Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste

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INTRODUCTION

Over the past decade, solid waste disposal has emerged as one of the messiest environmental problems facing the United States. Landfill space is running out rapidly in many areas;[1] a few states have already

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reached capacity.[2] Moreover, many old landfills are leaking hazardous materials into groundwater.[3] Many communities, in part as a result of leaks, have effectively blocked the construction of new landfills.[4] With landfill capacity on the decline, many states have turned to incineration as a means of solving their solid waste problems.[5] Widespread use of incineration, however, may exacerbate conventional air pollution in already polluted areas, significantly increase emissions of hazardous air pollutants,[6] and produce another solid waste problem: disposal of hazardous incinerator ash.[7] As many lawmakers, regulatory officials, policy analysts, environmental activists, and most Americans have recognized, these developments add up to a solid waste disposal problem of crisis proportions in many parts of the country.[8] Yet despite the magnitude of this problem, Americans continue to generate and dispose of more solid waste (both per capita and total) than residents of any other country on Earth.[9]

A major cause of the solid waste crisis is that the costs of solid waste disposal are largely hidden from American consumers. For most Americans, the cost of throwing away an additional item of refuse has been (and in many places continues to be) zero. In these communities, residents need merely place their empty bottles and cans, lawn clippings, and

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TRASH: WHAT NEXT FOR MUNICIPAL SOLID WASTE? 3, 6, 271-74 (1989) [hereinafter OTA REPORT]; Glenn & Riggle, *Biocycle Survey: Where Does the Waste Go?*, BIOCYCLE, Apr. 1989, at 34, 37 [hereinafter *Biocycle Survey*].

2. *See Biocycle Survey, supra* note 1, at 37.

3. *See* OFFICE OF SOLID WASTE, ENVIRONMENTAL PROTECTION AGENCY, THE SOLID WASTE DILEMMA: AN AGENDA FOR ACTION, BACKGROUND DOCUMENT 2.E-18 (1988) [hereinafter EPA BACKGROUND DOCUMENT] (draft report of the Municipal Solid Waste Task Force). Municipal solid waste landfills constitute 22% of the Superfund National Priority List sites. *Id.*

4. *See* Brunner, *NIMBYists Put Society at Risk*, WASTE AGE, Mar. 1988, at 65.

5. As of 1988, there were 134 incineration facilities operating in the U.S., concentrated mostly on the Eastern Seaboard. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.D-3 to 2.D-6; *see also* Meade, *Connecticut Chooses Combustion*, WASTE AGE, June 1989, at 128 (describing Connecticut's plan to burn 75% of its refuse).

6. *See generally* C. BRUNNER, HAZARDOUS AIR EMISSIONS FROM INCINERATION (1985); INSTITUTE FOR LOCAL SELF-RELIANCE, AN ENVIRONMENTAL REVIEW OF INCINERATION TECHNOLOGIES (1986); Denison & Silbergeld, Comprehensive Management of Municipal Solid Waste Incineration: Understanding the Risks (unpublished manuscript, due to appear in MUNICIPAL WASTE INCINERATION RISK MANAGEMENT (Office of Risk Analysis, Oak Ridge National Laboratory, 1990) (to be published by CRC Press)).

7. *See infra* notes 59-60 and accompanying text.

8. *See, e.g., Municipal Solid Waste Disposal Crisis: Hearings Before the Subcomm. on Transportation and Hazardous Materials of the House Comm. on Energy and Commerce*, 101st Cong., 1st Sess. (1989); H. NEAL & J. SCHUBEL, SOLID WASTE MANAGEMENT AND THE ENVIRONMENT: THE MOUNTING GARBAGE AND TRASH CRISIS (1987); *Solid Waste: Public Concern About Garbage Disposal Tops Police, Fire, Affordable Housing, Poll Shows*, 19 Env't Rep. (BNA) 1247 (Oct. 28, 1988) [hereinafter *Public Concern*]; Church, *Garbage, Garbage, Everywhere*, TIME, Sept. 5, 1988, at 81.

