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The Product Stewardship Movement

Understanding Costs, Effectiveness, and The Role for Policy

Karen Palmer and Margaret Walls

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Telephone: (202) 328-5000 · Fax: (202) 939-3460
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Executive Summary

In many European countries and in Japan, an increasing number of products are subject to "take-back" laws, under which producers must ensure that products and packaging are collected from consumers and recycled at the end of their useful lives. This "extended producer responsibility" (EPR) movement seeks to reduce waste disposal, relieve the burden on municipalities handling a growing volume of waste, and spur "design for environment" on the part of manufacturers. In the United States, policymakers have thus far pursued a more voluntary effort that applies up and down the product chain, under the rubric *product stewardship*.

In this study, we survey both kinds of programs and assess the economic rationale for policy intervention in waste and recycling markets. We reiterate the economic arguments for incentive-based policies. And we evaluate voluntary programs to see whether they have the potential to achieve environmental objectives.

Efforts in Europe and Japan

In 1991, the German government's Packaging Ordinance began requiring manufacturers and distributors to take back packaging from consumers and ensure that a specified percentage of it was recycled. Manufacturers and distributors could meet their obligations by joining a "producer responsibility organization" which, in turn, would ensure that obligations were met. Many other countries followed Germany's lead, and in 1994, the European Union (EU) adopted the Packaging Directive for member countries.

The product take-back idea eventually evolved into a broader concept, extended producer responsibility, in which a producer's physical and/or financial responsibility for a product extends to the postconsumer phase of the product's life-cycle. EPR has taken hold in both Europe and Japan, and EPR laws now cover consumer batteries, electrical and electronic equipment, and end-of-life vehicles. In September 2000, the European Union adopted the Directive on End-of-Life Vehicles and is expected to adopt the Directive on Waste Electrical and Electronic Equipment in spring 2003.

North American Initiatives

In the United States, there has been resistance to the EPR approach. U.S. businesses oppose the focus on *producer* responsibility, and policymakers recognize the difficulty of replacing or duplicating this country's decentralized solid waste collection and recycling system.

Nonetheless, the U.S. Environmental Protection Agency (EPA), some state governments, and environmental groups support the EPR concept, which has evolved into a derivative known variously as extended product responsibility, shared product responsibility, and product stewardship. These concepts share some features that distinguish them from EPR: first, they assign responsibility up and down the product chain rather than solely to producers and second, though they focus on postconsumer waste, they attempt to also address environmental effects throughout the product life-cycle. Product stewardship in the United States has been, for the most part, voluntary.

Firm-level initiatives include Nike's Reuse-a-Shoe program, several programs to recycle computers (IBM, Hewlett Packard and Compaq, Gateway, and Dell all have programs), and broader electronics recycling initiatives run by Sony, Panasonic, and Sharp. Retailers also have partici-

pated; for example, Best Buy, a national chain of retail stores specializing in electronic products, has operated a series of collection and recycling events.

In some industries, firms have joined together to coordinate their product stewardship efforts. In 1994, the manufacturers of rechargeable batteries and products that use those batteries established an industry-wide recycling program. In August 2002, Panasonic, Sharp, and Sony announced a temporary joint program, in collaboration with electronics recycler Nxtcycle, to begin recycling their companies' products in several locations. And in Canada, the oil industry in the western provinces of Alberta, Saskatchewan, and Manitoba runs a program to encourage the recycling of used motor oil, oil containers, and oil filters

Multistakeholder initiatives have been undertaken by industry with government and nongovernmental organizations. The carpet industry, for example, has signed an agreement with state representatives, EPA, nongovernmental organizations, carpet retailers, and materials suppliers to meet reuse and recycling goals. A similar multistakeholder effort is underway for electronic products.

Some U.S. states and Canadian provinces have legislated programs that promote greater participation by manufacturers and retailers in ultimate product disposal and recycling. These programs cover lead acid batteries, tires, motor oil, paints, pesticides, and pharmaceuticals. Bills that target electronic waste have been introduced in some states, and an "e-waste" bill was introduced in the U.S. Congress in July 2002. These programs all have features that are consistent with the product stewardship concept — namely, they make producers responsible, in some way, for products at the end of the products' useful lives.

Evaluation

Our assessment of product stewardship programs is rooted in the principles of economics and considers whether these programs are structured to achieve real environmental progress at the least cost to society. We ask three key questions that relate to the cost-effectiveness of the programs:

- Does the policy or program provide the proper incentives to all market participants — consumers, producers, recyclers, retailers, and waste handlers?
- Is the policy or program flexible enough that participants can respond in different ways, or does it mandate identical behavior?
- How difficult and costly is the system to enforce?

Performance of Voluntary Programs

Firm-level voluntary programs are not likely to achieve a socially desirable level of waste reduction and recycling for the same reasons that laissez-faire private markets don't achieve the socially desirable level of waste reduction and recycling: the firms bear the costs of their activities but don't capture all the benefits.

Industry-level initiatives face similar problems. A firm may choose not to participate and "free-ride" on the efforts of others. And for firms that do sign on, the absence of a penalty for noncompliance makes it easy to drop out. Cooperative agreements among industry participants can also provide opportunities for participants to collude along dimensions other than environmental concerns. And they may be a way of erecting entry barriers to the industry. Such anti-competitive behavior can lead to higher product prices and other problems for consumers.

Multistakeholder agreements in which government representatives participate may be more likely to have environmental targets that are closer to the efficient level, but a problem remains—it is still easy for firms to drop out.

Voluntary programs can have positive effects, however. They can lead to some environmental improvements, relative to no regulation. In addition, firms may learn about the costs and feasibility of certain approaches to collecting and recycling end-of-life products. This can lower the costs of product stewardship programs and policies in the future.

All in all, however, voluntary product stewardship initiatives, as they currently exist, fall short. At best, they are either short-run, stopgap measures that provide information for future policy choices or they are complements to more formal government policy instruments. If they are to do more, they need to overcome the problem that firms can easily opt out of the agreements at any time. Moreover, current voluntary programs do not provide incentives for consumers to do their part. For any product stewardship program to be cost-effective, it needs to provide incentives—either directly or indirectly—for consumers to return products for recycling. And for products where product design is a key determinant of the cost of recycling, it is essential that incentives are provided for design for environment (DfE). Thus, the crucial factor in any product stewardship program, regulatory or voluntary, is the nature and extent of the incentives it provides—incentives for consumers to recycle, for firms to design for the environment, and for firms to comply.

Incentive-Based Policies

Economists generally advocate economic incentives to reduce environmental externalities—side effects from production or consumption that are not accounted for in market transactions. Unlike command-and-control approaches to environmental problems—such as design and performance standards and outright bans on polluting activities—incentive-based approaches allow market participants to respond to incentives in different ways rather than forcing all to do the same thing. This flexibility leads to cost savings. Incentive mechanisms also motivate firms to develop cheaper, more effective ways to reduce waste or emissions.

The classic incentive-based instrument is a tax levied per unit of emissions or waste and paid by all polluters. The tax provides firms the flexibility either to reduce pollution to avoid the tax or to continue to pollute but pay a price for doing so.

A tax on waste disposal, however, could lead to illegal dumping. An alternative policy is a product tax coupled with a recycling subsidy—that is, a deposit refund, like a "bottle bill." 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 it for recycling. The combination of product tax and recycling subsidy gives firms the incentive both to produce less output and to substitute recycled inputs for virgin inputs in production, and it gives consumers the incentive to consume less and recycle more.

An approach with similar effects but probably lower administrative costs is an upstream combined tax-subsidy (UCTS). The UCTS combines a tax paid by producers with a subsidy granted to collectors of used products who subsequently sell the goods for reprocessing. Although the tax and subsidy bypass consumers, consumers feel the effect through higher product prices and can be expected to adjust their purchasing behavior accordingly. Moreover, recyclers receiving the subsidy would be expected to provide inducements to consumers to return products for re-

cycling. In at least one UCTS in operation—Western Canada's used motor oil program —such activities have taken place.

Research has also shown that a UCTS combined with a small disposal tax would encourage DfE and lead to cost-effective reductions in waste. And simulation research has shown that the UCTS is more cost-effective than either a fee on product sales alone or a recycling subsidy alone. Existing UCTS programs have been successful in raising recycling rates and reducing waste disposal of particular products.

Another instrument with potential to spur DfE is a tradable recycling credit system, similar to tradable emissions permits, a highly successful component of the Clean Air Act. Its virtue lies in its flexibility: firms whose products are difficult to recycle may choose to purchase credits, whereas firms whose products are recycled easily will sell credits. Because selling credits earns firms money, the scheme should encourage firms to design products to be more recyclable and to provide incentives for consumers to return used goods.

Any system, such as a tradable credit system, with strong incentives for DfE, however, could be costly to implement because of the need to track individual firms' products through the system. In our opinion, there is no way around this problem. Policymakers will have to consider the trade-offs: simplicity and flexibility coupled with minimal incentives for DfE versus complexity and high administrative and monitoring costs combined with sharp DfE incentives.

Summary

Mandatory take-back programs that exist in Europe and elsewhere are not feasible in the United States and are likely to be very costly because they lack flexibility. Voluntary stewardship programs are very flexible, but, on the other hand, they are likely to fall short of achieving substantial environmental improvements for at least two reasons. First, firms bear the costs, but they don't reap the benefits of any environmental improvements associated with their efforts, be they design changes or establishing new collection systems. Second, consumers don't have incentives to return products for recycling.

This doesn't mean that voluntary programs are necessarily bad. They can bring about some environmental improvements relative to no regulations at all and they can generate useful information about collection and recycling costs, product design, and so forth, which may be useful in complying with future regulations. However, without penalties for noncompliance, they are not a substitute for government policy instruments.

The key to successful product stewardship programs, regulatory or voluntary, is providing appropriate incentives to all participants—incentives for consumers and recyclers to recycle more, for consumers to reduce disposal, for firms to design for the environment, and for firms to comply with the policy or program. With these objectives in mind, we offer three rules of thumb for successful product stewardship programs. First, to have a substantial impact on recycling rates and waste diversion, a program must provide incentives for consumers to return their products for recycling. Second, the program must include penalties for noncompliance, to give firms an incentive to perform. And third, the program must provide firms with the flexibility to use low-cost compliance strategies without compromising overall environmental goals. Product stewardship programs that adhere to these recommendations have the potential to achieve desired environmental outcomes and do so at the least cost to society.

Introduction

In the United States and most other countries, managing solid waste has long been the domain of local government. Once consumer products reach the end of their useful lives, manufacturers and retailers play no role in collection and recycling or disposal of those used products. But in 1991, solid waste management changed when the German government began an international movement by passing the first so-called product take-back law. In an effort to relieve municipalities from the burden of rising waste management costs, the 1991 Packaging Ordinance requires manufacturers and distributors in Germany to take back packaging from consumers and ensure that a specified percentage of it is recycled. Manufacturers and distributors can meet their obligations by joining a "producer responsibility organization" that handles collection and arranges for recycling, thus bypassing the local system.

The product take-back idea has evolved in other countries into a broader initiative known as "extended producer responsibility" (EPR), a policy concept in which a producer's physical and/or financial responsibility for a product extends to the postconsumer phase of the product's life-cycle (OECD 2001). EPR policies include take-back mandates, as in Germany, but other types of instruments may also fall under the EPR umbrella (Palmer and Walls 1999).

EPR has taken hold in both Europe and Japan. A number of countries have passed laws and the European Union has passed directives covering a wide range of products. In the United States, however, there has been resistance to adopting wholesale the EPR approach. The singular focus on *producer* responsibility has been, not surprisingly, hotly contested by U.S. business interests. Furthermore, the idea of replacing or duplicating the decentralized solid waste collection and recycling system that exists in the United States with a centralized, mandatory system in which producers are responsible for collecting and recycling their products has been viewed as a draconian change from the status quo.

Nonetheless, the U.S. Environmental Protection Agency (EPA), some state governments, and several environmental groups support some of the ideas that lie behind the EPR concept. These ideas have evolved into a derivative of EPR known variously as extended product responsibility, shared product responsibility, and product stewardship. The American versions share two characteristics that differentiate them from extended *producer* responsibility: they assign responsibility up and down the product chain rather than solely to producers, and they address environmental effects throughout the product life-cycle rather than just at the post-consumer waste stage.

On its Web site, EPA gives the following definition of product stewardship:

Product stewardship is a product-centered approach to environmental protection. Also known as extended product responsibility, product stewardship calls on those in the product life cycle—manufacturers, retailers, users, and disposers—to share responsibility for reducing the environmental impacts of products.[2]

In the first section of this paper, we survey the wide range of EPR and product stewardship programs in Europe, Japan, and North America and assess the potential of these programs to cost-effectively reduce solid waste and promote recycling. As policymakers and other stakeholders grow more interested in EPR and product stewardship and consider its application to an expanding array of products and industries, it becomes increasingly important to understand existing programs and how well they are working. Our survey covers the legislated EPR programs in Europe and Japan as well as the voluntary product stewardship programs in the United States and Canada. Although information about these programs is available from other sources—namely various government documents and Web sites, newspaper articles, and a few academic studies—our survey is one of the broadest and most up-to-date in the literature. Our survey also includes a discussion of state legislative and regulatory initiatives that, while not often referred to as EPR or product stewardship, have the effect of increasing producers' responsibility for end-of-life products.

In the second section, we compare legislated EPR and voluntary product stewardship programs with other policies designed to reduce solid waste and promote recycling. Our evaluation is rooted in the principles of economics. As economists, we are concerned primarily with whether the policies and programs are structured to achieve the greatest good at the least cost to society or, at a minimum, to achieve some stated objective, such as a waste diversion or recycling target, at least cost. We do not have data from EPR programs—particularly data on costs—with which to perform a numerical benefit-cost analysis for every program. Moreover, as other authors (Tojo et al. 2001) have pointed out, one needs to be extremely careful comparing results across countries because of differences in how waste flows are defined and how costs and recycling rates are calculated. Instead, we look at the main features of the programs and evaluate whether they are likely to be cost-effective. We use as our guide the fundamental principles of environmental economics and results in the extensive economics literature on solid waste policy. Unlike previous studies, we focus on the economic incentive features of a range of programs and initiatives that expand the role for producers in dealing with end-of-life products.

We focus on three fundamental questions:

1. Does the program or policy provide appropriate incentives to all market participants—consumers, producers, recyclers, retailers, and waste handlers?
2. Is the program or policy flexible—that is, does it allow heterogeneous market participants to respond in different ways or does it mandate identical behavior by all involved?
3. How difficult and costly is the system to enforce?

