S. of a \$1.00 charge per 32-gallon bag could reduce total municipal solid waste disposed by approximately 13 percent per year.

Key Words: solid waste, extended product responsibility, recycling, unit pricing

JEL Classification Numbers: Q2, H2

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EXTENDED PRODUCT RESPONSIBILITY: AN ECONOMIC ASSESSMENT OF ALTERNATIVE POLICIES

Karen Palmer and Margaret Walls*

I. INTRODUCTION

Economists since A. C. Pigou in the 1920s have acknowledged that private markets generally do not adequately address the adverse environmental consequences of economic activity. When consumption or production leads to environmental problems such as air or water pollution, there is almost always a role for government. What exactly that role should be is a matter of debate and depends on the particular environmental problem at hand; invariably, however, economists search first for incentive-based options such as emissions taxes or marketable pollution permits.

In this paper, we examine the basic economic arguments for such approaches and discuss the possibility of applying them to solid waste disposal and upstream pollution problems associated with consumer products. We discuss the findings in the economics literature on solid waste and recycling and the conclusion among many that a combined product tax and recycling subsidy can be an efficient approach to reducing waste generation and increasing recycling. We view this finding in light of the goals of Extended Product Responsibility, asking whether such a policy option is consistent with Extended Product Responsibility goals and contrasting this price-based approach with manufacturer "take-back" requirements. Finally, we contrast these options focused upstream on producers with a downstream policy of unit-based pricing of solid waste disposal.

II. OPTIMAL ENVIRONMENTAL POLICIES

A. The Advantage of Pigovian Taxes

The quintessential incentive-based environmental policy is the Pigovian emissions tax. An emissions tax is one levied per unit of emissions and paid by each polluter on all its emissions. To be a true *Pigovian* tax, the tax rate must be equal to the marginal environmental costs of those emissions at the social optimum. The social optimum is the level of pollution where the extra benefit to society from eliminating another unit of the pollutant is exactly equal to the extra cost. Another policy option with many of the same

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features of the Pigovian tax is marketable pollution permits. If the number of permits issued by the government is set to generate the socially optimal level of pollution, then the permit price is exactly the same as the Pigovian tax.¹

These incentive-based options have several advantages over "command-and-control" policies such as requiring all polluters to reduce their emissions by the same absolute or relative amount. First, a tax or equivalent marketable permit system is the least cost way of achieving any given environmental goal, including one that differs from the social optimum. A tax brings about more pollution abatement from producers who find it relatively easy to abate and less from those for whom abatement is difficult. This means a given reduction in total emissions is achieved at the lowest possible cost.

Second, a pollution tax has what are often called "dynamic efficiency" effects. Because polluters pay the tax on all units of pollution, they have an incentive to develop cheaper and more effective ways of reducing their pollution, since doing so reduces their costs.² Emissions standards or technology-based standards do not similarly reward efforts to do better than the standard. Furthermore, many existing air and water pollution regulations in the U.S. specify standards per unit of output; this means that pollution necessarily increases as production increases.

Third, recent research suggests an added benefit from environmental taxes over command-and-control approaches: the revenues generated from such taxes can be used to reduce other distortionary taxes such as income taxes. This does not mean that the environmental policy imposes no costs of its own--it does--but alone among environmental policies, pollution taxes (or auctioned permits) generate revenues and thus have the ability to reduce the burden of other taxes.

B. Solid Waste Disposal and Optimal Policies

Despite these desirable properties of Pigovian taxes, there may be many circumstances in which they are infeasible. Hazardous and solid waste disposal may be the best example. Because of the relative ease of disposing illegally of one's waste, charging a price--i.e., a Pigovian tax--for disposal could have unwelcome repercussions. The tax would necessarily have to be accompanied by a penalty for illegal dumping. However, enforcement would be difficult and extremely costly.

Several studies by economists suggest an alternative incentive-based policy that has many of the desirable features of a Pigovian tax without the attendant illegal disposal problem: a product tax coupled with a recycling subsidy. This combination of policy

¹ In a world of uncertainty about the costs of abatement, there can be differences in the outcomes with taxes and permits (see Weitzman (1974) for the classic treatment of this problem; Baumol and Oates (1988) have a good explanation in Chapter 5).

² Under the SO₂ allowance trading program in the U.S., electric utilities and their suppliers have lowered their costs of reducing SO₂ emissions through innovations in coal switching and blending and cost-reducing improvements in flue gas desulfurization equipment (see Burtraw, 1996, for discussion).

instruments has the two features of a Pigovian tax that make it an optimal policy: an output reduction effect and an input substitution effect.³ The product tax and recycling subsidy give firms the incentive to both produce less output and substitute recycled inputs for virgin inputs in production.