9. *See* WORLD RESOURCES INSTITUTE, WORLD RESOURCES 1986, at 252 (1986) (summary of waste generation in 21 industrialized nations).

old newspapers in a trash chute or at the curbside. Such refuse "disappears" when the municipality (or its contractor) picks it up. Although the costs of refuse removal and disposal are significant, consumers typically bear these costs only indirectly, by way of a fixed disposal charge or an annual property tax assessment.[10] Given the largely hidden cost of solid waste disposal in the United States, it is not hard to understand why the "throwaway ethic" has thrived.[11]

The implications of the hidden cost of solid waste disposal go beyond consumer disposal choices. In a market economy, consumer preferences for products and packaging form the basis for product design decisions by manufacturers. Consumers who do not bear the incremental social cost of disposing of their refuse have no financial incentive to prefer reduced or more readily disposable packaging. In many cases, because disposal is free, consumers actually favor products with *more* packaging so as to reduce the risk of breakage or increase convenience. While reducing breakage and increasing convenience can be worthwhile product design objectives, so is reducing the environmental costs of resource recovery and disposal. Because the traditional incentive structure ignores the costs of disposal, however, manufacturers do not strive to reduce these environmental costs.

Government at all levels has been slow to respond to the solid waste crisis. Recently, however, many states and municipalities and, to a lesser degree, the federal government have begun to take action. In January 1988 the EPA set a national goal of twenty-five percent source reduction and recycling by 1992.[12] Many states have issued directives calling for similar reductions. Moreover, states and localities have adopted a variety of command-and-control strategies to limit waste and increase recycling. These include mandatory separation by households of one or a few categories of solid waste; prohibitions on the landfilling of specific items such as yard clippings; and bans on packaging and products, such as plastic food containers and disposable diapers. In addition, many states have enacted deposit-refund systems for beverage containers.

Although these policies respond to some of the symptoms of the solid waste crisis, they fail to systematically address the causes of the throwaway ethic. These policies do not remedy the distorted incentives that underlie consumer and manufacturer behavior. Indeed, in some cases, they exacerbate existing distortions. For example, a requirement

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10. *See* D. WILSON, WASTE MANAGEMENT: PLANNING, EVALUATION, TECHNOLOGIES 31 (1981).

11. The average American household discards 13,000 paper items, 1800 plastic items, 500 aluminum cans, and 500 glass bottles *per year*. Kovacs, *The Coming Era of Conservation and Industrial Utilization of Recyclable Materials,* 15 ECOLOGY L.Q. 537, 539 (1988) (citing Virag, *The All-Consuming Lifestyle,* Newsday, Dec. 13, 1987, at G11, col. 4).

12. EPA AGENDA, *supra* note 1, at 22.

that consumers separate glass containers encourages increased purchases of products packaged in other materials, which may have higher social disposal costs, in order to avoid the separation requirement. In other cases, ad hoc adjustment of an inherently flawed system may create new distortions. For example, a ban on certain types of packaging or products might prevent consumers with strong preferences for such items and a willingness to pay their full disposal cost from obtaining them, without significantly reducing environmental problems.[13]

This Article uses an economic framework to analyze a wide range of policy options aimed at remedying the distorted incentives that underlie the existing system of solid waste regulation. The focus is upon identifying market interventions that will cause true social disposal costs to be taken into account in consumer and manufacturer decisionmaking. A system that perfectly charged each consumer all of the social costs of disposal of each item of refuse would correct the market distortions noted above. Consumers would economize on disposal resources just as they are now prompted by retail prices to economize on other resources. The transaction costs of such a system, however, would be prohibitive. An optimal system must reflect the tradeoff between the efficiency gains resulting from improved manufacturer and consumer decisions and the transaction costs of implementing the system.

The Article concludes that, while comprehensive monitoring systems would be prohibitively expensive, there are feasible economic incentive systems that would be extremely effective in reducing the quantity and improving the composition of the municipal solid waste stream. Moreover, the transaction costs of implementing these systems could be kept within reasonable bounds. Simple curbside charges, based on the volume or weight of mixed refuse, provide strong incentives for source reduction, separation of valuable materials, and purchasing of materials that are reusable, recyclable, or less expensive to landfill or incinerate. Another possible option is a highly flexible system of retail charges implemented by entering data on disposal costs into optical scanning cash register systems. This system would facilitate carefully tailored adjustments to individual product prices to reflect disposal costs. If this pricing system were combined with a curbside charge, even greater social benefits could be reaped.