Those basic questions pertain to the cost-effectiveness of any environmental policy, and they apply to EPR and product stewardship programs as well. In addition, we address two subsidiary questions in more detail: whether the programs can achieve "design for environment" (DfE) objectives—that is, whether they can encourage producers to redesign products so that they have less waste, contain fewer toxic materials, and are more recyclable—and whether voluntary programs can be successful. DfE should be a part of any cost-effective waste reduction strategy, and advancing DfE objectives has been a major justification for getting producers involved in managing postconsumer waste. Thus, we spend some time discussing this important aspect of EPR and product stewardship programs. Because voluntary programs seem to be a focus of current

U.S. environmental policy, we assess the motivations for firms' participation in voluntary initiatives and the potential for these programs to yield real environmental gains.

We begin the first section of the report with a largely descriptive survey of existing EPR and product stewardship programs and related legislative programs in some U.S. states that expand producers' responsibility for end-of-life products. The second section contains an evaluation of EPR and product stewardship. We present economic arguments for the use of policies to address waste disposal externalities. We argue the virtues of incentive-based policies and contrast them with command-and-control approaches. We then discuss voluntary approaches to environmental protection and their strengths and weaknesses, with applications to voluntary product stewardship efforts. Finally, we present our conclusions about the role for government policy in achieving the goals of EPR and product stewardship.

■ ■ ■

Section i

European countries—Germany in particular—have been the pioneers in the EPR movement. The movement began more than a decade ago with policies focused on packaging, and it has grown in several places to cover other products, including consumer electronics and vehicles. To capture the evolution and broad scope of the EPR movement as it has unfolded internationally, we begin with a fairly lengthy review of EPR policies in Europe and Japan. Experiences with early and more recently initiated programs abroad provide some important benchmarks against which to compare U.S. initiatives.

EPR Initiatives in Europe and Japan

The original motivation for EPR in Europe—particularly for the Packaging Ordinance in Germany—was to relieve municipalities' financial burden for waste management and to promote DfE. The thinking was that making producers take back and recycle their products would relieve municipalities from collecting and disposing of those products—and most importantly, incurring the cost of those activities—and also give producers an incentive to reduce packaging and to design packaging to be more recyclable. In this section of our paper, we describe several EPR programs in Europe and Japan. In Section II, we return to this motivation for EPR and present our view of its merits.

The German Packaging Law

The German Ordinance on the Avoidance and Recovery of Packaging Waste, passed in 1991, requires manufacturers and distributors (i.e., retailers) to take back the packaging associated with the products they sell. The requirements were phased in over three stages. As of December 1991, manufacturers and distributors were required to take back all transport packaging, such as barrels, canisters, and pallets used during transport of goods from manufacturers to distributors. As of April 1992, all distributors had to take back secondary packaging at the point of sale, and as of January 1993, distributors had to take back sales packaging.

The ordinance sets recycling rate targets that vary across materials and currently range from 60% to 75% (Schmid 2001). Under the ordinance, there are several "responsible parties"—manufacturers of packaging, manufacturers of materials intended for use in packaging, fabricators and assemblers of packaging articles, commercial "fillers" (primarily owners of product brand names), distributors selling packaged goods, and distributors placing goods in packaging at the point of sale. These responsible parties may be released from their responsibility for take-back by joining a "producer responsibility organization," or PRO. In response to this PRO provision

in the law, industry designed the now well-known Green Dot system. A nonprofit firm, the Duales System Deutschland (DSD), licenses its logo, the Green Dot, to companies, then arranges for collection, transport, and recycling of all packaging marked with the logo. The licensing fees, which are usually paid by the filler, vary across materials and are assessed on product sales. The fees currently range from 0.076 euro/kilogram ($0.04/pound) for glass to 1.508 euro/kilogram ($0.69/pound) for plastics.[3] There are small additional fees based on volume.

DSD handles 92% of all packaging waste in Germany and since 1995 has allowed its Green Dot logo to be used in other countries. It does this through an organization it founded in 1995, the Packaging Recovery Organization Europe (PRO EUROPE), which grants the right to use the Green Dot trademark to national collection and recovery systems in other European countries. The Green Dot is now being used by about 70,000 licensees in 13 European countries and in Canada.

German policymakers and government officials seem convinced that their approach to waste management and recycling is the right one. According to most published reports, the amount of packaging and packaging waste has been greatly reduced since the law was passed. Schmid (2001) reports that 1.5 million fewer tons of packaging were on the market in 2000 than in 1991. Tojo et al. (2001) cite government and DSD reports saying that the recycling targets have been met or exceeded for all materials. Most studies also report some material substitution, away from plastics toward materials, such as glass, that have lower licensing fees. In an interesting comparison of a typical German city of 200,000 residents with a similarly sized city in Japan, Ueta and Koizumi (2001) found that although only 5%, by weight, of the household waste stream in the German city in 1998 consisted of plastics, that figure was more than twice as high in the Japanese city. Glass, on the other hand, made up more than 13% of the German city's household waste stream in 1998 but only 4.4% in the Japanese city.[4] In addition, there is reportedly more reuse of packaging in Germany, particularly transport packaging. Refillable beverage containers are also common.

There have been problems with the German system, however. One problem is free riders. There are two types of free riding: (1) packaging without a Green Dot—from producers who do not join the DSD and pay the licensing fee—often gets collected and recycled along with Green Dot packaging because consumers mix it together, and (2) licensees sometimes put the logo on packaging for which they have not paid fees, and nonlicensees—the producers who have not joined the DSD—have used the Green Dot logo. Jaeckel (1998) reports that 20% of the waste handled by the DSD is non-Green Dot packaging. A second problem with the system is the DSD's monopoly nature and concerns raised by some firms that it sets licensing fees in a monopolistic manner.

One crucial question about the system is its cost. It is difficult to know the full costs of the system and even more difficult to compare Germany's approach to managing packaging waste with that in other countries. In a 1997 study, the Organisation for Economic Co-operation and Development (OECD) estimated that the total costs for a ton of material in the DSD system—that is, a ton collected and recycled by the DSD that otherwise would have been disposed of in a landfill—was approximately 700 DM, or $404. For the DSD's material volume of 4.7 million tons in 1994, total costs equaled 3.3 billion DM in that year, or $2 billion. The DSD estimates that of the total costs, 80% goes to collection, transport, and sorting; of the remainder, 15% was plastic recycling subsidies. These costs do not include costs to regulators overseeing the pro-

gram, nor do they include costs of producers outside the DSD system who must still abide by the law. The OECD (1997) study states that 700 DM exceeds the costs of incineration in Germany and "approaches costs for handling a ton of hazardous waste."[5] DSD licensing fees have decreased in recent years and the costs of the program have decreased as well.

It is very difficult to compare costs across countries. To put the $400 per ton figure into some context, however, we cite a 1999 study by the Institute for Local Self-Reliance, funded by EPA, which analyzed 18 successful community recycling programs in the United States—programs that achieved high rates of waste diversion and recycling. Total costs of waste diversion, including both recycling and composting programs, ranged across the communities, but the highest cost was $161 per ton.[6]

Packaging EPR Programs in Other Countries

Several other European countries followed the German lead in the early 1990s, developing packaging EPR programs of their own. The Netherlands has a system that is slightly more voluntary than the German ordinance. So-called covenants, or negotiated agreements, are used extensively in environmental policy in the Netherlands. The Packaging Covenant lays out recycling, packaging reduction, hazardous materials reduction, and other goals; companies then voluntarily agree to specified goals that they have negotiated with government. Once they sign up, the companies are legally bound to the terms of the agreement. Responsibility for collection and transport of used packaging remains with the local authorities in the Netherlands, whereas in Germany, the DSD operates a separate waste collection system alongside municipalities. As in Germany, though, a producer responsibility organization ensures that recycling targets are met.

Austria's 1993 packaging law is very similar to the German system. Recycling targets are set, and a single PRO charges its members licensing fees determined by the weight of packaging. The United Kingdom has a different system.[7] Although its basic elements are similar to those of Germany and other countries—there are mandatory recycling rate targets that industry is required to meet, and manufacturers, packers, fillers, sellers, and other participants in the supply chain are responsible for meeting specified percentages of the total—implementation is carried out somewhat differently. Several packaging PROs, called compliance schemes, operate in the United Kingdom, and firms have the choice of joining a compliance scheme or taking individual responsibility for meeting their recycling obligations themselves. Whenever a pound of packaging material is recycled, a packaging waste recovery note is generated by recyclers. These notes can be bought and sold, and a firm or a compliance scheme can meet its recycling obligation by buying notes. Organized exchanges handle waste recovery note transactions.[8]

Tojo et al. (2001) report that other European countries with packaging EPR laws are Finland, France, Norway, Sweden, and Switzerland. The authors state that published reports in Germany, Austria, the Netherlands, and Sweden show almost universally high recycling rates for packaging in each of the countries.

In 1994, the European Union (EU) adopted the Packaging Directive, which sets out recycling targets for packaging but allows each member country to decide how to go about meeting the targets. At the end of 1999, the EU Commission submitted a review reporting the experiences with the Packaging Directive thus far. This report concluded that the recovery targets have already been achieved by all the member states to which the targets applied, four years

before the end of the implementation period. On the basis of this report, the commission is currently working on an amendment to the directive. Schnurer (2001) reports that EU working documents contain both a proposed increase in the recovery quotas as a whole and a proposed increase in the targets for individual packaging materials.

Like the European countries, Japan has adopted a legislated EPR approach. Packaging waste is viewed as a particular problem in Japan, where it makes up 60% of the total volume and 20% to 30% of the total weight of the municipal solid waste stream (Clean Japan Center 2001; Tanaka 1998). The Container and Packaging Recycling Law, passed in 1995, made manufacturers responsible for meeting phased-in recycling rate targets for glass and plastic polyethylene terephthalate (PET) bottles, followed by targets for paper and plastic containers and packaging.[9] For PET bottles, the rate is 50% by 2004; for glass containers it is 80% by 2005. The PET recycling rate goal is voluntary, but it is understood by all parties that a mandatory target will be imposed if the goal is not met.

TABLE 1.

JAPAN CONTAINER AND PACKAGE RECYCLING ASSOCIATION FEES IN 2002 (IN YEN/KG)*

Clear glass	3.6
Brown glass	7.8
Other colored glass	9.1
Paper	42.0
PET bottles	75.1
Other plastic	82.0

*In July 2002, $1 equaled approximately 116 yen.

Source: E-mail communication, Yasuo Tanabe, Ministry of Economy, Trade, and Industry, March 2002.

As in the Netherlands, local government in Japan maintains responsibility for collection of packaging waste. It incurs the cost of collection and also handles the packing and baling of materials before they are turned over to recyclers for processing. Industry is responsible for, and pays for, recycling. A PRO, the Japan Container and Package Recycling Association, assesses fees on producers based on packaging sales, enters into contracts with recyclers for recycling, and collects baled materials from local governments and transports them to recyclers. Table 1 shows the fees charged by the Container and Package Recycling Association in 2002. Japan has had some success with its packaging EPR program. Okazawa (2001) reports that a 35% recycling rate was achieved for PET bottles in 2000, up from virtually zero prior to passage of the law.

EPR Programs for Products Other Than Packaging

EPR moved beyond packaging in Europe and Japan in the 1990s to cover consumer batteries, electrical and electronic equipment, and end-of-life vehicles. Austria, Belgium, Germany, Japan, the Netherlands, and Switzerland all have mandated EPR programs for small consumer batteries; some programs cover a wide range of batteries while some cover only nickel-cadmium (Ni-Cd) batteries (Raymond 2001).

In September 2000, the European Union adopted the Directive on End-of-Life Vehicles, which incorporates the concept of EPR. Implemented in April 2002, the directive requires that all member states set up national take-back and recycling systems for end-of-life passenger and light commercial vehicles and that consumers be able to return vehicles for recycling without payment. The directive also states that by 2006, at least 85% of the average weight of an end-of-life vehicle must be recovered, and at least 80% reused or recycled. By 2015 these recovery targets are increased to 95% (recovery) and 85% (recycling).

Some European countries had already been moving ahead on EPR programs for vehicles. Indeed, one reason for the EU directive, as with many EU directives, was to harmonize laws, to some extent, across countries. Germany and the Netherlands established voluntary vehicle EPR programs in the mid-1990s. Germany approached the vehicle problem first with the 1992 pro-

posed Scrap Car Rule, which more or less replicated the approach that the German government had taken with packaging. The rule mandated that producers take back cars from their last owners "principally" free of charge and meet reuse or recycling goals, which varied by material and ranged from 20% for plastics to nearly 100% for steel. The auto industry responded to the draft rule by greatly increasing recycling in an effort to show the government that a voluntary approach could work. In March 1996, the government dropped the Scrap Car Rule in favor of the Voluntary Pledge Regarding the Environmentally Compatible Management of End-of-Life Vehicles. The German auto industry agreed to set up a national infrastructure of certified dismantlers; ensured that vehicles would be taken back free of charge; pledged to reduce the amount of automobile shredder residue sent to landfills (from the current 75% of the weight of a vehicle to a maximum of 15% by 2002 and 5% by 2015), allowing incineration with energy recovery as an option; and pledged to redesign vehicles with an eye toward recycling.

As it did for packaging, the Netherlands signed a negotiated agreement with industry for end-of-life vehicle take-back and recycling. The binding agreement was entered into by vehicle importers in the Netherlands in 1994 and establishes a government-imposed advance disposal fee to help fund recycling. Veerman (2001) reports that the fee is currently 40 euro (approximately $40) and is paid by consumers when they buy a new vehicle. It was originally paid by importers into a PRO-managed fund that was established by importers and other actors in the product chain in the Netherlands, the Auto Recycling Nederland. This fund manages the financing, take-back, and processing of end-of-life vehicles.

Japan is also close to implementing a vehicle recycling program. A bill currently before the Diet would require vehicle manufacturers to charge a fee on the sale of each new vehicle, as well as a fee at time of inspection for vehicles already on the road. The fee revenues would go into a fund managed by a new government entity and would be used to pay for recycling. Although manufacturers would set the fee themselves, it is estimated that the fee would be approximately 20,000 yen ($172). Automakers also would be required, under the law, to collect chlorofluorocarbons from onboard air conditioners, retrieve air bags and automobile shredder residue from scrap dealers, and ensure proper disposal of these items.[10]

Waste electrical and electronic equipment (WEEE) has received a great deal of attention in recent years, with several countries passing EPR laws addressing these products. The Netherlands has two systems for WEEE: household appliances, televisions, and stereos (so-called white and brown goods) are handled in one way, but computers, printers, fax machines, copiers, telephones, and other information technology (IT) equipment are handled in another.[11]

Fees ranging from zero on small products to $15 for refrigerators and some TVs are charged at the point of sale; those fees are collected and managed by the Dutch PRO, which arranges for transportation and recycling of the products. As with packaging, municipalities handle most of the collection; however, retailers are required to take back an old product when selling a new one.[12] Recovery and reuse targets were negotiated with industry and vary across products, ranging from a high of 75% for refrigerators down to 45% for small appliances (Ministry of Housing, Spatial Planning and the Environment 1998). All the items are banned from landfills and incinerators. The EPR law covering white and brown goods in the Netherlands has been in effect since June 1998.