The product tax/recycling subsidy policy is often referred to as a "deposit-refund." In traditional deposit-refund, or "bottle-bill," programs, consumers pay a deposit (tax) on a container at the time of purchase and receive a refund (subsidy) equal to their initial deposit when they return the container to a designated collection center. Bottle bill programs generally have fairly high administrative and transaction costs associated with them resulting from the following features: bottles must be returned to a collection center such as a supermarket; the supermarket then must sort the containers by brand; brand distributors then pick up the sorted containers for recycling.

An approach with similar results for recycling and solid waste but much lower administrative costs is something we call an "upstream combination tax/subsidy (UCTS)." In Palmer, Sigman, and Walls (1997), the UCTS combines a tax on produced intermediate goods such as aluminum ingot, rolls of a specific grade of paper, and sheets of steel, with a subsidy granted to collectors of recyclables such as used beverage cans, old newspapers, and so forth, who subsequently sell the goods for reprocessing. The upstream tax in the UCTS is a tax levied per pound rather than per unit of a good, and because it is focused on materials, it acts to reduce the pounds of materials that end up as waste disposal.⁴ Walls and Palmer (1998) show that the UCTS can also give producers the incentive to reduce the weight of their products, thus encouraging at least one type of "design for environment (DfE)."

Palmer, Sigman, and Walls (1997) calculate the cost-effectiveness of the UCTS for achieving given reductions in waste disposal and compare it to the upstream tax by itself--sometimes called an "advance disposal fee (ADF)"--and a recycling subsidy by itself.⁵ We find that a 10 percent reduction in disposal of these materials can be achieved with a UCTS of \$45/ton, an ADF of \$85/ton, or a recycling subsidy of \$98/ton. The results highlight the importance of the output effect and input substitution effect we described above. The recycling subsidy encourages substitution of recycled for virgin inputs but has a perverse output effect: output increases because of the drop in production costs brought about by the subsidy. This means that the subsidy has to "work overtime" to accomplish waste reduction goals. This proves particularly costly for materials such as aluminum, which already achieves high recycling rates and thus has a relatively high cost of additional recycling, and for plastics which tend to be costly to recycle. The ADF, on the other hand, contains an output effect but

³ For good discussions of this point, see Spulber (1985) and Fullerton (1997).

⁴ In our work, we analyze a uniform tax and subsidy, but the tax and subsidy could vary by material.

⁵ We use information on the amount of paper, glass, aluminum, steel, and plastics disposed of and recycled in the United States in 1990, along with estimated price elasticities of supply and demand from the economics literature for each of these materials, to calibrate a simple simulation model of disposal and recycling.

no input substitution effect. We find this to be particularly costly for paper since many paper products can be recycled at relatively low cost.

III. IS A UCTS CONSISTENT WITH THE PRINCIPLES OF EXTENDED PRODUCER AND PRODUCT RESPONSIBILITY?

Extended Product Responsibility embodies the notion that individuals along a product chain should share responsibility for the life-cycle environmental impacts of the product--i.e., the impacts from raw material extraction through manufacturing, distribution, consumption and ultimate waste disposal. Extended Producer Responsibility has a slightly narrower interpretation: it is less focused on life-cycle concerns and shared responsibility and more explicitly focused on post-consumer waste disposal and *producer* responsibility.

Manufacturer "take-back" requirements, which we discuss in section IV below, are the policy lever that many people associate with Extended Producer Responsibility. However, producer responsibility encompasses much more than just take-back requirements; it can be thought of as an umbrella concept that covers a wide range of specific policy instruments. The two key features of any Extended Producer Responsibility policy are: (1) some shifting of the burden of waste management back upstream to producers and away from municipalities, and (2) giving producers incentives for DfE, i.e. to undertake cost-effective changes in product design, including increasing product recyclability, and to substitute secondary materials for virgin materials in production. Many observers see a broader objective for Extended Product Responsibility: providing incentives to reduce the life-cycle environmental problems associated with consumer products.⁶ The Dutch Packaging Covenant addresses life-cycle concerns.