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13. Bans on fast-food packaging and disposable diapers may well fall into this category. Paper and plastic fast-food packaging currently account for about 0.3% of new landfill volume; disposable diapers comprise 1.5% of landfill volume. *See* OTA REPORT, *supra* note 1, at 26. Furthermore, it is far from clear whether disposable or cloth diapers are more environmentally sound. Although disposable diapers consume more raw materials and result in greater solid waste, cloth diapers consume significantly more energy and water and cause greater water pollution. *See* Holusha, *Diaper Debate: Cloth or Disposable?*, N.Y. Times, July 14, 1990, at 46, col. 1.

Beyond the analysis of particular policy tools, the Article also considers means whereby incentive-based regulatory policies could be implemented within our complex federal system encompassing diverse local communities. Given the heterogeneity of population density, land use, hydrogeology, and other factors, local governments are in the best position to select and implement a regulatory policy tailored to the specific needs and values of their community. Yet the federal government has an extremely important role to play in regulating disposal technologies, gathering and disseminating information, conducting research, and correcting distortions in markets for recycled materials. State governments also have a role to play in coordinating local solid waste regulatory policies.

As background to this analysis, Part I provides an overview of the solid waste stream and the various technologies available for disposing of or recovering waste. Part II describes the traditional system for regulating solid waste generation and disposal and new approaches that have recently been adopted or are under serious consideration. Part III uses an economic framework to analyze the efficacy of different policy instruments for addressing the solid waste problem. This part concludes that economic incentive approaches, which in the past have been largely ignored, perform better than existing and proposed solid waste regulatory policies. Part IV describes how these incentive approaches could be implemented within a coherent federal system of solid waste regulation.

I

AN OVERVIEW OF THE MUNICIPAL SOLID WASTE STREAM

There are five principal sources of solid waste: (1) residential and commercial consumers, (2) agriculture, (3) industry (including mining), (4) construction, and (5) pollution control equipment.[14] Each of these presents different regulatory problems, although important common elements apply to the generation and disposal of all types of solid waste. This Article focuses upon the regulation of municipal solid waste, which is generated by residential and commercial consumers. Although municipal solid waste comprises less than thirty percent of the total U.S. waste stream,[15] it presents the most difficult regulatory challenge because of its heterogeneity and the diversity of people and entities that contribute to it.[16]

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14. *See* A.BAGCHI, DESIGN, CONSTRUCTION, AND MANAGEMENT OF SANITARY LAND-FILLS 50 (1990); L. BONOMO & A. HIGGINSON, INTERNATIONAL OVERVIEW ON SOLID WASTE MANAGEMENT: A REPORT FROM THE INTERNATIONAL SOLID WASTES AND PUBLIC CLEANING ASSOCIATION 243-44 (1988).

15. Figure calculated from WORLD RESOURCES INSTITUTE, *supra* note 9, at 252.

16. Many of the other sources of waste produce large quantities of relatively uniform wastes. Consequently, there is typically one preferred resource recovery or disposal technology for such wastes. *See* EPA AGENDA, *supra* note 1, at 6 n.*. Moreover, unlike municipal

In order to appreciate the dimensions of the municipal solid waste problem, it is necessary to understand the sources and composition of the municipal solid waste stream, the technologies available for disposal of and resource recovery from this stream, and the social costs associated with each of these technologies. Section A presents a descriptive overview of the municipal solid waste stream. Section B describes the major disposal and resource recovery technologies and discusses their social costs.