The main difference between the white-and-brown goods program and the IT program in the Netherlands is the way funds are raised by the PRO to pay for recycling. White and brown

goods are assessed a fee up front, but the costs of recycling IT equipment is covered by payments made in arrears by manufacturers and importers *after* the products have been processed. This means that processors separate products by brand name and assess fees on individual producers based on the cost of recycling each producer's products. As far as we know, this is the only EPR program that works in this way.

According to the Environmental Resources Management (1999), Denmark, Sweden, Austria, Belgium, and Italy have already passed EPR laws on WEEE, and Finland and Germany are expected to do so. Switzerland has a program as well, as does Norway, which is not a member of the European Union. The products covered in these programs vary slightly across countries, and the systems work somewhat differently as well. However, in all these countries a PRO collects fees up front, when products are sold, and uses them to pay for recycling. Local government is involved in collection in all of the countries, but the mandatory "old for new" retail trade-in provision in the Netherlands also exists in Sweden and Switzerland. Italy, Norway, and Belgium have mandated recycling rate targets; Switzerland and Sweden have set no specific numerical requirements.[13]

In contrast to Europe and Japan, the approach to EPR and product stewardship in the United States has been, for the most part, purely voluntary.

In 2000, the European Union introduced its WEEE Directive; final approval of the directive is expected in Spring 2003. The directive mandates that member countries have systems for take-back and recycling of WEEE that allow consumers to exchange old products for new ones; allow holders of items collected from consumers to bring those items in for recycling free of charge; ensure that producers collect WEEE from sources other than private households (and be permitted to collect from households if they so desire); and reach a WEEE collection target of 4 kilograms per household per year by 31 December 2005. The directive also sets recycling rate targets for specific types of WEEE. These targets range from 50% to 75% and must be met by 31 December 2005.[14]

The Japanese passed the Household Electric Appliances Recycling Law in 1998. The law, which took effect in April 2001, covers air conditioners, refrigerators, washing machines, and TVs and sets recycling rate targets of 50% to 60% for these items. It requires retailers to collect and transport the appliances to transfer stations; municipalities may also collect and transport. Unlike the European systems, Japan's law requires consumers to pay end-of-life fees. These fees currently range from 500 to 2,500 yen for collection and from 2,400 to 4,600 yen for recycling; thus, the total fee for collection and recycling, in U.S. dollars, ranges from approximately $21 to $40. Once items are collected and transported to recycling facilities, producers are responsible for recycling. According to Tanabe (2001), the government decided upon end-of-life fees to encourage consumers to extend the lives of their products; in Japan, it is typical for consumers to buy new household appliances before the old ones have worn out. Tanabe (2002) reports some success in this regard: a September 2001 government survey found that compared with the prior year, the average useful life of some appliances had increased by about five months.

Recycling of computer equipment in Japan, covered by the Law for the Effective Utilization of Resources, is financed with front-end fees. Local governments apparently argued strongly for this type of system rather than the end-of-life fee system used for home appliances. Tanabe (2002) reports also that the government was interested in experimenting with different types of

systems. In 2002, the fee is 2,000 yen ($17) for a laptop computer and 5,000 yen ($43) for a desktop model. Collection of computers in Japan is handled by local governments as well as through producer take-back. Business computer recycling has begun; recycling of household computers is scheduled to begin in 2003.

Taiwan also has an EPR program for WEEE; in 1998 it passed a law that covers computers, household appliances, and air conditioners. Unlike the European programs, in Taiwan the national government is more involved in the financing of the system. It assesses fees on producers, which cover collection, transport, and recycling costs; it then distributes these fees to local governments, which collect the used items from households and transport them to recyclers.

Product Stewardship in North America

In contrast to Europe and Japan, the approach to EPR and product stewardship in the United States has been, for the most part, purely voluntary. Firms, acting individually and collectively, have initiated a host of programs to promote product recycling and, in some cases, design for environment (DfE).[15] These initiatives can be categorized into three types: firm-level programs, industry-wide programs, and multistakeholder efforts involving industry, government, environmental groups, and others.

Product stewardship in Canada has been a mix of voluntary programs, coordinated by industry and facilitated by government, and some legislated programs. There are also some legislated programs in the United States as well. These are all at the state level and cover mainly lead acid batteries, tires, and used motor oil and oil products. Bills have been introduced in some U.S. states in the past year that target electronic waste, particularly computer monitors. And an e-waste bill was introduced into the U.S. Congress in July 2002.

Below we describe several voluntary programs in each category and the government programs and proposed laws.

Voluntary Firm-Level Product Stewardship Initiatives

In the United States, a number of product stewardship programs have been developed at private firms.

Nike's Reuse-a-Shoe Program. In 1993 Nike began an athletic shoe recycling effort it calls Reuse-a-Shoe. Under this program Nike collects and grinds up defective and postconsumer athletic shoes to make a material, known as Nike Grind, which is then used to produce athletic surfaces for tennis and basketball courts, tracks, fields, and playgrounds. Nike gives the material to five sports surface manufacturers that have paid a licensing fee for using the Nike logo on the surfaces they produce. The revenues from the licensing fees are used by Nike to donate sports surfaces to nonprofit organizations and communities around the world.[16]

The Nike program recycles just over 2 million shoes per year.[17] Most of the shoes that are recycled are defective and cannot be sold in the marketplace.[18] The rest are used shoes that consumers have returned to one of 55 retail outlets in 16 states that accept shoes for recycling or to Reuse-a-Shoe collection events run by schools, community organizations, or community solid waste programs. Nike will accept any brand of athletic footwear as long as the shoes do not have metal cleats or other metal parts. There is no charge for the service.

The effectiveness of this program in reducing disposal of athletic shoes in the United States is difficult to evaluate. Nike sold roughly 80 million pairs of shoes in the United States in the fiscal year that ended in May 2001.[19] If all of the 2 million shoes recycled were postconsumer shoes, the program yielded a recycling rate of approximately 2.5% in fiscal 2000–01. If only half were postconsumer—and this is still probably an optimistic assumption—the recycling rate would be 1.25%.[20]

The low recycling rate is not surprising, given the spotty geographic coverage of the collection system and the lack of incentives for consumers to return their old shoes. Even consumers who live near a collection point are probably not aware of the program. There is also little incentive for consumers to go to the trouble of taking shoes in for recycling when disposal is easy and essentially free in most communities. Nike says that its program has led the company to redesign its shoes to be more recyclable. It has also undertaken a major initiative to reduce the use of toxic substances in Nike shoes, starting with the elimination of polyvinyl chlorides (PVCs) in most of its products as of January 2002.[21]

Nike's Reuse-a-Shoe program is unique within the footwear industry.

IBM's PC Recycling Service. On November 14, 2000, IBM started a recycling service for residential and small business computer users in the United States who are getting rid of a single PC (or a small number of PCs). The PC Recycling Service costs $29.99, and for that price the customer receives a box (26 by 26 by 26) for shipping the equipment, a prepaid shipping label (UPS) addressed to Envirocycle, the electronics recycler under contract to IBM, and packing instructions. The box will hold a 15-inch monitor, a printer, a computer, and a keyboard. IBM accepts computers made by any manufacturer.

On receipt, Envirocycle evaluates the equipment to determine whether it is suitable for donation to charity. IBM has an arrangement with Gifts in Kind International to provide PCs that are of reasonably recent vintage (currently, a Pentium I or higher) and in good working order for donation to nonprofit organizations throughout the world. If a computer is deemed suitable for donation, the customer who sent it in receives a receipt that can be used for income tax purposes.[22] Otherwise, the customer receives a receipt indicating that his or her PC has been recycled.

IBM promotes this service primarily on its Web page, where it may catch the eye of people who are shopping for new equipment or looking for a way to recycle their old PCs.[23] The $29.99 fee covers the cost of shipping the equipment and recycling it. IBM sells roughly 200 units of this service per month.[24]

Hewlett Packard and Compaq. Hewlett Packard also offers a computer hardware recycling service to residential and business computer owners through its Planet Partners Product Take-Back Program. Unlike IBM, HP does the recycling itself rather than contract with an independent recycler. Customers use a Web interface accessible at www.hp.com/go/recycle to sign up for the service, which includes pickup, transportation, and evaluation of their equipment.[25] Equipment from any manufacturer is accepted. Equipment that is deemed usable is donated to charity, and other equipment is recycled. Under HP's program, consumers do not receive a receipt regarding the fate of their equipment.

The price for the service varies with the equipment, as shown in Table 2. The fees range from $13 for a handheld device to $34 for a laser printer or piece of network equipment.[26] This price

includes pickup, transport, and assessment for donation or recycling of equipment not suitable for donation.

Before being acquired by Hewlett Packard, Compaq Computer did not have its own computer recycling program, but it did participate in the Electronic Take-Back Program, which is run by United Recycling Services of West Chicago, Illinois.[27] Under this program, which is similar to the IBM program in many ways, customers pay $27.99 to recycle used personal computer equipment. The price covers the cost of a prepaid UPS shipping label to United, assessment for reusability, and donation and recycling costs.[28] Customers also receive a certificate for a 6% to 9% discount on future purchases of selected Compaq equipment. This service is available only for residents of Illinois, Wisconsin, Indiana, Missouri, Minnesota, Michigan, and Iowa.

TABLE 2.

FEES FOR HP'S PLANET PARTNERS PRODUCT TAKE-BACK PROGRAM

EQUIPMENT	FEE
Handheld device (PDA, calculator)	$ 13
Ink printer	17
Scanner	21
PC (no CRTs) or laptop, with keyboard	21
Monitor, CRT, or flat-panel terminal	29
All-in-one (copier)	30
Laser printer or fax machine	34
Network equipment	34

Gateway Computers. Gateway offers incentives for purchasers of new Gateway computers to either donate or recycle their old computers.[29] Under this program, Gateway provides a credit of up to $50 for a computer that has been donated to a charity or sent for recycling. To get the credit, customers furnish a receipt indicating that the equipment was donated or recycled and provide information on how to contact the charity or recycler to verify what has taken place. The credit ranges from $25 for a monitor or CPU by itself to $50 for a complete system.

Dell Computer Corporation. Dell Computer Corporation offers a Web-based service for trading, recycling, or donating used PC equipment. Known as Dell Exchange, this service provides consumers with alternatives to disposal for used computer equipment, including a trade-up program, an on-line auction for used PCs, a recycling service and a donation program.[30]

Users of the trade-up service get a credit based on the value of the computer they are trading in toward the purchase of a new Dell computer. Any brand of computer is acceptable, although it must be of sufficiently recent vintage to have value on the secondary market.

The on-line auction is a forum where participants can post the specifications of their old computer equipment and offer it for sale to the highest bidder. This service is similar to E-bay and other more general on-line auction services, but it specializes in computer equipment.

Dell's computer donation program is a partnership with the National Cristina Foundation, an organization that donates computers to training and educational organizations that help disabled and economically disadvantaged individuals. The foundation collects information on the computer specifications, identifies a recipient for the equipment, and arranges shipment if the donor does not choose to do so.[31] Donors are given a receipt listing the market value of their equipment to use for tax purposes.

Dell also offers a recycling service that covers desktops including mice and keyboards, notebook computers, monitors, and printers. According to a corporate press release, this service allows consumers to send their used equipment to a designated recycling center, where it will be recycled for free.[32] After recycling has taken place, consumers will receive a verification notice.

Sony, Panasonic, and Sharp. These companies have similar programs designed to facilitate the recycling of electronic products. All three companies are most active in Minnesota—not

surprising, given that this state is at the forefront in developing and promoting product stewardship programs in the United States. (See below for a discussion of Minnesota's Plug into Recycling program.)

In October 2000, Sony began a five-year partnership with Waste Management to promote electronics recycling in Minnesota.[33] Under this partnership, Sony electronic products are accepted for free for recycling during certain hours (in particular, Saturday hours when waste transfer stations are not busy[34]) at several Waste Management facilities located throughout the southern part of the state. Electronic products made by other manufacturers are also accepted for recycling at the Waste Management facilities, but a fee is charged. In the first seven months of the program, almost 5,000 pounds of product had been recycled.[35] This represents about 1 pound of equipment for every 227 persons living in the counties of Minnesota where the Waste Management facilities are located.

Sony, Panasonic, and Sharp partnered with Asset Recovery Corporation (ARC) in a series of electronics collection events held in the St. Paul-Minneapolis area in April 2001 and again in fall 2001 (ARC 2001). Each of the three companies paid for transporting and recycling its own equipment returned for recycling; customers paid for the recycling of equipment from other manufacturers. The fees charged for other equipment at the first event ranged from $5 to $25, with console TVs, stereos, and copiers charged the highest fees.[36]

During those collection events, nearly 41 tons of electronic equipment were collected for recycling—roughly 1 pound for every 18 people in the St. Paul-Minneapolis metropolitan region. Analysis of items collected at the kickoff event showed that of the more than 6 tons of material collected, just over 30% had been manufactured by one of the three participating manufacturers.[37] At subsequent events, an average of 6% of collected equipment had been manufactured by one of the sponsors.

Panasonic and Sharp have also agreed to pay for the recycling of their equipment collected through the Hennepin County, Minnesota, electronics recycling program. Hennepin County has run a drop-off recycling program for electronic waste for many years; under the arrangement with Panasonic and Sharp, the county disassembles equipment and transports it to ARC, and the two companies pay ARC for recycling the components of their equipment.

Best Buy. Best Buy is a national chain of retail stores specializing in electronic products. In the summer and fall 2001, Best Buy sponsored ten electronics collection events at different locations in the United States.[38] All but two of these events were held at Best Buy retail stores, and some were cosponsored by manufacturers, including Toshiba America Inc. and Panasonic.

The list of items accepted at the events included computers, monitors, printers, fax machines, televisions, stereos, video cameras, cellular phones, and VCRs. Most of the items were accepted for free, but there was a $10 charge for monitors and a $15 charge for televisions.

For each event Best Buy had a contract with a recycler that was responsible for taking items from consumers and transporting the equipment in its own trucks to the recycling facility. The Rechargeable Battery Recycling Corporation (see below) attended several of the events to reclaim rechargeable batteries. A local charity also attended each event to select pieces of equipment—generally computers, printers, and scanners—that could be reused.[39]

Four events were held in Minnesota, the corporate home of Best Buy, two of which ranked highest of the ten events in participation and in total weight of equipment collected. The third

highest-ranked event was the one held in Framingham, Massachusetts. Higher than average participation in Massachusetts is not surprising, given that disposal of anything with a CRT—such as monitors and TVs—at municipal solid waste incinerators and landfills is prohibited in that state. The fourth highest participation rate was at an event in Skokie, Illinois, where residential consumers were not charged for dropping off monitors or TVs; instead, the cost of recycling these items was subsidized by the local solid waste agency. In total, across all events, 286 people participated, bringing in 25,724 pounds of equipment, or approximately 90 pounds per participant.[40]

In some industries, firms have joined together to mount coordinated voluntary product stewardship efforts.