A UCTS is consistent with the objectives of both Extended Product and Producer Responsibility. First, the product tax provides a mechanism for collecting some of the costs of ultimate product disposal from product manufacturers. This can help to alleviate the financial burden on municipalities of managing solid waste. Second, since the tax discourages production, it acts to reduce waste. And if the tax is assessed per pound of intermediate material produced, it gives producers of those intermediate goods the incentive to produce lighter-weight products. This further reduces the amount of materials entering the waste stream. Third, the subsidy for recycling encourages the use of secondary materials in production by reducing their cost relative to virgin materials.

Fourth, our recent research (Walls and Palmer, 1998) suggests that, with some adjustments and in combination with existing pollution standards, the UCTS is capable of addressing at least some life-cycle pollution concerns as well as waste disposal. We analyze a situation, typical of many air and water pollution regulations in the U.S., in which an emissions standard per unit of output is in place. Such a standard cannot be an efficient way of reducing pollution because, as explained above, it does nothing to prevent pollution from

⁶ Ackerman (1997) has argued that the upstream pollution externalities associated with consumer products are far more serious than disposal externalities.

increasing as production increases. However, combining the emission standard with a product tax can be efficient. Moreover, the product tax is capable of addressing multiple upstream pollution problems along with downstream waste disposal. The level of the tax is simply adjusted to reflect the marginal environmental costs associated with each externality. The recycling subsidy part of the UCTS remains the same and is only needed to address the waste disposal concern.

The key to the life-cycle findings is the upstream pollution standard per unit of output. Other types of standards such as technology requirements or standards per unit of energy input (as some U.S. air emissions standards are specified) may have different effects. Also, neither the UCTS by itself nor any other policy instrument by itself, such as an ADF or take-back requirements, is efficient for addressing life-cycle environmental problems. To be efficient and cost-effective, a policy must have both an output effect and an input substitution effect--i.e., discourage production or encourage greater material efficiency and encourage cost-effective substitution of "cleaner" inputs to production for "dirtier" ones. In the case of life-cycle concerns, this input substitution effect includes substitution of pollution abatement efforts for other inputs and substitution of recycled for virgin materials.

IV. PRODUCER TAKE-BACK REQUIREMENTS

Take-back requirements mandate that producers take back, or authorize a "producer responsibility organization (PRO)" to take back, their products from consumers at the end of the products' useful lives. Take-back is applied to packaging in Germany and to electronic goods, automobiles, rechargeable batteries, and other products in other countries. In Germany, collection and sorting quotas for each material accompany take-back requirements; these quotas effectively generate material-specific recycling rate standards, a requirement that a certain percentage of each material collected for disposal and recycling must be recycled. Below, we distinguish between take-back mandates by themselves and take-back coupled with recycling rate standards.

The second key feature of Extended Product and Producer Responsibility identified in section III above and also a major impetus for European take-back programs is encouraging firms to engage in DfE. It is often argued that producers do not have enough incentive to make their products easy to recycle. For example, certain electronic goods, televisions, and the like may be difficult to disassemble and/or may contain particularly difficult to handle, toxic materials that make it costly to recycle those products. Because of the "public good" aspect of recyclability, individual producers do not have enough incentive to make those products recyclable; they do not see their own products again at end-of-life, so they cannot reap the full benefits of their DfE efforts. Similarly, the use of different processes (blow molding versus injection molding) for making plastic packaging leads to a lack of uniformity which makes recycling of plastic packaging difficult. Again, some observers argue that this problem exists because there is no incentive for individual producers to demand uniformity, and thus recyclability, in plastics. Mandating that producers take back their products or packaging is seen, then, as a way to combat these problems.

The way take-back requirements are designed in theory and the way they work in practice are quite different, however, particularly for packaging. It is infeasible, in practice, for the myriad manufacturers of consumer products to actually physically collect their products from consumers. Thus, the German arrangement is likely to be typical of any packaging take-back mandate--i.e., a PRO is formed and contracts with individual waste haulers in local areas to collect waste covered by the program, sort it, and transport it to recyclers. The PRO then charges member companies a fee for collecting and sorting the waste from their products. In Germany, the fee was initially assessed on a volume basis but was soon changed by the German PRO, known as the DSD, to a weight basis and made to vary by material. Plastics face a much higher fee than other materials. The fees are collected up-front and are assessed to each producer based on its reported production.

Thus, take-back requirements with a PRO look, in the end, very much like either our upstream product tax or an ADF. The fee will have the same effects on production, DfE, and waste disposal that an ADF would have. The fee, by itself, will also not be cost-effective at reducing waste disposal since it does nothing to encourage recycling.