A. Composition of the Municipal Solid Waste Stream

The municipal solid waste stream comprises the complex process by which wastes move from raw materials to reuse, recovery, or disposal. Along its course, the stream is shaped by numerous manufacturer, consumer, waste processor, and municipal decisions. The waste stream begins with raw material and product design choices by manufacturers. These choices reflect consumer preferences for products and packaging, as well as the availability and cost of materials. Consumers influence the municipal solid waste stream both through their purchasing decisions and, later, through their disposal choices. Wastes that consumers reuse or compost[17] do not reach the disposal end of the municipal solid waste stream. Wastes that consumers separate can be recycled; in addition, some valuable wastes that consumers do not separate, such as ferrous metals, can feasibly be separated for recycling after they reach a waste transfer station or disposal site.[18]

Table 1 shows the total quantity and average composition of the municipal solid waste stream in the United States for 1970 and 1986. During this period, the total quantity of municipal solid waste disposed of by landfilling and incineration grew more than twenty-five percent while the population grew eighteen percent.[19] Thus, municipal solid waste per capita grew from 3.01 pounds per day in 1970 to 3.19 pounds per day in 1986, enabling the United States to remain the most profligate nation on Earth.[20] Table 1 also demonstrates the heterogeneous charac-

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solid waste, these other sources of solid waste are typically generated and disposed of far from population centers, and therefore generally do not present immediate threats to human health.

17. Composting refers to controlled biological decomposition of organic wastes (such as food, grass clippings, and leaves) under aerobic conditions (i.e., in the presence of oxygen). Composting produces materials such as humus and mulch, which can be used to enrich soils. For a report on current composting practices, see EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.C-1 to 2.C-13.

18. *See id.* at 2.B-15.

19. The population of the United States was approximately 205 million in 1970 and 241.6 million in 1986. BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, STATISTICAL AB-STRACTS OF THE UNITED STATES: 1990, at 7 (1990).

20. Americans, especially those in our larger cities, generate significantly more solid waste per person than citizens of other industrialized countries. The average resident of Los Angeles generates 6.4 pounds of municipal solid waste per day. NATIONAL SOLID WASTES

ter of municipal solid waste. Most of the components, when separated, have significant salvage values.[21] In addition, many wastes (particularly plastics, rubber, textiles, wood, and paper products) have high energy contents, which can be extracted through modern incineration technologies.[22] The components of the waste stream also vary widely in their volume[23] and bio- and photodegradability. Food and yard wastes degrade rapidly when exposed to high oxygen environments.[24] By contrast, most plastics do not degrade, even in the presence of light and oxygen.[25]

MANAGEMENT ASSOCIATION, SOLID WASTE DISPOSAL OVERVIEW 1 (1990). By contrast, the average resident of Tokyo, Paris, Singapore, Hong Kong, Hamburg, and Rome generates 3 pounds, 2.4 pounds, 1.9 pounds, 1.87 pounds, 1.87 pounds, and 1.5 pounds of solid waste per day, respectively. C. POLLOCK, MINING URBAN WASTES: THE POTENTIAL FOR RECYCLING 9 (Worldwatch Paper No. 76, 1987). The residents of cities in lesser developed countries generate far less waste, in the neighborhood of 1 pound per person per day. *Id.*

21. *See generally* C. POLLOCK, *supra* note 20, at 20-27.

22. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 1-36.

23. For example, plastics have significantly lower densities than the average for landfilled materials, and hence take up significantly more volume for a given weight. OFFICE OF SOLID WASTE, ENVIRONMENTAL PROTECTION AGENCY, THE SOLID WASTE DILEMMA: AN AGENDA FOR ACTION, APPENDICES A-B-C A.C-11 to A.C-14 (1988) [hereinafter EPA APPENDIX] (draft report of the Municipal Solid Waste Task Force). Plastic containers, however, tend to weigh less per unit volume than containers made from other materials. OTA REPORT, *supra* note 1, at 100. Moreover, advances in plastics manufacturing have substantially reduced the amount of plastic needed to package a given amount of material. W. Rathje, Municipal Refuse: Are Misconceptions Misleading Policymakers? 14 (Briefing, Senate Caucus Room, Feb. 22, 1989) (transcript available from the Environmental and Energy Study Institute, Washington, D.C.). Therefore, even though plastics use has grown significantly over the past two decades, the percentage of landfill space devoted to plastics has remained relatively constant at about 14%. *Id.* By contrast, the amount of landfill space devoted to paper has increased from 20% to 55% over this same period. *Id.* at 12, 14; *see also* OTA REPORT, *supra* note 1, at 82-84 (discussing Rathje's "Garbage Project," an excavation study of various landfills).

24. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 1-29 to 1-30.