Voluntary, Industry-Led Coordinated Initiatives

In some industries, rather than acting individually, firms have joined together to mount coordinated voluntary product stewardship efforts. We describe three such efforts.

Rechargeable Battery Recycling Corporation. In 1994 the manufacturers of rechargeable batteries and of products that use those batteries established the Rechargeable Battery Recycling Corporation (RBRC) to manage an industry-wide recycling program. This program was established because eight states had already passed laws requiring take-back of Ni-Cd batteries, and others were considering doing so (Fishbein 2001). To avoid having to comply with different laws in different states, the industry set up the RBRC, a nonprofit corporation, to operate the battery take-back and recycling program. Before 1996, the RBRC ran pilot collection programs in selected states, including Minnesota and New Jersey. In 1996, RBRC began a national program to collect rechargeable Ni-Cd batteries. The program spread to Canada in 1997, and in 2001 the RBRC added nickel metal hydride (Ni-MH), lithium ion (Li-ion), and small sealed lead batteries to its program.

The RBRC is funded through a system of licensing fees. The corporation licenses battery manufacturers to place its seal on the battery cells they produce indicating that the batteries can and should be recycled through the RBRC program at the end of their useful lives. The program charges participating manufacturers a licensing fee based on the weight of the battery cell and the cell type (Millard 2001). Thus, the RBRC operates very much like the DSD in Germany and its logo serves much the same purpose as the Green Dot. The RBRC estimates that more than 90% of the rechargeable Ni-Cd batteries sold in the United States are included in the program. More than 320 companies are paying to apply the RBRC seal to their batteries, but no seal is required to return a rechargeable battery to an RBRC collection site.

The RBRC currently has arrangements with nearly 39,000 collection sites in the United States. More than 90% are at retail stores; the other sites are operated by communities, other public agencies, or licensees themselves. All the collection boxes and bags and promotional materials are supplied and paid for by RBRC. Operators of collection sites ship the collected batteries to regional consolidation centers at no cost, and RBRC pays all recycling costs. The batteries are recycled under contract with Inmetco.

Battery returns and recycling have not grown in line with RBRC's expectations. In a 1998 report, RBRC projected that it would recycle more than 8 million pounds of Ni-Cd batteries in 2000 and that the rechargeable battery recycling rate for the United States and Canada would increase from 15%, its level in the mid-1990s, to 35% by 2000.[41] In fact, RBRC reports that it

collected approximately 2.4 million pounds of Ni-Cd batteries to be recycled in 2000 and just over 2.5 million pounds in 2001 (Millard 2002).[42] Collections of other types of rechargeable batteries, those recently added to the program, increased by a much larger percentage in 2001. RBRC collection of Ni-MH batteries increased from 53,400 pounds in 2000 to 207,535 pounds in 2001. Collections of Li-ion batteries grew by an even larger percentage, rising from 2,952 pounds in 2000 to 137,028 pounds in 2001. Although the RBRC program does not charge consumers for recycling, it also does not provide them with any direct incentive to return batteries for recycling.

RBRC does not report recycling rates and has not done so since 1998. RBRC executives point out that estimating how many RBRC-eligible batteries are purchased or disposed in a particular year requires sales data for a wide range of battery-powered products, information about battery lifetimes, and information about consumer hoarding of batteries, none of which is available (Millard 2002). Thus, the RBRC no longer attempts to estimate the size of the rechargeable battery waste stream. Nonetheless, if earlier forecasts of Ni-Cd battery disposal for 2000 and 2001 are assumed to be roughly correct,[43] and if 90% of all Ni-Cd batteries are in the RBRC program, then the recycling rate for RBRC-participating Ni-Cd batteries for 2000 and 2001 would be around 10%, below the 15% rate estimated for 1995. Adding the 1 million pounds of Ni-Cd batteries recycled outside the RBRC system (see footnote 42 above) and comparing the result with the total estimated weight of Ni-Cd battery disposal from Fishbein (2001) yields an estimated overall recycling rate of 12.5% for 2000.

The RBRC spent a total of $7.5 million in 2001; this includes nearly $4.0 million on recycling and $3.3 million on public education and marketing. In the same year, $8.5 million in licensing fees were collected, primarily from Ni-Cd battery marketers.[44]

Western Canada Used Oil Programs. The oil industry in the western Canadian provinces of Alberta, Saskatchewan, and Manitoba runs a program to encourage the recycling of used motor oil, oil containers, and oil filters.[45] In the late 1980s, the environmental problem caused by improper disposal of used oil drew attention in western Canada. At the request of the Canadian Council of Ministers of Environment, the oil industry set up a task force to address the problem. In 1993, the Western Canada Used Oil/Container/Filter Industry Task Force was formed to coordinate efforts to reduce disposal of used oil and to develop a consistent program across provinces. What resulted in Alberta, Saskatchewan, and Manitoba was an industry-run program in which sales and imports of motor oil, oil containers, and oil filters are subject to a fee, referred to as an environmental handling charge (EHC). Authorized collectors and transporters of used oil are paid a "return incentive" for every liter, container, and filter that is collected and transported to an authorized processing or rerefining center.[46] The program is run separately in each province. The Alberta Used Oil Management Association, a nonprofit organization, collects the fees and pays out the return incentives. Saskatchewan and Manitoba also have nonprofit associations. Laws passed in each province allow the private, nonprofit associations to set the EHCs and require businesses selling or importing oil and oil filters in each province to join the associations.[47] Alberta's and Saskatchewan's programs began in 1997, with Manitoba's following in April 1998. On average across all three provinces, 32% of all containers, 81% of filters, and 73% of used oil were recycled in 2001 (see www.usedoilrecycling.com). These rates are far higher than before the program began, when there was virtually no recycling of filters and containers, and

a low recycling rate for used oil. Saskatchewan, for example, which had a 79% recycling rate for used oil in 2001, reportedly had only a 30% rate prior to the program's implementation.[48]

An interesting result of the western Canada program is that even though the refunds are paid to authorized collectors and transporters, the generators of used oil, including do-it-yourself oil changers, farmers, and others, are benefiting, too. Collectors in Alberta have paid generators up to 37% of the return incentive for turning in their used oil and 35% of the return incentive for oil filters (McCormack 2000). This system thus provides incentives to downstream consumers even though the return incentive payment created by the system is paid only to authorized collectors.

Vehicle Recycling Partnership. In 1991, a bill was introduced in the U.S. House of Representatives that the auto industry considered a precursor to mandatory recycling. About the same time, legislation was being proposed in Germany and discussed in other European countries. In response to these perceived threats, the three major U.S. automakers, GM, Ford, and Chrysler, formed the Vehicle Recycling Partnership to improve recycling technologies and find ways to recycle the nonmetal components of a car. The group researches ways to improve the recycling process, especially for nonmetal components, and ways to promote use of recyclable and recycled materials in new car design. The Vehicle Recycling Development Center—a joint project between the three automakers and the Automotive Recyclers Association, the American Plastics Council, and the Institute for Scrap Recycling Industries—is examining different models of cars and developing a database to help dismantlers sort vehicle components for recycling.

Individual firms in some industries have collaborated with government, environmental groups, and other stakeholders to develop voluntary product stewardship programs.

For a while, Saturn and Ford had take-back and recycling programs for plastic bumpers. Ford entered into an agreement with a recycler to purchase plastic made from recycled bumpers; Saturn had its own take-back and recycling program. It is unclear whether these programs are still in operation.[49]

Electronics Recycling Shared Responsibility Program. In August 2002, Panasonic, Sharp, and Sony announced a temporary joint program, in collaboration with electronics recycler Nxtcycle, to begin recycling their companies' electronic products in several California locations. The program is an attempt to stave off passage of a state senate bill that would impose a fee on sales of new TVs and computer monitors to help finance California's recycling programs. The Electronics Recycling Shared Responsibility Program also plans to operate in Utah, Idaho, Washington, and New Jersey. Nxtcycle has processing facilities in Utah and in Mexicali, Mexico.

Voluntary Joint Efforts among Industry, Government, and Other Stakeholders

Recently, individual firms in some industries have collaborated with government, environmental groups, and other stakeholders to develop voluntary product stewardship programs.

Minnesota Electronics Recycling Initiative. In 1999, the Minnesota Office of Environmental Assistance initiated the first large-scale public-private effort to learn more about the costs and feasibility of electronics recycling (Hainault 2001b; Hainault et al. 2001). Sony, Panasonic, Waste

Management's Asset Recovery Group, and the American Plastics Council cosponsored this effort, called Plug into Recycling. The state agency selected local groups to run a variety of collection events, including single-event drop-offs, on-going drop-offs, collection at retail stores, and curbside collection (at one location only). All types of electrical and electronic equipment—essentially anything with a cord or a battery—were eligible for collection, and there was no charge to consumers for dropping off items. The program sponsors paid for transport and processing of recyclables and provided some financial support to communities for promoting the events.

The Minnesota project had five primary objectives: to explore the extent of economies of scale in collection and recycling, to evaluate high-end recycling of CRT glass and engineering plastics, to evaluate the costs of recycling materials, to increase privately funded electronics recycling, and to identify infrastructure needs and compare the costs of different approaches to collection. Roughly 9,000 people participated in the 64 events in summer and fall 1999, out of an estimated 1.3 million people served by the events. This implies a participation rate of less than 1%. A total of 575 tons of electronic equipment, just under 1 pound per person in the region served by the events, was collected. And the program was costly: the cost of collecting, transporting, processing, and marketing materials from the electronic equipment collected in the program averaged $448 per ton. Collection and transport together accounted for approximately 75% of this cost. The Minnesota program provides some of the best data on recycling electronics that is publicly available. In the appendix, we summarize more of the important findings from the project.

Carpet Stewardship Memorandum of Understanding. In 2000, representatives from Minnesota, Iowa, Wisconsin, EPA, nongovernmental organizations (NGOs), and the carpet industry joined with carpet retailers and materials suppliers to form the Midwestern Workgroup on Carpet Recycling. Members of this group signed a memorandum of understanding (MOU) in January 2001 that included two important provisions. The first was a commitment to create an independent organization, funded by industry, to be responsible for collecting and recycling discarded carpet.[50] The second was an agreement to continue meeting and develop a set of "negotiated outcomes" to serve as goals for reusing and recycling carpet for the next ten years.

After the initial agreement was signed, a newly constituted working group, the Negotiated Outcomes Group, began meeting in March 2001. This group included representatives from a larger set of state governments, the federal government, manufacturers of fiber and carpet, and environmental NGOs. It developed a list of goals for the disposition of postconsumer carpet by 2012 that include a reuse goal of 3% to 5%, a recycling goal of 20% to 25%, and caps on the use of waste carpet as fuel in cement kilns (maximum of 3%) and in waste-to-energy facilities (maximum of 1%).[51] The goals are enumerated in the Memorandum of Understanding on Carpet Stewardship, which took effect in January 2002.

The MOU also commits the carpet industry to establishing a third-party organization that is responsible for meeting those recycling and reuse goals. This group, the Carpet America Recovery Effort, will be responsible for enhancing the used carpet collection infrastructure and for assessing the industry's progress in achieving the goals set out in the MOU. The carpet industry is responsible for providing the funding required to meet the goals of the Negotiated Out-

comes Group. The MOU also establishes a timeline for evaluating progress toward meeting the MOU goals and for establishing new goals for future time periods.

National Electronics Product Stewardship Initiative. A multistakeholder effort similar to the recently completed carpet initiative is underway for electronic products. This effort, known as the National Electronics Product Stewardship Initiative (NEPSI), brings together representatives from more than 20 state governments, EPA, electronics manufacturers, retailers, recyclers, and nongovernmental organizations. The group seeks to develop a system to maximize collection, reuse, and recycling of used electronics and to provide incentives for environmentally friendly changes to product design, including source reduction, reduced use of toxics, increased use of recycled inputs, and making products that are easier to recycle. The group began meeting in July 2001 and hopes to reach an agreement on how best to achieve its goals by the end of 2002.[52] In March 2002, agreement was reached to study a front-end fee on new products to fund recycling. To date, no agreement has been reached on exactly what type of fee should be used and what its level should be.

Government Policies to Promote Product Stewardship

Although most of the product stewardship programs in the United States are voluntary efforts, there are some state laws and regulations that are designed to encourage greater involvement by producers or retailers (or both) in managing products at the end of their useful lives and, in particular, in assuming financial responsibility for recycling products. Similarly, in Canada, there are provincial laws that extend responsibility for end-of-life products to retailers and producers. State and provincial laws address disposal and recycling of tires, batteries, paint and paint products, and used motor oil.[53] Some of these laws or regulations speak directly to the role of producers and retailers; others are more indirect. Examples of some of these laws are discussed below, followed by a description of state and federal bills regarding electronic waste.

Tires. According to the Scrap Tire Management Council, 37 states ban disposal of whole tires in landfills, although more than 80% of these states allow landfill disposal of shredded tires. Thirty-four states impose advance disposal fees on new tire sales. The fees, which are collected and managed by the tire dealer, the tire wholesaler, or the state, range from $0.25 to $5 per tire.[54] The funds accumulated from these fees are generally used to finance a variety of waste tire management activities, including promoting recycling, promoting the use of tire-derived fuels, and funding the cleanup of existing scrap tire piles. Unlike other consumer products, initial tire collection is generally not difficult because most people are willing (even eager) to leave their old tires at the dealers when they purchase new ones. Where the system can fall apart is getting tire dealers to recycle or dispose of tires in a responsible manner. Funds collected by the dealers can help cover the costs of responsible management of the used tires that are returned to them. Across the country, recovery of scrap tires for use as fuel or new products, such as asphalt and flooring material, is growing. Of the 270 million used tires generated in 1998, 177.5 million (or almost 66%) were recovered. By 2000, scrap tire generation had grown to 273 million, and 196 million, or nearly 72%, were recycled or sold to fuel markets (Rubber Manufacturers Association 2001).

Eight Canadian provinces have tire product stewardship programs. In each province, a fee is charged on the purchase of a new tire. These fees range from $2 to $4 (Canadian), with a fee of $9 charged on truck tires in some provinces. Retailers collect the fee and turn it over to the provincial authority, and they are required to accept an old tire for each new tire purchased. In British Columbia, revenues collected in the program are used to pay for transportation of scrap tires to processors and as credits for purchase by end-users of materials or fuel made from scrap tires. In New Brunswick and Nova Scotia, the government itself contracts with a single private recycler and uses the fees to directly pay for tire recycling. In Manitoba and Québec, private recyclers are subsidized.