Used in combination with recycling rate standards, take-back requirements perform better. However, theoretical research suggests that this policy combination is still not as efficient at reducing waste disposal as the UCTS. Palmer and Walls (1997) find that a closely-related policy, a recycled content standard, even when accompanied by an ADF, cannot achieve the socially optimal levels of disposal and recycling. The standard and ADF must be combined with taxes on other inputs to production. These taxes are necessary to reduce output and, ultimately, waste disposal to their optimal levels. The size of the tax on other inputs will depend on the ease of substituting other inputs for recyclables in the production process; thus, the efficient tax will differ across firms if production functions are different. The recycling rate standard and the tax on output will also need to be firm-specific if production functions differ across firms. This is a serious drawback of this approach over the UCTS.

In terms of easing the financial burden of waste management on communities--another rationale often used for take-back--there seems to us to be no advantage to mandating take-back as opposed to simply transferring government ADF revenues to municipalities to help cover waste management costs. Either way, the burden on local government is eased--with take-back, the burden is eased because the municipality has less waste to handle; with the tax, the municipality receives revenues to help cover its costs. The ADF and the PRO fee should bring about equivalent reductions in waste volumes, thus both policies extend the life of existing landfills and both policies reduce total disposal costs since less is being disposed of.

V. TRANSACTIONS COSTS

The most important difference between the UCTS and take-back requirements with recycling rate standards concerns transactions costs. The transactions costs associated with take-back requirements, whether in combination with recycling rate standards or alone, are likely to be very high, especially in the United States. This is so for several reasons. First,

producers would need to organize themselves and form the PRO (or several PROs); this involves substantial up-front costs. Second, the PRO must contract with individual producers to handle their products at end-of-life, collect payment from producers, and enforce accurate reporting by producers. Third, the PRO must contract with many different individual waste haulers to collect the covered materials. Moreover, it must coordinate with the thousands of local governments who still have responsibility for managing non-covered wastes. Fourth, the PRO has to figure out how to minimize free-riding, both by consumers who use the PRO bin for all kinds of waste and by producers who falsely designate their products as part of the system when they are not. This involves costly monitoring activities by both haulers and the PRO, and it involves the PRO finding ways to encourage efficient monitoring efforts on the part of waste haulers. These issues are not insignificant for a country the size of Germany, and they would be monumental for a country as populous and geographically large as the U.S.

The question then is whether either (1) the PRO approach has some advantages that offset these costs, or (2) the UCTS has similarly high costs. It is possible that the PRO might serve a useful coordination function in acting as a "middle-man" between producers and processors of recyclables and in ensuring that the recycling rate standard, if there is one, is met across producers in an industry. But if the middleman benefits are large, it seems likely that, when faced with a UCTS, industry could form a similar organization to perform exactly these kinds of tasks. Moreover, these potential benefits could be offset by the possibility for anti-competitive behavior that exists with this kind of arrangement. There are two anti-competitive issues. First, forming a PRO involves collusion among firms, something prohibited by anti-trust law. Second, the PRO ends up as a monopoly supplier of its services as an intermediary between producers and waste haulers.

The UCTS is not without transactions costs of its own. Most importantly, collecting the tax revenues and making the subsidy payments imposes administrative costs on the government. These administrative costs may be roughly equivalent to the costs that the PRO incurs when it contracts with the individual producers to handle their waste, collect payment from them, and enforce accurate reporting. But the costs that the PRO incurs from contracting with waste haulers, the costs from coordinating with individual communities, and the costs involved in monitoring both the waste stream and producers are all avoided with the UCTS. This is because there is no change in existing waste collection arrangements.

VI. A POLICY NOT TARGETED AT PRODUCERS: UNIT-BASED PRICING

Most communities in the United States have traditionally covered the cost of residential solid waste collection and disposal services by assessing households a flat fee that does not vary with the amount of waste collected. Such fees are usually recovered in property taxes or utility bills. Since the same amount is paid regardless of how much is thrown away, such fees provide no incentive for households to economize on waste disposal. The inefficiency generated by this zero price has long been recognized by economists (see Wertz, 1976; Goddard, 1975; Jenkins, 1993).

In recent years, communities in the U.S. have begun to adopt various forms of unit-based pricing programs. Miranda et al. (1998) estimate that 3887 communities in the U.S. now have some form of UBP.