25. *See id.* at 1-30. Recently, photo- and biodegradable plastics have attracted a lot of attention. Photo- and biodegradability are particularly important attributes with regard to littering. Littered wastes disrupt natural ecosystems and are aesthetically unpleasing in natural settings. Some plastic litter poses a particular threat to marine mammals and birds. *See* H. NEAL & J. SCHUBEL, *supra* note 8, at 67-69; *cf.* Meade, *Degradability: Hoax or Boon?*, WASTE AGE, July 1989, at 22, 22-28 (describing controversy over the residues of recently developed degradable plastic products). Degradability is also essential for composting wastes.

Degradability is not, however, a desirable attribute for most properly disposed of wastes. Reused products remain in the stream of commerce; hence degradability is undesirable if it reduces recyclability. *See* Beck, *Buried Alive — The Garbage Glut: An Environmental Crisis Reaches Our Doorstep*, NEWSWEEK, Nov. 27, 1989, at 66, 69. Incineration largely destroys wastes through high temperature combustion. Therefore, nonbiodegradability of wastes which are to be incinerated does not present an environmental problem. In fact, natural degradability is often correlated with high moisture content, which reduces the efficiency of incineration. And, contrary to some perceptions, *see* KEEP AMERICA BEAUTIFUL, OVERVIEW: SOLID WASTE DISPOSAL ALTERNATIVES 22 (1989) (noting that many citizens and legislators are looking to degradability to solve the solid waste problem); Alexander, *Packaging and the Challenge of Managing Municipal Solid Wastes*, CONVERTING & PACKAGING, Mar. 1988, at 205, 206 (describing "the myth of biodegradability"), landfills are typically designed to slow or prevent degradation. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 1-28; *Garbage 'Stored' in Municipal Landfill Shows Little Decomposition, Archaeologist Says,* 19

The components of the municipal waste stream also vary in toxicity. Although most of the municipal waste stream is not toxic, a number of hazardous household materials, including batteries, inks, used oils, anti-freeze, paints and paint solvents, insecticides, and herbicides, find their way into the municipal solid waste stream.[26] These substances can cause serious harm to both humans and ecosystems if not disposed of properly.[27]

TABLE 1				
Overview of the U.S. Municipal Solid Waste Stream*				
	1970		1986	
Materials	million tons	percent	million tons	percent
Paper and Paperboard	37.5	32.4	50.1	35.6
Glass	12.5	11.1	11.8	8.4
Metals	13.5	12.0	12.6	8.9
Plastics	3.0	2.7	10.3	7.3
Rubber and Leather	3.0	2.7	3.9	2.8
Textiles	2.0	1.8	2.8	2.0
Wood	4.0	3.6	5.8	4.1
Food Wastes	12.8	11.4	12.5	8.9
Yard Wastes	23.2	20.6	28.3	20.1
Miscellaneous Inorganics	1.9	1.7	2.6	1.8
total	112.5	100.0	140.8	100**

* Wastes discarded after materials recovery (i.e., recycling) and before energy recovery.

** Total corrects for rounding error.

source: Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States, 1960 to 2000 (Update 1988) (Mar. 30, 1988) (prepared for U.S. EPA).

Waste generation rates and waste stream composition vary significantly across the United States as a result of differences in population density, climate, season, social attitudes toward the environment, economic characteristics, and municipal solid waste policies.[28] For example, the average resident of Los Angeles, Philadelphia, Chicago, and New York generates 6.4 pounds, 5.8 pounds, 5 pounds, and 4 pounds of solid

Env't Rep. (BNA) 2368 (Mar. 10, 1989) (noting that landfills may more aptly be described as storing, rather than disposing of, wastes and reporting that recent excavations of garbage buried in landfills used in 1962 indicate almost no degradation due to the oxygen-starved environment); Beck, *supra,* at 69-70.

26. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 4.B-3 to 4.B-4.
27. *See* OTA REPORT, *supra* note 1, at 86.
28. *See* O'Leary, Walsh & Ham, *Managing Solid Waste,* SCI. AM., Dec. 1988, at 36, 37.

waste per day, respectively.[29] By contrast, residents of Perkasie, Pennsylvania, Long Meadow, Massachusetts, and Woodbury, New Jersey, communities that have instituted aggressive solid waste regulatory policies, generate 0.6 pounds, 1.7 pounds, and 1.9 pounds of waste (net of recycling) per person per day, respectively.[30]

B. *Disposal and Resource Recovery Technologies*

There are three principal means of waste disposal and resource recovery: landfill, incineration, and recycling.[31] Currently, the United States relies heavily upon landfilling, burying 76% of its municipal solid waste; approximately 13% is incinerated and 11% is recycled.[32] For a variety of reasons, the utilization of waste disposal and resource recovery technologies varies significantly within the United States.[33] This section describes the major waste disposal and resource recovery technologies, discusses the environmental problems associated with each approach, and explains the main factors affecting the utilization of different technologies.

1. *Landfill*

From antiquity to modern times, dumping of solid waste on land has been the primary mode of waste disposal.[34] Prior to the mid-1970's, most landfills in the United States were little more than open pits into which all types of wastes, including hazardous wastes, were deposited.[35] In addition to creating noxious odors and aesthetic blight, this method of landfilling poses a number of grave environmental risks.[36] Rain, wind, sunlight, and other natural forces can cause hazardous materials to leach out of dumps into groundwater aquifers, the major source of drinking water in the United States.[37] Furthermore, mixing and biodegradation of

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29. NATIONAL SOLID WASTES MANAGEMENT ASSOCIATION, *supra* note 20, at 1.

30. These figures were calculated from INSTITUTE FOR LOCAL SELF-RELIANCE, BEYOND 25 PERCENT: MATERIALS RECOVERY COMES OF AGE 23, 31, 47 (1989).

31. Although some solid waste in the United States used to be dumped in the ocean, this practice has been largely discontinued. *See* H. NEAL & J. SCHUBEL, *supra* note 8, at 4.

32. KEEP AMERICA BEAUTIFUL, *supra* note 25, at 2. In contrast, West Germany landfills 55%, incinerates 30%, and recycles 15%. NATIONAL SOLID WASTES MANAGEMENT ASSOCIATION, RESOURCE RECOVERY AND THE ENVIRONMENT 1 (1990). Japan recycles 50%, incinerates 23%, and landfills only 27%. *Id.*

33. Although approximately half of the states have almost no recycling (two percent or less), seven states (Washington, Oregon, Delaware, Maine, Vermont, New Jersey, and Minnesota) recycle between 13% and 22% of their waste. Similarly, while 20 states incinerate little or none of their waste, Connecticut incinerates 66% of its waste and another six states incinerate 20% or more of their waste. *See Biocycle Survey, supra* note 1, at 35.

34. O'Leary, Walsh & Ham, *supra* note 28, at 36.

35. KEEP AMERICA BEAUTIFUL, *supra* note 25, at 21.

36. *See* Note, *Problems Associated With the Management of Solid Waste: Is There a Solution in the Offing?,* 83 W. VA. L. REV. 131, 133-34 (1980).

37. *See* N. NEMEROW, INDUSTRIAL SOLID WASTES 71 (1989); OTA REPORT, *supra* note

wastes can generate methane and other explosive gases.[38] Open dumps also harbor and facilitate the spread of diseases.[39]

Current landfill technology can largely prevent (or more correctly in many cases, forestall) these threats to human health and the environment. Modern sanitary landfills are generally located where the risk of groundwater contamination is low.[40] A state-of-the-art structure[41] includes a clay or synthetic liner, a network of drains to collect leachate that percolates down to the liner, equipment for treating leachate, and landfill gas control and groundwater monitoring equipment.[42] During the operation of a sanitary landfill, care is taken to prevent the disposal of any hazardous materials. When a sanitary landfill reaches capacity, an impermeable cap is placed above the filled material. Leachate collection and treatment, gas control, and monitoring must continue indefinitely to prevent environmental harms. Even with state-of-the-art technology, however, there is no guarantee that a landfill will never leak.

As a result of increased design, construction, and operating costs, as well as rising land costs and local opposition to the construction of new landfills,[43] the cost of landfilling has skyrocketed in the past decade in many parts of the United States. Tipping fees, the costs charged to haulers per ton of nonhazardous refuse deposited in a landfill, are a commonly used measure of the cost of landfilling.[44] In 1980, tipping fees were rarely more than a few dollars per ton anywhere in the United States.[45] Many communities permitted free dumping. By 1987, average tipping fees were $20.36 per ton nationally, with some landfills in the

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1, at 275.