Lead acid batteries. Some form of legislation governing disposal and recycling of lead acid batteries has been adopted in 37 states. Many of these states have adopted a variation of the model battery recycling law developed by the Battery Council International. This law includes an explicit ban on disposal of lead acid batteries and a deposit on all battery sales not accompanied by a trade-in. Ten states have a battery deposit, usually between $5 and $10, that must be paid on each new lead acid battery that is purchased without a trade-in of a used battery.[55] In most states, part or all of this deposit will be refunded if a used battery is brought back to the store within 30 days of the purchase. Retailers are required to ensure that the used batteries that they take back are recycled. The recycling rate for lead acid batteries is close to 96%. The favorable economics of reclaiming lead from spent batteries undoubtedly contributes to this high rate, but the deposit refund programs also appear to help. Before such programs, the recycling rate was approximately 85%.

Used motor oil. In 1991, California passed the Oil Recycling Enhancement Act, which is administered by the California Integrated Waste Management Board. This act was designed to discourage illegal disposal of used oil. Under the act, oil manufacturers must pay a fee of $0.16 per gallon of lubricating oil sold in California to the Waste Management Board. The fee is then refunded in full on a per gallon basis to used oil collection programs certified by the state, including curbside programs and collection centers. These programs must collect used oil from the public at no charge and offer the $0.16 per gallon fee to consumers who bring in used oil to be recycled. The program has resulted in a 150% increase in the quantity of oil being recycled in the state over the seven-year period from 1993 to 2000 (CIWMB 2001). In 2000, 70.1 million gallons of lubricating oil were recycled, compared with a sales volume in that year of 149.2 million gallons.[56]

Some form of legislation governing disposal and recycling of lead acid batteries has been adopted in 37 states.

In addition to the industry-led used oil programs in Alberta, Manitoba, and Saskatchewan discussed above, there are government-legislated used oil programs in Nova Scotia, Prince Edward Island, and British Columbia. The British Columbia program has more of a command-and-control nature to it: retailers are required to act as return facilities and accept used oil from any consumer at no cost. They must also arrange for and pay to have a waste management company collect the used oil and transport it to a refinery. Enforcement has apparently been somewhat of a problem—some retailers are not accepting used oil—and there is some discussion about giving producers more of a role.

Paint products, pesticides, flammable liquids, and pharmaceuticals. As part of British Columbia's Waste Management Act, regulations passed in 1994 mandate industry-funded col-

lection systems for paints and paint containers (the Post-Consumer Paint Stewardship Program Regulation), and 1997 regulations mandate the same type of system for residual pesticides, flammable liquids, gasoline, and pharmaceuticals (the Post-Consumer Residual Stewardship Program Regulation). Before passage of the latter regulation, the pharmaceutical industry decided to run its own voluntary take-back program, called BC EnviRx, through participating pharmacies, which are required to take back, free of charge, any unused medicines from consumers. As of December 2000, there were 550 participating pharmacies, representing more than 75% of all pharmacies in British Columbia.[57]

In the product stewardship program for flammable liquids, pesticides, and paints, brand owners and importers pay fees to a producer responsibility organization called Product Care Association; the fees are assessed on product sales. The fees are passed on to consumers visibly on the products when they are sold and are known as eco-fees. The fees are intended to cover collection, transportation, and recycling and range from 1 cent (Canadian) to as much as $4, depending on the type of product and the size of the container. Paint eco-fees are in the 10¢ to $1 range. The fees cover the association's costs of managing the products; no incentives are provided to consumers to return products. However, consumers are not charged for product return, and there are currently 104 collection depots in the province.

Electronics. In July 2002, Representative Thompson from California introduced a bill in the U.S. Congress that would establish a grant and fee program to promote recycling of computers. The bill, H.R. 5158, proposes that a fee—to be determined by EPA but not more than $10—be charged on the sale of each new computer and computer monitor in the United States, as well as other computer equipment to be determined by EPA. The revenues, which would be managed by EPA, would be used to fund organizations collecting, processing, reusing, or reselling used computers, monitors, and other designated devices.

E-waste legislation has also been introduced at the state level. California, New York, North Carolina, Nebraska, Massachusetts, Minnesota, and Georgia have all introduced bills in the past one to two years to address a growing concern with end-of-life computers. A Massachusetts bill introduced in late 2001 (House bill 4716) would require any manufacturer selling a product with a cathode ray tube to provide a system for its take-back and recycling.[58] Several bills were introduced into both houses in California. In September 2002, California Senate bill 1523, which would have imposed a $10 fee on all computer monitors and televisions to fund recycling programs, was passed by both houses. Governor Gray Davis did not sign the bill but released a statement in support of the product stewardship concept and challenging industry to set up a voluntary program.

Summary of government programs. The policies reviewed above represent just a sample of the growing number of laws and regulations that states are adopting to limit disposal and promote recycling of different products. We highlight the above programs because most of them place some financial responsibility on producers by assessing up-front fees, and in some cases, they require retailers or other collectors of used products to guarantee that products are recycled.

One interesting feature shared by most of these programs is the inclusion of some type of financial incentive to promote collection and recycling. In the next section, we argue that such incentives are the key to successful programs. The discussion centers on the use of incentive-based policies and how they might be structured to encourage DfE and promote producer responsibility.

Section ii

In this section of the paper, we lay out the economic arguments for policy intervention in waste, recycling, and product markets and describe the relative merits of economic incentive-based (IB) approaches to environmental problems compared with so-called command-and-control approaches. We describe results in the economics literature on optimal policies and focus on the implications of various policies for design for environment. Finally, we evaluate voluntary product stewardship programs.

Incentive-Based Waste and Recycling Policies

Both legal and illegal disposal of solid waste can cause negative externalities—side effects from production or consumption that are not accounted for in private market transactions. Illegal dumping is unsightly and can pollute land and waterways. Legal disposal in a landfill or an incinerator can also lead to water or air pollution, smells, and unsightliness. Moreover, certain products may contain hazardous materials that cause further environmental problems. In addition to these direct externalities are indirect ones, such as the upstream life-cycle externalities associated with material extraction, production, and use. Some studies find that such ancillary effects actually outweigh the direct waste disposal externalities.[59] All of these externalities imply that, from a social welfare standpoint, purely private markets will lead to too much waste disposal, too much consumption and production of raw materials, and too little recycling.

Economists generally advocate the use of economic incentive-based, or market-based, instruments to internalize environmental externalities. Incentive-based (IB) instruments are characterized by the use of financial incentives provided to market participants to reduce an externality-generating activity. A clearer picture of an IB instrument arises when we offer the contrast of command-and-control (CAC) instruments. CAC approaches to environmental problems include design standards that require firms to use a particular control technology, performance standards that specify a maximum amount of pollution from each polluter (or pollution per unit of some input or output), or outright bans on the use of something (e.g., lead in gasoline). Obviously, command-and-control options provide incentives of a sort. They are necessarily accompanied by penalties for noncompliance, so polluters have an incentive to comply to avoid the penalty.[60] The main distinction between IB and CAC approaches lies in the former's flexibility and the potential cost savings that result from allowing heterogeneous firms to respond to the incentives in different ways rather than forcing them all to do the same thing. The IB instrument motivates firms to develop cheaper and more effective ways to reduce their waste or emissions.

The quintessential incentive-based instrument is the Pigovian tax. A Pigovian tax is levied per unit of emissions or waste, paid by each polluter on all units of its emissions or waste, and set at a rate equal to the marginal social costs of those emissions at the social optimum. The social optimum is the level of pollution or waste disposal where the extra benefit to society from eliminating another unit of the pollutant is exactly equal to the extra cost.

Although a Pigovian tax has many desirable properties, there may be circumstances in which it introduces problems. One potential problem with a tax on waste disposal is that it could lead to illegal dumping. An alternative IB policy that has many of the desirable features of a Pigovian tax without the possible attendant dumping problem is a product tax coupled with a recycling subsidy (e.g., Dinan 1993; Fullerton and Kinnaman 1996; Palmer and Walls 1997; Calcott and Walls 2000). This combination of policy instruments has the two features of a Pigovian tax that make it optimal: an output reduction effect and an input substitution effect.[61] In other words, the product tax and recycling subsidy give firms the incentive both to produce less output and to substitute recycled inputs for virgin inputs in production. Likewise, they give consumers the incentive to consume less and recycle more. If the tax and subsidy are weight-based, producers have the incentive to downsize products, and if the tax and subsidy vary by material, the policy encourages material substitution.

Product taxes and recycling subsidies give firms the incentive both to produce less output and to substitute recycled inputs for virgin inputs in production.

The product tax-recycling subsidy policy is sometimes 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. The lead acid battery programs described above work the same way as bottle bills.[62]

An approach with similar results for recycling and solid waste but probably lower administrative costs for many products is something we refer to as an upstream combined tax-subsidy (UCTS).[63] The difference between a UCTS and a traditional deposit refund lies mainly in where in a product's life-cycle the tax and subsidy are placed. In Palmer et al. (1997), the UCTS combines a tax (i.e., deposit) on produced intermediate goods—such as aluminum ingot, rolls of a specific grade of paper, and sheets of steel—with a subsidy (i.e., refund) granted to collectors of used beverage cans, old newspapers, and so forth who subsequently sell the goods for reprocessing. Although the tax and subsidy are not levied directly on consumers, consumers feel the effect through higher product prices, and if the tax is levied per pound, consumers can be expected to adjust their purchasing behavior and favor lighter-weight products. It is also possible that collectors or processors would pass some of the refund back to consumers for returning products.

The western Canada used oil program described above exemplifies a UCTS. The environmental handling charge on the sale of motor oil, containers, and filters is the upstream tax, and the return incentive, paid to collectors of used oil, is the subsidy. As we pointed out in our discussion of that program, collectors have passed on a portion of the return incentive to consumers who return their used oil and filters.

An important question about the UCTS, and the one most relevant to our discussion of product stewardship, is whether such a policy—or any IB policy—can provide incentives for DfE.

A strong impetus for producer take-back and EPR as it originated was to encourage producers to make design changes that would reduce the waste associated with their products.

Before we evaluate IB policies, however, it must be pointed out that in current take-back programs, the incentives for DfE are largely muted because of the way the programs are implemented. Individual producers do not recycle their own products at end-of-life, nor do they pay the cost of recycling their own products. Third-party organizations arrange collection and recycling of all member firms' products jointly; thus an individual firm has little incentive to redesign its products because the costs are borne by the firm itself while the benefits are reaped by everyone.

Calcott and Walls (2000, 2001) explore the DfE issue in a theoretical model that incorporates producer design choices that affect product recyclability. They find that if recycling markets work perfectly—that is, if recyclers pay consumers for used products and the prices they pay vary with the degree of product recyclability—then either a Pigovian tax on disposal or a UCTS can yield a first-best, efficient level of waste disposal, recycling, and design for environment. If, however, recycling markets do not work perfectly—more specifically, if it is too difficult and costly for recyclers to pay prices that vary with the degree of the products' recyclability—then a first-best outcome cannot be reached. Calcott and Walls argue that in reality, there is probably some "sand in the gears" of recycling markets preventing attainment of the first-best. It is costly to collect and transport recyclables, and it is difficult for recyclers to sort products according to their recyclability and pay consumers a price based on that degree of recyclability.[64]

A strong impetus for producer take-back and EPR was to encourage producers to make design changes that would reduce the waste associated with their products.

Calcott and Walls find that although transaction costs in recycling markets preclude achieving the social optimum, a constrained, second-best optimum can be reached. A UCTS combined with a disposal tax set at less than the Pigovian rate—that is, less than the full marginal social costs of disposal—will achieve the second-best outcome.[65]

In the Calcott and Walls models, the constrained optimum is the best outcome that can be achieved given the transaction costs in recycling markets. It is important to emphasize this point. If firms have a choice over the design of their products, in particular over the recyclability of their products, and recycling markets fail to work perfectly, then price signals are not transmitted from consumers and recyclers back upstream to producers. It is extremely difficult to design a *feasible* policy that overcomes this problem.[66] On the other hand, the Calcott and Walls results are encouraging: the second-best outcome is attainable with a simple set of policy instruments. And the second-best outcome is one in which there is less consumption, less waste, more recycling, and a higher degree of recyclability of products than in the free market.

Another policy instrument that deserves further study for its potential to spur DfE is a tradable recycling credit system. Tradable recycling credits are similar in spirit to tradable emissions permits (e.g., Tietenberg 1985). One important difference between the two approaches is that a tradable emissions permit system typically is associated with a cap on total emissions from all sources with trading allowed between sources, whereas a tradable recycling credit system imposes a minimum recycling level or rate on a particular industry and allows trading between responsible parties to reduce the cost of achieving that minimum level.[67]

A tradable recycling credit program for electronics, for example, might work as follows. Every manufacturer or importer would be required to meet a recycling rate target for its products. The target could be an overall weight target, such as 50% of the weight of the product must be recycled, or a set of specific targets by component material type. Producers could do the recycling themselves or they could pay a recycler to do it or—and this is the interesting twist on current policies in Europe and elsewhere—they could purchase credits from others who have recycled more than their own obligation. Recyclers would be required to keep track of what they recycled by brand. At the end of the year, producers would have to show that they had met the recycling target or hold enough credits purchased from others to comply with the target.[68] The virtue of a tradable credit system is the flexibility it has over a system in which each firm must recycle a certain percentage of its products. Firms whose products are particularly difficult to recycle may choose to purchase credits, whereas firms whose products are recycled more easily will sell credits. Because selling credits earns firms money, the scheme should encourage firms to design products to be more recyclable.

Of course, designing and implementing a tradable recycling credit scheme raises several issues and challenges. These include questions about how collection might work and the effect of different collection schemes on incentives for DfE, how to address hazardous components of products, and how to deal with long-lived products, such as electronics and vehicles.[69]

Another possibility worth exploring might be a combination of a UCTS with a system of financial rewards for the attainment of particular design objectives. This still means that the government or some third party would need to determine the design objectives—difficult but perhaps feasible for some products.

A tradable recycling credits scheme—and virtually any system with strong incentives for DfE—could be very costly to implement because of the need to track individual firms' products through the system.

Both a reward system and a tradable recycling credits scheme—and virtually any system with strong incentives for DfE—could be very costly to implement because of the need to track individual firms' products through the system. In our opinion, there is no way around this problem. Thus, there seem to be critical trade-offs that policymakers need to consider when deciding on policy options: simplicity and flexibility coupled with minimal incentives for DfE on the one hand, versus complexity and high administrative and monitoring costs combined with sharp DfE incentives on the other. More research is needed on the potential for IB policies with strong DfE incentives.

Given that policy dilemma and the current focus in the United States on voluntary environmental initiatives, we turn to an economic assessment of the voluntary programs. We have argued that one of the virtues of an incentive-based policy is that it allows for flexibility across firms. Voluntary programs also allow flexibility, and that is the main reason they are popular with industry. However, as we explain below, they are perhaps *too* flexible. In the next section, we compare voluntary programs with IB approaches and evaluate their potential for achieving environmental objectives in a cost-effective manner. Though far from ideal, voluntary programs do offer some advantages, particularly over a situation with no regulation, which we also discuss.