Some observers argue that Extended Producer Responsibility initiatives are not needed because UBP can cost-effectively reduce waste disposal (Parker, 1998). Although we do not address the issue in detail here, we compute a rough estimate of the reduction in waste disposal that could be expected if UBP was used widely in the United States. Kinnaman and Fullerton (1998) estimate a 43.8 percent reduction in disposal from the introduction of a price of \$1 per 32-gallon bag.⁷ Assuming that a \$1 price is imposed on all households in the U.S. who live in single-unit dwellings--i.e., omitting apartments--and netting out the waste generated by the 28 million people whom Miranda et al. (1998) estimate are already subject to UBP, we estimate that waste disposal could drop by approximately 19.75 million tons per year. This is a 21.6 percent reduction in all household waste and a 13 percent reduction in total MSW.⁸

This is a significant reduction in waste disposal at a fairly reasonable cost--\$1 per 32-gallon bag is a typical price in communities with UBP. At this price and using UBP only in single-unit dwellings, available empirical evidence suggests that illegal disposal would not be a serious concern (Miranda and Bauer, 1996; Podolsky, 1994; Miranda, Everett, Blume and Roy, 1994). The advantage of UBP over policies focused upstream on producers is its ability to capture some wastes that those upstream policies can't: most notably, yard and some food waste and waste from clothing and other fabrics.⁹ A disadvantage of UBP is its limited ability to differentiate charges based on the relative hazards imposed by different components of the waste stream; this can be readily accomplished with a UCTS (Dinan, 1993). Moreover, a 13 percent reduction in total MSW may be less than environmental policy-makers or municipalities would like to see. If so, our calculations suggest that other policy instruments, such as the UCTS, may be necessary to get those reductions.

Another potential disadvantage of UBP may be an ineffectiveness at encouraging firms to undertake DfE if signals from unit prices to reduce product size or increase recycling are not being transmitted back to producers. This perceived failure of UBP to communicate signals upstream could be due in part to its limited application at the present time. Firms may not be receiving or responding to UBP signals because only a small subset of their customers,

⁷ The arc price elasticity based on this estimate from Kinnaman and Fullerton is -0.28--i.e., increasing price by 10 percent reduces waste disposal by 2.8 percent; this elasticity is in the range of estimates from other studies.

⁸ We assume that an average person in a UBP community disposes of 1.53 pounds per day (see Podolsky and Spiegel, 1998) for an estimated 7.82 million tons of MSW currently subject to UBP. We subtract this number from our estimate of 52.9 million tons from single-unit dwellings in the U.S. (which we obtain using U.S. Census Bureau figures on the number of single-unit dwellings and EPA's total MSW number from households in 1996, 91.47 million tons). Thus, we estimate that 45.1 million tons per year is available to be unit-priced and we apply Kinnaman and Fullerton's 43.8 percent reduction to that.

⁹ Nestor and Podolsky (1998) report that a significant increase in households' donation of used clothing to charitable organizations resulted from unit-pricing in Marietta, Georgia.

if any, face UBP. On the other hand this absence of signal transmission might exist even in the presence of more widespread UBP if it is the result of imperfectly competitive markets or poorly informed consumers. For example, the economics literature on product quality and imperfect competition tells us that when a market is served by a limited number of competitors who compete both in terms of product quality and product price, the market will produce an inefficiently low level of product quality (Spence, 1975, 1976; Ma and Burgess, 1993; Bulow, 1986). This finding could be instructive for recyclability (an aspect of product quality) as well. In addition, consumers may be poorly informed about the potential recyclability of a product and this could further contribute to producers with a degree of market power underproviding recyclability (Shapiro, 1982; Leland, 1979). Lastly, high transaction costs associated with executing all of the various transactions associated with the collection, sorting, and processing of recyclables may impede the ability of unit pricing of disposal to change manufacturers' behavior. More research is needed on these issues.

VII. CONCLUSION

Achieving the twin goals of shared financial responsibility for waste management and more "design for environment" can be accomplished in many different ways. The best known Extended Producer Responsibility mechanism is the manufacturer take-back policy, often coupled with a sorting or recycling requirement that varies by material. In this paper we discuss another policy tool consistent with Extended Producer and Product Responsibility objectives, an upstream combination tax/subsidy (UCTS). We argue that this policy is generally more cost-effective and imposes fewer transactions costs than the take-back approach, either with or without a recycling rate requirement. We also consider the strengths and weaknesses of another solid waste policy that is gaining popularity in many communities in the United States, unit-based pricing of disposal. We show that widespread application of a \$1.00 per 32-gallon bag charge for trash disposal has the potential to achieve non-trivial reductions in solid waste. We conclude that a UCTS policy coupled with increasing use of UBP could lead to cost-effective reductions in waste disposal in the US and promote the goals of Extended Product Responsibility in a cost-effective manner.

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