Evaluating Voluntary Environmental Programs

Although there has been no analysis by economists of voluntary product stewardship programs, a fairly substantial literature exists on voluntary environmental programs of other types, primarily those initiated by environmental regulators.[70] EPA has supported a number of such voluntary efforts and pollution prevention initiatives over the past decades.[71] WasteWise, for example, is an EPA program to reduce solid waste generation by participants and their customers; it is open to a wide range of organizations, including firms, schools, hospitals, nonprofits, and local governments. The Green Lights program, begun in 1991, had a goal of reducing greenhouse gas emissions from electricity generation by increasing the efficiency of lighting systems used by businesses; it was merged into EPA's Energy Star program. The 33/50 program, also launched in 1991, had a goal of reducing releases and transfers of 17 priority toxic chemicals tracked in the Toxics Release Inventory (TRI)[72] by 33% from 1988 levels by 1992 and by 50% by 1995. The firms that volunteered to participate in the program collectively met the goal of 50% reduction in 1994, a year earlier than scheduled (U.S. EPA 1999). Project XL is a program in which firms negotiate individual agreements with EPA to replace specific regulatory requirements; a firm's overall environmental performance has to improve for EPA to sign on. And finally, Section 1605(b) of the 1992 Energy Policy Act created a program, administered by the Department of Energy, in which firms can establish a public record of greenhouse gas emissions, emissions reduction, and/or sequestration; firms can also provide details of the changes they made to reduce emissions.

Virtually all of the environmental economics literature on voluntary programs focuses on such government-initiated programs. Voluntary product stewardship programs, however, are either purely private, such as the company and industry initiatives described above, or cooperative efforts involving multiple stakeholders, including government. This difference may limit the relevance somewhat of the insights from this literature for voluntary product stewardship programs.

Efficiency Aspects of Voluntary Programs

The degree to which voluntary product stewardship programs can effectively internalize environmental externalities, deal with other market failures, and achieve a socially desirable level of solid waste and recycling of products depends on the nature of the program. Firm-level voluntary programs are not likely to achieve the socially desirable level of the externality for the same reasons that laissez-faire private markets don't achieve the socially desirable level: the firms bear the costs but don't capture all the benefits. Firms also have little incentive to stick with a voluntary program because such programs can generally be discontinued with no penalty and are likely to be dropped when revenues dip and cutting costs becomes paramount.[73]

Industry-level initiatives face similar problems. A firm may choose not to participate in the initiative in the first place and free-ride on the efforts of others. And for firms that do sign on, the absence of a penalty for noncompliance makes it easy to drop out during difficult financial times or when the opportunity cost of participating becomes too high.

Cooperative agreements among industry participants could also lead to collusion and higher prices for consumers.[74] Parties to product stewardship agreements may have opportunities for frequent contact with others in the industry, and in some cases, agreements may lead to standardization of technologies, both of which can facilitate coordination of pricing strategies among

would-be competitors. And as with individual firm-level initiatives, there is no particular reason that a consortium is likely to choose the socially desirable level of waste reduction and recycling.

Multistakeholder agreements may have more going for them in this regard. Because government representatives are typically participants, the agreements are, arguably, more likely to have environmental targets that are closer to the efficient level.[75] Firms also may be less likely to drop out of multistakeholder agreements because the reputational costs of doing so are arguably higher when a larger group of stakeholders, including potential government regulators, sit at the table. To some extent, the potential for firms to drop out depends on the nature of the agreement. To date, most multistakeholder agreements, such as the carpet industry MOU, are essentially good-faith agreements; they are not legally binding. As a result, the incentives to comply are weaker than if the agreement were in the form of a contract. If, in the future, multistakeholder agreements are backed by federal legislation that requires all firms in the industry to participate, the dropout problem will be less of an issue. However, absent that legislative requirement, failure to comply is more likely to be a problem than with an incentive-based regulatory approach.

Other Features of Voluntary Programs

The shortcomings of voluntary product stewardship initiatives identified above are not meant to imply that those initiatives are necessarily bad. They may have positive effects:

- Potential environmental improvements (relative to no regulation);
- Cost reduction;
- Learning by doing;
- Greater investment in environmental technologies; and
- Preempting new regulations.

The potential for each of those effects is discussed below, drawing from the broader literature on environmental volunteerism. In some cases the motivations that lead to these outcomes can have offsetting negatives effects, which we also consider.

Potential environmental improvements. Even though voluntary initiatives are unlikely to produce the socially desirable level of an environmental externality, they may still lead to environmental improvements, particularly compared with an unregulated status quo. Unfortunately, the size of the effects attributable to the program versus what would have happened anyway is often difficult to discern. Harrison (1998) and others have argued, for example, that firms may have signed up in EPA's 33/50 program to make emissions reductions that they would have made in the absence of the program. Thus, attributing all of those emissions reductions to the voluntary program itself would be wrong.[76]

The fact that voluntary initiatives generally produce, at best, small environmental improvements suggests that in practice, voluntary programs may be complements to rather than substitutes for environmental regulation. EPA's 33/50 program is an example of this.

Cost reduction. In some cases, environmental initiatives have been credited with reducing costs.[77] In general, voluntary measures that reduce costs have a positive effect on social welfare

as long as the opportunity costs of those voluntary programs are small and the resulting cost reductions exceed those opportunity costs. However, Reinhardt (1999) points out that two conditions must hold for firms' environmental volunteerism to be cost reducing. First, there needs to be an obstacle that prevents firms from minimizing costs in the first place, such as a market imperfection, an information asymmetry, or a government intervention. Otherwise, if markets were perfectly competitive, firms would already need to be minimizing costs to stay in business. Second, the action that firms take under the voluntary initiative needs either to change the costs or benefits of some of the firm's activities or to change the information flow to managers and shareholders so that workers can be motivated to perform more efficiently.

In anticipation of future regulation or a future voluntary product stewardship agreement, firms may be operating their own programs to learn more about the costs and feasibility of certain approaches to collecting and recycling end-of-life products.

The evidence that improved environmental performance actually reduces costs is largely anecdotal, and the role of the various market imperfections suggested by Reinhardt in contributing to these results has not been analyzed empirically. Voluntary programs could reduce costs of environmental compliance when offered as an alternative to command-and-control programs. Project XL is an example of a voluntary program with this characteristic. However, one study by Boyd (1998) suggests that firms are rejecting some Project XL opportunities for reducing their emissions or use of hazardous substances—so-called pollution prevention initiatives—because after some study or small-scale experimentation, these efforts revealed themselves unlikely to be profitable.

In certain cases, cost reduction or direct profit enhancement may be an important motivator for firm-level product stewardship initiatives. For example, IBM currently leases about 35% of all hardware that it sells and is actively and profitably recycling equipment that is returned at the end of those leases (Bloomberg News 2002). In 2001, the recycling side of this business had a higher profit margin than the computer leasing side. Customers also receive a share of the money that IBM receives from recyclers, generally in the form of lower lease rates. This business-only program is profitable in part because of the large volumes of equipment that can be collected, which helps lower the per unit collection costs. In contrast, IBM's PC Recycling Service costs $29.99 per box of equipment shipped for recycling, and a substantial part of that fee covers the high costs of collecting used computers one at a time. It is unlikely that any of the firm-level product stewardship initiatives that we described in Section I are profitable.

Learning by doing. In anticipation of future regulation or a future voluntary product stewardship agreement among producers in their industry, firms may be operating their own programs to learn more about the costs and feasibility of certain approaches to collecting and recycling end-of-life products. This desire to learn is clearly part of the motivation for IBM's PC Recycling Service, Sony's and Panasonic's electronics recycling program with ARC, Best Buy's electronics recycling program, and the Electronics Recycling Shared Responsibility Program recently initiated in California by Panasonic, Sharp, and Sony. Although some firms have published information about the performance of their programs (e.g., Cloutier and Conroy 2002) many of these firm-level programs are producing information that is proprietary and, as such, will

primarily affect each firm's ability to respond to new programs or regulations. Participants in the California program, however, plan to share information. When describing that program to a reporter from *Greenwire*, David Thompson, general manager, Panasonic Corporate Environmental Division, said, "What we are trying to do is to work with other manufacturers and figure out what the challenges are." (Leavitt 2002).

Greater investment in environmental technology. One reason a firm might initiate a voluntary environmental program is to gain a competitive advantage in the marketplace.[78] For example, a firm may undertake a voluntary program to demonstrate that achieving a particular environmental objective or imposing a particular constraint is not costly and thereby raise the chances that what the firm did voluntarily will become mandatory for its competitors. DuPont pursued such a strategy in the case of chlorofluorocarbons (CFCs), a substance invented by DuPont that was shown to contribute to ozone depletion. Prior to any regulatory requirement to do so, DuPont announced that it had developed substitutes and would stop producing CFCs, thereby facilitating the worldwide ban on use of CFCs. Industry-wide voluntary programs may also be a way of raising the costs of all firms in the industry and thus reducing entry by new competitors or limiting the ability of smaller firms to compete. Reinhardt (1999) suggests that the chemical industry's Responsible Care initiative might be an example of such a program.[79]

The potential for gaining such competitive advantage has the positive effect of creating incentives for firms to develop environmentally friendly technologies. On the other hand, firms can use environmental initiatives to create barriers to entry.[80] Voluntary product stewardship initiatives do not appear, on the surface, to be driven by a desire to promote more stringent environmental regulation of firms as a barrier to entry. Nonetheless, an agreement could have this effect even without promoting regulation. For example, there is currently almost universal participation by U.S. carpet manufacturers and fiber suppliers in the carpet stewardship program. Under the MOU, carpet manufacturers and their suppliers are responsible for the financial support of the industry's producer responsibility organization, and of its collection and recycling efforts. Even though this is a voluntary agreement, there would be substantial pressure on any firm attempting to enter the U.S. carpet manufacturing business to join in this agreement and contribute financially to the effort. Moreover, a new entrant's access to the secondary fibers collected through this effort might be limited. The added costs of fulfilling the implicit MOU obligation and paying more for raw materials could be enough to make an entrant think twice about entering, to the benefit of all existing firms in the industry.[81]

One reason a firm might initiate a voluntary environmental program is to gain a competitive advantage in the marketplace.

Preempting new regulations. Preempting regulations is clearly a motivation for voluntary product stewardship initiatives. Having been affected by the spread of mandatory take-back regulations in Europe, consumer electronics firms and firms in other industries are eager to find an alternative to such costly regulations in the United States. Firms also do not want to see fundamentally different approaches to product regulation adopted in different states. The rechargeable battery industry provides an example. When RBRC was created, eight states had already passed laws requiring retailers and manufacturers of products that contain rechargeable batteries to take back those batteries for recycling or proper disposal, and many more states were con-

sidering following suit. Members of industry, envisioning a patchwork of regulations across different states, decided to establish the national voluntary RBRC program that focused exclusively on recycling. Similarly, participation in NEPSI by electronics producers is likely motivated, in large part, by a desire to prevent states from adopting take-back legislation—particularly legislation that varies by state. To some degree, such concerns may have motivated the carpet producers to participate in the carpet MOU.

Voluntary programs that seek to preempt future regulations have mixed welfare consequences. As Maxwell et al. (2000) point out, organizing a push for a new environmental regulation is costly to consumers. Firms can help deter these efforts—and avoid the transaction costs—by voluntarily advancing the environmental goals. Both groups could end up better off as a result and social welfare would be greater than in the case with regulation.[82] On the other hand, when legislators allow negotiated agreements between industry and regulators to preempt new laws, the outcome could include very weak agreements. Work by Segerson and Miceli (1998) suggests that if the regulators at the negotiating table are not motivated to maximize social welfare and have been delegated the authority to negotiate agreements that could substitute for legislation, these negotiated agreements could reduce welfare.

TABLE 3.

RECYCLING RATES FOR SELECTED PROGRAMS

Bottle bills in 10 U.S. states	62–95%
U.S. lead acid battery programs	96
California used oil program	72*
Western Canada used oil program	73**
U.S. tire programs	72

**This includes all used motor oil that is recycled; the state estimates that 35% of the used oil from do-it-yourselfers is recycled.*
***81% of filters and 32% of containers are recycled in the western Canada program.*

Sources: www.bottlebill.org/USA/states-all_deposit_systems_11–00.htm; www.batterycouncil.org/states.html; CIWMB (2001); www.usedoilrecycling.com; www.rma.org/scraptires/pdf/scraptire_leg.pdf. All Web sites accessed October 8, 2002.

In summary, voluntary product stewardship initiatives fall short of the achievements of economic incentive-based instruments. Although they may be relatively low cost and flexible, they are very unlikely to achieve the waste reduction and recycling outcomes of IB policies, such as the UCTS or tradable recycling credit scheme discussed above. On the other hand, voluntary approaches do have some things going for them and may be better than nothing at all (though opportunity costs need to be factored into any evaluation). The potential learning-by-doing effects and investment in environmental technologies that may be taking place could have future payoffs. The effects on competition and product pricing in the affected industries, however, deserve more empirical study.

Revisiting Incentives

The crucial factor in any product stewardship or EPR program, regulatory or voluntary, is the nature and extent of the incentives it provides. Incentives for consumers to recycle, for firms to downsize products and design for the environment, and for firms to comply with the basic elements of the program are all essential features of any successful program. It is not coincidental that programs such as the western Canada used oil program, the lead acid battery programs, California's used oil program, and the bottle bills in many U.S. states—all programs with strong incentives for the return of products—achieve some of the highest recycling rates. Table 3 shows recycling rates for some of these programs.

As we pointed out in Section I, the recycling rates for other types of programs—to the extent that the information is available—appear to lag far behind the numbers shown in Table 3. The rechargeable battery program in the United States is a good example. There is virtually no incentive for consumers to return batteries for recycling, and at the same time, disposing of batteries in the trash is easy and, in many places, free. Moreover, because firms are allowed to choose

whether to join the RBRC and pay its licensing fees, there is a free-rider problem as well: only licensed firms pay the fees but all rechargeable batteries returned to a collection site are recycled. The RBRC does not publish recycling rates, but our best guess is that the rate is somewhere between 10% and 12%.[83]

The Minnesota Plug into Recycling program is another example of a program that has had relatively minor impacts on waste and recycling volumes. Calculating recycling rates for long-lived products such as electronics is difficult, but the overall participation rate for the 64 events—the number of people who returned products for recycling divided by the number of people served by the events—was less than 1%. This is similar to results achieved in other electronics recycling programs, such as that sponsored by Best Buy, described above.[84] These programs have similar features: most returned items are accepted at no charge, with the exception of TVs and computer monitors, which usually involve a fee of $5 to $10. Consumers return products to designated collection sites, such as retail outlets or community drop-off recycling facilities, and only on selected days.

Information from the product stewardship programs that are run by individual firms, such as Nike's Reuse-a-Shoe program or the computer company programs, is very limited. In Section I, we made a rough calculation that the recycling rate achieved through the Nike program ranges from 1.25% to 2.5%. There is no publicly available information from the programs run by IBM, HP-Compaq, Dell, and others. The carpet industry's recent agreements on recovery and recycling targets will be a very interesting case to study, but it is too early for any results to be available.

A program that lacks incentives for consumers to return products is destined to be either a recycling failure or a very expensive "success."

Clearly, there are many differences among these products and the programs set up to recycle them, and there is more than one reason why a particular program achieves a high recycling rate while another does not. Moreover, we have not discussed the costs of the programs. The objective of any program or policy should be to achieve its goals in a cost-effective manner. Thus a program that achieves a high recycling rate but is very costly is not a program we should want to emulate. In theory, however, policies that combine up-front taxes with back-end recycling subsidies should be cost-effective. Palmer et al. (1997), in a simulation model of the costs of different policies for reducing municipal solid waste, found that an advance disposal fee (ADF) alone was 89% more costly at achieving a 10% reduction in waste than an ADF combined with a subsidy for recycling—that is, a UCTS. We feel strongly that a program that lacks incentives for consumers to return products is destined to be either a recycling failure or a very expensive "success."

The question, then, is whether voluntary programs can be structured to provide incentives for consumers to return products. The answer is yes. The western Canada program is, after all, administered by the oil industry. In each of the three provinces in which the program operates, a nonprofit industry association sets the fees on product sales, collects them, and pays out the return incentives for used oil. But legislation was passed that allows the nonprofit associations to set the fees and ensures that fees are collected on all sales. In other words, the free-rider problem that exists with the RBRC program is eliminated through legislation. Some industries in the United States have self-regulatory bodies, and further study of how a private system could work to facilitate voluntary product stewardship initiatives would be worthwhile.[85]

If we leave private industry to choose the goals for itself, there is no reason to believe it will choose the right goals.

Even a voluntary system with appropriate incentives for recycling that eliminated free riders and noncompliance problems through legislation or other means could still have an additional problem: the environmental outcomes may be less than those that are socially desirable. If we leave private industry to choose the goals for itself, there is no reason to believe it will choose the right goals. Negotiated agreements between industry and government could help overcome this problem, but the outcome depends on the relative bargaining powers of the two parties, the perceived threat of regulation, the goals of the regulators at the negotiating table, and several other factors.

Conclusions and The Role for Government

In this study, we reviewed extended producer responsibility programs in Europe and Japan and the voluntary product stewardship efforts in the United States and Canada. We then analyzed these programs from an economic standpoint, first describing the economic efficiency justification for policy intervention in waste, recycling, and product markets and then discussing the relative merits of incentive-based approaches, command-and-control instruments, and voluntary initiatives. We evaluated the voluntary product stewardship programs and made some suggestions for ways to improve them to achieve environmental goals more cost-effectively. Next we provide some rules of thumb that apply to any policies or programs, be they legislated or voluntary initiatives. And we say a bit more about design-for-environment issues and about voluntary programs.

Rules of Thumb for Success

First, to have a substantial impact on recycling rates and waste diversion, product stewardship programs or policies need to provide incentives for consumers to return their products for recycling. Incentives can take several forms, including banning disposal, establishing convenient collection sites, and providing refunds for returned items or allowing returns in lieu of deposits on replacement products. These are incentives that are explicitly targeted at consumers. Incentives for consumers could also filter down from producers and recyclers. For example, if recyclers or collectors of used products were subsidized, as they would be in our proposed upstream combined tax-subsidy (UCTS) system, the recyclers and collectors should have an incentive to increase the volume of materials they get from consumers and find innovative ways to do that. More study of this important practical issue is needed, including identification of bottlenecks in the system that could prevent recyclers from obtaining products from consumers.

Actually charging consumers for recycling services, as many of the computer company programs do, particularly when consumers have access to free legal disposal, is unlikely to increase recycling by much. Programs that merely make free collection available, like the RBRC program, may not be enough to overcome the hassle costs of getting products back to collection sites and the virtually zero cost of throwing the item in the trash. Offering free collection at drop-off sites is also unlikely to have much of an effect when those opportunities are not well publicized. And the cost of publicizing the programs can be high.

Second, product stewardship programs or policies need penalties for noncompliance to give firms an incentive to perform. Environmental programs backed by legislation or regulations generally do this: legislation has the force of law behind it, and regulations usually have the threat of penalties for noncompliance. Purely voluntary agreements have neither.

It is worth drawing out that comparison. IB approaches, like voluntary environmental programs, allow firms and consumers the flexibility of not "complying"—that is, not changing their behavior in response to the policy instrument (be it an emissions tax, disposal fee, UCTS, or tradable recycling credit scheme). However, there is a price for not complying. For example, taxes must be paid on all emissions, thus if firms continue to pollute, they pay a penalty for doing so. With purely voluntary programs, there is no penalty. For voluntary agreements to make significant inroads into environmental problems, this inherent drawback must be overcome.

Although penalties for noncompliance are critical, all firms should not necessarily be required to do the same thing, in either a legislated program or a voluntary agreement

Third, although penalties for noncompliance are critical, all firms should not necessarily be required to do the same thing, in either a legislated program or a voluntary agreement. Thus, our final rule of thumb is that firms be allowed flexibility under whatever approach is adopted. For example, an industry-wide recycling rate target should not be met by forcing each company to meet the target. Allowing flexibility across firms is the motivation for the tradable recycling credit system we suggested in Section II. Such a system could be legislated or it could be part of a voluntary system. If a tradable credit approach were adopted for carpet, for example, the carpet industry's producer responsibility organization could set up a system whereby each manufacturer would receive a recycling credit each time some unit—a ton, a cubic yard—of its carpet was recycled. Such a system would provide incentives for manufacturers to provide refunds for returned carpet and to find ways to make their carpet more recyclable. Flexibility across firms is a hallmark of incentive-based approaches to environmental protection.

In addition to those three rules of thumb, we offer some concluding thoughts about designing for the environment and about voluntary programs.

Design for Environment

We explained in Section II that providing incentives for DfE is very difficult and could be prohibitively costly. Requiring take-back and recycling of products by individual firms is likely to be expensive. But systems that collectively manage products through a third-party organization provide, at best, only minimal incentives for DfE. We believe it would be very difficult to design a policy that is flexible and inexpensive to implement that also provides efficient incentives for DfE. In our opinion, policymakers in the United States and elsewhere need to acknowledge the difficulty in designing such a policy and the trade-offs between flexibility and low cost on the one hand, and increased incentives for DfE on the other. We think it may be impossible to design a program that does it all.

It is important to understand, however, that the extent of the DfE concern varies by product type. Packaging and short-lived consumer products, for example, might be perfectly suited to a UCTS, which provides limited incentives for DfE. The tax and subsidy should be set per

pound and perhaps vary across materials. We could expect, as results, downsized products and packaging and some material substitution. Moreover, as Calcott and Walls (2001) explain, the policy would spur producers to make items somewhat more recyclable to reach the threshold at which recycling becomes profitable. So some DfE—and in the case of packaging, perhaps the most important type of DfE—is encouraged by the policy.

For products such as electronic equipment, consumer appliances, and automobiles, on the other hand, product redesign could be a critical part of reaching waste reduction goals in a cost-effective way. At the same time, though, DfE is more complex for these products. How electronic products, for example, should be redesigned to be more recyclable is not an easy thing for producers themselves to figure out, much less poorly informed government policymakers. Studying how a tradable credit system might work for these products could be a fruitful avenue for future research. Another possibility would be to institute a financial reward system for producers that improve their product designs. Such a system could operate in conjunction with a simpler UCTS or other incentive-based approach. How government policymakers or regulators would pick winners in such a system is an empirical question and one that would likely vary by product.[86]

Issues with Voluntary Programs

It looks as though voluntary initiatives in the United States are here to stay, at least in the near term. The question then is whether voluntary initiatives can achieve product stewardship goals and can be improved to better achieve those goals.

We believe that firm-run voluntary programs are unlikely to be very effective in achieving overall waste diversion and recycling goals. However, these programs do provide opportunities for firms to learn about the costs of collecting and recycling the products they make, and about bottlenecks in the collection and recycling system. Producers may also learn from working with recyclers about cost-saving changes that they can make in their product design. The potential for these types of lessons depends on the costs of recycling, the volume of material that firms are getting back from consumers, and whether the producer is indeed even interested in learning about recycling its products. It is essential, in our view, for policymakers to understand that these programs may be complements to, or important precursors of, policies and regulations, but they are not substitutes.

Voluntary efforts that involve collaboration among firms in an industry or collaboration among firms and other stakeholders, such as government and environmental groups, hold more promise. These arrangements could have a bigger impact on product disposal and recycling because a larger segment of the market is covered. Also, there is a greater possibility for realizing economies of scale in collection, transport, and processing of recyclables and thus reducing the costs of the program. For these voluntary programs to be effective, most firms in the industry must be participating to reduce free riding, and the programs need to have binding sanctions on firms for not achieving the recycling goals of the agreement, or conversely, strong incentives for firms to behave in a way that advances the recycling and product design goals.

A potential problem with joint collaborative efforts by industry, however, is that they might facilitate collusion among firms to raise prices and engage in other monopolistic behavior, either in product markets or in markets for secondary materials. Moreover, the agreement itself can

act as a serious barrier to entry into the industry. The potential magnitude of such problems is worthy of further study.

Summary

We believe that the key to success of either voluntary or mandatory product stewardship programs lies in the degree of incentives provided within the system. Incentives for consumers to return products and for recyclers and producers to collect those products are crucial. Incentives for firms to participate in the system are also important, as are incentives for firms to reduce product weight and size and, at least for some products, redesign their goods to be more recyclable. And finally, the system should provide incentives for recyclers to recycle more. Economic instruments such as the combined product tax-recycling subsidy scheme or a tradable recycling credit system could help create the right types of incentives for participants throughout the product life-cycle while offering the flexibility that helps minimize the cost to society of reducing waste. The current voluntary initiatives are unlikely to make significant contributions to this environmental problem. However, if incentives in those programs can be improved—incentives for firms to participate, incentives for consumers to return products, and incentives to design for the environment—they may hold some hope for the future.

■ ■ ■

Notes

1 Contact: walls@rff.org; palmer@rff.org. We deeply appreciate the support of the Economic and Social Research Institute of Japan and Resources for the Future, and helpful comments on an earlier draft from Julie Hewitt. Responsibility for errors and opinions rests with the authors.

2 See www.epa.gov/epr/about/index.html (accessed October 9, 2002).

3 For more information about the DSD and its fees, see www.gruener-punkt.de (accessed October 9, 2002).

4 This same study also reported that the German city generated approximately 15% less nonrecyclable waste per household than the Japanese city.

5 See OECD (1997), 36.

6 This community achieved a 40% waste diversion rate and 23% recycling rate (composting makes up the rest of the waste diversion). Other communities did better and had lower costs (see ILSR 1999). These are curbside recycling programs, which for the most part recycle packaging from consumer products; they also recycle newspapers, and costs usually cover yard waste collection and composting programs as well, something clearly not covered in the DSD system. On the other hand, the costs do not cover the costs of recycling upstream packaging, such as transport packaging, as in Germany. Thus the ILSR study costs cannot be strictly compared with the German system. They are simply presented as a rough benchmark.

7 See Salmons (2002) for a more extensive discussion of the U.K. system.

8 See www.t2e.co.uk (accessed October 9, 2002). We say more about the use of tradable recycling credits in general in Section II.

9 Steel and aluminum cans, paper packs, and cardboard are not subject to the law. However, Okazawa (2001) reports that manufacturers "voluntarily" recycle these materials.

10 There are no mandatory recycling rate targets in the bill. However, the Japan Automobile Manufacturers Association has set voluntary recycling rate goals for the industry. See www.jama.or.jp/eco/eco_car/en/en_1_11c.html (accessed October 9, 2002). One important issue in Japan is how to deal with exports of secondhand vehicles, which some estimates put at approximately 1 million per year. Tanabe (2002) reports that the government is considering refunding the front-end fee to consumers whose vehicles are exported.

11 Household appliances include small items such as coffee makers, toasters, irons, and the like, as well as dishwashers, washers, and dryers.

12 In the Netherlands, 90% of white and brown goods is handled through the municipal collection system and only 10% through retailer take-back.

13 We do not know, at this point, whether targets exist in Denmark or Austria.

14 The lower target holds for small appliances such as irons and toasters; for consumer equipment such as TVs, video recorders, and radios; and for electric tools and toys. The higher target applies to large household appliances such as washers, dryers, refrigerators, and microwaves.

15 Some of the European and Japanese programs have some voluntary aspects to them. For example, in the Netherlands, producers can choose not to enter into negotiated agreements with the government. There are, however, repercussions should they not. Moreover, the EU packaging and electrical equipment directives impose sanctions on countries that do not meet the recycling targets established in the directives. In Japan, many of the EPR programs have voluntary recycling rate targets, but it is generally understood that if the targets are not met, they will be followed by mandatory standards.

16 See discussion of Reuse-a-Shoe program at www.nikebiz.com/environ/reuse.shtml (accessed October 9, 2002).

17 Personal communication, Jim Goddard, Nike Corporation (2001).

18 Exactly how many of the 2 million shoes recycled each year are postconsumer and how many are defective shoes from manufacturing facilities is unclear. Nike officials cannot—or at any rate, do not—provide that information.

19 These numbers are estimated based on total revenues from shoe sales reported in the Nike's annual report on Form 10-K (August 2001). Total revenues from sales of footwear in the United States were $3,208 million; if the average wholesale price is approximately $40 per pair, then the total quantity of shoes sold in the United States is approximately 80 million pairs. All of the postconsumer shoes currently reprocessed by the Nike Reuse-a-Shoe program come from the United States.

20 Even this recycling rate is not strictly correct, since consumers can recycle shoes from any manufacturer, not just Nike, through the Reuse-a-Shoe program. In 2000 Nike's share of the U.S. shoe market was 39% (Business Wire 2000). See www.snowboardnetwork.com/sports/athletic_footwear_market_share.htm (accessed October 9, 2002).

21 For more about Nike's PVC-free pledge, see http://www.nike.com/nikebiz/news/pressrelease.jhtml?year=1998&month=08&letter=f (accessed November 7, 2002).

22 For more information on this program, see www.ibm.com/ibm/environment/ (accessed October 9, 2002).

23 For several years IBM has been recycling obsolete computer equipment that was leased to large business customers. Under this program, IBM has been able to reap some economies of scale in computer recycling and to realize some value from reclaiming parts and materials from old computers and finding new uses for them. In 2001, leases accounted for 35% of all hardware sales by IBM (Bloomberg News 2002).

24 Personal communication, Rhea Hale, IBM Corporation (2001).

25 Web site accessed October 9, 2002.

26 A box including a PC, a monitor, and a laser printer would cost $76, reflecting a discount applied to orders containing multiple pieces of equipment. For more information about pricing of shipments containing multiple pieces of equipment, see https://warp1.external.hp.com/recycle/hardware_id.asp.

27 See www.unitedrecyclingind.com/takeback/main.html (accessed October 9, 2002) for more information on this program.

28 With this service, customers are responsible for supplying the box.

29 This program is described at www.gateway.com/home/programs/recycle.shtml (accessed October 9, 2002).

30 For more information, see www.dell.com/html/us/segments/dhs/dell_exchange.htm (accessed October 9, 2002).

31 For more information on the donation program, see www.cristina.org/dsf/dell.ncf (accessed October 9, 2002).

32 This program was announced in a corporate press release that is available at www.dell.com/us/en/gen/corporate/press/pressoffice_us_2002–05–17-aus-000.htm (accessed October 9, 2002). The press release does not say who is responsible for the cost of shipping the computer, but presumably it is the consumer.

33 For more information, see Sony's press release at www.sel.sony.com/SEL/corpcomm/news/corporate/108.html (accessed August 10, 2001).

34 Hainault (2001).

35 See the Minnesota Office of Environmental Assistance Web site at www.moea.state.mn.us/plugin/sonyevents.cfm (accessed October 9, 2002).

36 Fees differed across the different collection events and in some locations were disaggregated across products (personal communication, Ryan Laber, September 2001).

37 ARC expects that this high percentage of equipment from participating partners was probably due to the much higher visibility of this particular event, in which the names of the partners were highly publicized. The role of the partner companies was less prominently promoted in the other events.

38 This program is managed for Best Buy by e4 Partners, a Minnesota consulting firm. For more information about the Best Buy program, see www.e4partners.com/homepage.htm (accessed October 9, 2002). An event scheduled to be held in Frederick, Maryland, in mid-September 2001 was postponed until spring.

39 The charities did not take any monitors except at the Chicago-area collection event (Conroy 2001).

40 See www.e4partners.com/homepage.htm (accessed October 8, 2002).

41 Fishbein (2001) presents a table that shows RBRC's 1998 projections of Ni-Cd battery recycling in the United States and Canada through 2005.

42 An estimated total of 3.5 million Ni-Cd batteries were collected in 2000; thus, approximately 30% are collected outside of the RBRC program.

43 This is a big assumption. The RBRC numbers from 1998 assume that total poundage of Ni-Cd batteries entering the waste stream increases at an average annual rate of 9.5% between 1995 and 2000 and then remains roughly flat. This assumption is likely overly ambitious, given the success of Ni-MH and Li-ion batteries in penetrating the market.

44 The RBRC has postponed collecting licensing fee revenue from producers of Li-ion, Ni-MH, and small sealed lead batteries until 2003.

45 The British Columbia program, which is not a voluntary industry program, is discussed below.

46 In 2000, the EHC for oil was $0.05/litre (Canadian). The return incentive varies by location. In Alberta in 2000, it ranged from $0.10/litre to $0.17/litre (McCormack 2000; www.usedoilrecycling.com, accessed October 8, 2002). The sales volume of motor oil is far greater than the volume of used oil, since approximately 35% is burned in normal operation of light-duty trucks and cars. This is why the return incentive can be greater than the EHC.

47 For this reason, it might be better to classify this program as not purely voluntary. We will come back to this point in Section II.

48 To figure recycling rates, a calculation is made of how much used oil is available for recycling or disposal; the amount sold is adjusted by the approximate amount burned during vehicle use.

49 Ford has several initiatives to use more recycled inputs in its cars and has purchased an automotive recycling facility in Tampa that it plans to expand. See www.ford.com/en/ourCompany/environmentalInitiatives/reduceReuseRecycle/fordPlansMajorEntryIntoVehicleRecycling.htm (accessed October 9, 2002) for more information.

50 Wilt and Hickle (2001), 5.

51 These caps are subject to modification if greater use of waste carpet in these two energy applications is deemed necessary to encourage collection of used carpet and if the environmental consequences of increased incineration of carpet are deemed acceptable.

52 See www.nepsi.org (accessed October 8, 2002).

53 Eleven U.S. states and eight Canadian provinces have beverage container deposit-refund systems—so-called bottle bills. Although there is a product stewardship aspect to these programs, they have been discussed extensively elsewhere; our focus here is on newer programs targeting other materials and products. For more information on the current status of bottle bill programs in the United States and Canada, see www.bottlebill.org (accessed October 9, 2002) and www.ec.gc.ca/epr/inventory/en/SearchResults.cfm?list=all&newQuery=1 (accessed October 9, 2002).

54 Details on the fees charged by states can be found at www.rma.org/scraptires/pdf/scraptire_leg.pdf (accessed October 9, 2002).

55 Information on state fees is found at www.batterycouncil.org/states.html (accessed October 9, 2002).

56 Allowing for the 35% loss of motor oil through normal operation of cars and light trucks, these numbers imply a recycling rate of approximately 72%. Some of this comes from mechanics and businesses; the state estimates that about 35% of the used oil from do-it-yourselfers is recycled, up from only about 10% before the introduction of the program.

57 See wlapwww.gov.bc.ca/epd/epdpa/ips/meds/meds2000.html (accessed October 9, 2002).

58 Massachusetts has a ban on CRTs in landfills. The state negotiates fees with two recyclers but local government pays all costs—collection, transport, and the recycling fees. (The state has offered grants to some communities.) (Massachusetts Department of Environmental Protection 2001).

59 We do not address this issue here. For more about life-cycle analysis, see Ackerman (1993), Hocking (1991), and Powell et al. (1996). In Walls and Palmer (2001), we examine the optimal choice of policy instruments when there are downstream waste disposal externalities as well as upstream production-related externalities.

60 The penalty could take the form of a monetary fine or it could mean shutting down operations until a problem is fixed.

61 For good discussions of the output and substitution effects, see Spulber (1985) and Fullerton (1997).

62 Bottle bill programs generally have fairly high administrative and transaction costs because bottles must be returned to a collection center, such as a supermarket; the supermarket then must sort the containers by brand, and brand distributors then pick up the sorted containers for recycling. The California beverage container recycling program uses a more limited network of parking lot redemption centers where consumers can return their containers for a refund. This system limits the costs imposed on beverage retailers. Lead acid batteries are not sorted by brand, and in many cases, returning batteries is not inconvenient because the consumer is having a new battery installed by a mechanic.

63 The UCTS described here is similar to the two-part instrument advocated by Fullerton and Wolverton (1999). They envision a combination tax on "dirty" production and a subsidy for recycling or "clean" production that can be imple-

mented upstream in the production process; this system avoids transaction costs.

64 Curbside collection programs are good examples: households simply toss a variety of items in the bin—PET bottles alongside aluminum cans—and are not paid individually (or at all) for these items.

65 Calcott and Walls also find an alternative policy instrument yields the constrained optimum: a UCTS in which the product tax takes on one of two rates depending on whether the product is recyclable enough to be accepted by processors—that is, processors do not incur a loss if they recycle it. The tax on products that do not reach that recyclability threshold is the standard Pigovian tax and thus can be viewed as an advance disposal fee. Products that meet the threshold receive a subsidy when they are recycled that is equal to the tax paid up front.

66 Calcott and Walls (2001) show that a tax and subsidy that vary with the degree of recyclability of products can yield the first-best social optimum, but it is difficult to conceive of a situation in which policymakers would have enough information to set these instruments and have the political wherewithal to set tax rates that vary across firms.

67 Another analogy would be a renewable energy portfolio standard, under which electricity producers are required either to produce a minimum portion of their electricity using renewable energy sources such as wind or solar or to hold credits showing that another generator has produced the requisite amount of renewable energy. For more information, see Clemmer et al. (1999)

68 This approach is different from the approach described in a report, *Tradable Certificates for Recycling of Waste Electrical and Electronic Equipment*, produced by Environmental Resources Management (1999) for the European Commission. Under that scheme, credits are awarded to the company that pays for the recycling of the electronics equipment and not to the company that originally produced or imported it. In such a system, recyclers would not keep track of exactly which firms' products they are recycling. The costs of such a scheme might be lower than the one we describe, but so are the incentives for DfE.

69 In the U.K. Packaging Waste Recovery Notes program, there is a tradable credit system for packaging. However, individual firms' packaging is not tracked through the system (indeed, tracking is likely to be impracticable for packaging). However, the credit prices vary by material and are weight-based, so there could be some incentives for material substitution and dematerialization. Other DfE incentives are likely to be minimal. Further study of the U.K. system could be useful for determining the pros and cons of that system and the extent to which its desirable features might be transferable to a tradable recycling credit system for electronics equipment or other products.

70 For a discussion of the different types of potential voluntary environmental agreements available to firms, see Harrison (1998).

71 To read more about these programs, see the references we cite below and the EPA Web site (www.epa.gov, accessed October 9, 2002).

72 The Toxics Release Inventory is the publicly available database in which manufacturing and other firms with more than ten employees report on-site releases and off-site transfers of more than 600 hazardous chemicals.

73 There may be some reputational effects associated with discontinuing a program, but they are likely to be small in most cases and probably temporary.

74 As Videras (2002) points out, collusion is more likely to be an issue when the voluntary agreements relate to limiting emissions, emissions are directly related to output, and emissions are required to be reported. Product stewardship initiatives promoting greater collection and recycling of end-of-life equipment do not speak directly to limiting inputs to production, as emissions limits usually do, and thus they may not affect production per se. As a result, they may be less effective as a

means of promoting collusion than the kinds of agreements studied by Videras.

75 The extent to which this is true depends on the motivations of the government representatives participating in these negotiations. Government regulators who are not interested in maximizing social welfare could be supportive of targets that are less stringent than the socially efficient level (Segerson and Miceli 1998).

76 Other regulations may also have contributed to the reductions in releases that are often credited to this program. Arora and Cason (1996) point out that two of the chemicals included in the 33/50 program were being phased out by other regulations that addressed ozone-depleting substances.

77 See Porter and van der Linde (1995) for a list of examples.

78 Firms may also initiate voluntary environmental programs in response to pressure from stockholders or to make their stock more appealing to environmentally minded shareholders or mutual funds and to provide material for increasingly visible corporate environmental annual reports. Voluntary environmental initiatives can also help firms attract environmentally conscious employees. Lyon and Maxwell (1999) discuss these motivations.

79 This program, developed by the American Chemistry Council, calls on member firms to comply with behavioral codes designed to reduce the probability of an accidental release and to improve relations with surrounding communities.

80 Another way firms seek to gain competitive advantage is by appealing to "green" consumers. The desire to appeal to environmentally conscious customers may be a factor in some initiatives, such as Nike's Reuse-a-Shoe program and several take-back or recycling services for used personal computers. Reinhardt (1999) points out that this strategy will work only if consumers are willing to pay for the environmental attribute in question, if credible information about this environmental attribute is available to consumers, and if there is some protection against imitators. In Nike's case, the firm appears to have distinguished itself among its competitors by being the only company currently offering a take-back program for shoes (even though collection sites are limited). In the case of personal computers, however, several programs are available from a variety of computer companies. This suggests that perhaps another motive may be operating here, since Reinhardt's condition of barriers to imitation does not appear to hold.

81 Wood, tile, and laminate flooring are substitutes for carpet and would act as a constraint on the extent of monopolistic pricing behavior that could be practiced by carpet manufacturers as a result of limiting entry into the industry.

82 This result depends on savings from avoided transaction costs. However, in the case of multi-stakeholder efforts where a diverse group of parties come together to negotiate the regulatory outcome, the savings may not be that great.

83 See Section I for more discussion.

84 The Northeast Recycling Council (2002) carried out a national survey of 500 residential electronics collection programs in the United States in 2001. It found that on average across all locations, 1% of households participate. In half of the programs surveyed, no fees were charged for collected items; in the other half, some fees were charged. In most cases, TVs and computer monitors were charged fees of around $5. In none of the programs were financial incentives provided for return of products.

85 One example of a self-regulating agency is the National Association of Securities Dealers (NASD). NASD is responsible for testing securities dealers, examining securities firms to ensure compliance with federal securities laws, and reviewing sales and advertising literature. The Maloney Act of 1938 gave legal authority to an industry-run regulatory board and the Securities and Exchange

Commission authorized NASD to fill that role in 1939. More study of such associations and how they could be used as models for industry product stewardship agreements would be useful.

86 Useful information on how to design such a program could be gleaned from existing EPA, nonfinancial, reward programs. For example, EPA's WasteWise program has a "Partner of the Year" award, as well as a "Challenge Partner of the Year" and "Endorser of the Year" award that it presents annually to either a business, government, or educational group that is deemed to have made the most progress in reducing wastes as well as costs (see www.epa.gov/wastewise/about/benefits.htm). Similarly, the new "Presidential Green Chemistry Challenge Awards Program" allows individuals, groups, and organizations to compete for "annual awards in recognition of innovations in cleaner, cheaper, smarter chemistry (see www.epa.gov/opptintr/greenchemistry/presgcc.html)."

■ ■ ■

Appendix: Minnesota's Plug into Recycling Program

The Minnesota Office of Environmental Assistance, with electronics companies Sony and Panasonic, Waste Management's Asset Recovery Group, and the American Plastics Council, ran a series of electronics collection and recycling events in 1999. This program, called Plug into Recycling, was extensively studied and is one of the few sources of publicly available data (see Hainault 2001b; Hainault et al. 2001). The main findings from the project follow.

- The participation rate for the collection events sponsored by the program was less than 1%: of the 1.3 million people estimated to be served by the events, 9,000 attended .
- Televisions and computer monitors accounted for 76% of the equipment collected. The remainder consisted of 7% household electronics, 12% consumer electronics, and 5% CPUs.
- Collection events at retail stores were the best attended.
- Packaging of items was found to be important to preventing breakage. Packaging also contributed nontrivially to the weight of the material delivered to the recycler. In addition to the 575 tons of electronic equipment was 125 tons of packing material (shrink wrap, pallets, and metal roll-off boxes). Most of this material could be reused, but its weight contributed to the costs of transporting the recyclables.
- The program was costly.

1. Collection costs were roughly $288 per ton of material collected and just under $18.60 per participant. Collection costs per participant were 35% below average at the retail store events because of the high level of participation at those events.

2. The net cost of transporting, processing, and marketing reusable and secondary materials was $160 per ton (cost net of revenues from sales of reusable or secondary materials). Nearly 40% of this cost was attributable to transportation from collection points to the recycling center.

- Together, collection and transport accounted for roughly 75% of the total net costs (collection, transport, and recycling) averaged across all types of equipment collected .

A recent EPA-sponsored study (see footnote 6) of recycling and municipal solid waste diversion costs in 18 U.S. communities found the highest waste diversion costs to be $161 per ton. Although these costs are provided only as a benchmark, they illustrate the high cost of current electronics recycling programs.

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