38. *See* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 22.

39. Note, *supra* note 36, at 134.

40. *See* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 21. Groundwater contamination is unlikely if a landfill is located where groundwater flow is deep or slow and soil and rock layers between the landfill and groundwater have low permeability. *See* V. PYE, R. PATRICK, & J. QUARLES, GROUNDWATER CONTAMINATION IN THE UNITED STATES 17-19 (1983) [hereinafter GROUNDWATER CONTAMINATION].

41. *See generally* OTA REPORT, *supra* note 1, at 276-84 (discussion of modern landfill procedures).

42. *See* Glebs, *Landfill Costs Continue to Rise,* WASTE AGE, Mar. 1988, at 84, 84. Some large landfills have equipment for collecting methane for resale, although the gas must usually be cleaned or blended before use. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 3.D-9.

43. *See supra* note 4 and accompanying text; EPA BACKGROUND DOCUMENT, *supra* note 3, at 3.A-1 to 3.A-5.

44. *See, e.g.,* Pettit, *The 1987 Tip Fee Survey: Last Year's Rise was Biggest Ever,* WASTE AGE, Mar. 1988, at 74. Tipping fees often exclude many important social costs associated with landfilling, such as the costs of closure and environmental risks. In addition, compacted volume, rather than weight, may be a better yardstick for measuring the social cost of landfilled materials. For example, plastics consume at least three times as much landfill space for their weight as other materials. *See* Barrett, *Recyclers Plucking Profits from Plastics in Trash,* AM. METAL MARKET, Sept. 7, 1988, at 4. Nonetheless, tipping fee data serves the more limited purpose here of showing how dramatically landfill costs have risen.

45. *See* Church, *supra* note 8, at 81.

Northeast charging $65 and up.[46] In 1988, tipping fees at some North-
east landfills were as high as $110 per ton.[47] Although tipping fees have
risen throughout the United States during the 1980's, they remain low in
many parts of the Midwest, South, and West.[48] Despite some commerce
in waste, the high cost of transporting waste and restrictions imposed by
some states and municipalities on landfilling of waste from other jurisdic-
tions have helped maintain large interregional differences in tipping fees.

2. Incineration

    High temperature incineration serves as a means of both reducing
the volume of solid waste and generating energy. Incineration can, de-
pending upon the waste composition, reduce volume by sixty to ninety
percent[49] and generate significant amounts of industrial steam, electric-
ity, and fuel.

    The three principal types of incineration technologies currently in
use are mass burn, modular, and refuse-derived fuel (RDF) facilities.[50]
Mass burn facilities, which make up about seventy-five percent of the
incineration facilities in the United States,[51] burn unseparated refuse to
fire boilers which produce steam and electricity. These facilities can burn
up to 3000 tons of refuse per day. Modular combustion units are smaller
scale mass burn facilities, with capacities of 25 to 300 tons per day, typi-
cally built within factories. These units can also be built on separate sites
to handle the solid waste generated by a small community. RDF facili-
ties shred and screen wastes to produce highly combustible fuel pellets.
This technology requires extensive sorting of wastes to remove noncom-
bustible components such as glass and metals. The resulting pellets,
which can be stored or transported for burning at another site, have a
high energy content. They can be burned in isolation or mixed with coal.

    The efficiency of incineration facilities, in terms of both energy gen-
eration and solid waste reduction, depends upon the design and opera-
tion of the incinerator and the composition of the wastes burned.[52]
Plastics have the highest energy content of the major components of mu-
nicipal solid waste, producing 15,000 - 20,000 Btu per pound, twice the
heating content of Wyoming coal and nearly as much as residual fuel

    46.   *See* Pettit, *supra* note 44, at 74-77.
    47.   *Biocycle Survey, supra* note 1, at 37.
    48.   *See id.*; Pettit, *supra* note 44, at 75-77. For example, in 1987 the tipping fee in Boise,
Idaho was only $3.15 per ton. *Id.* at 77.
    49.   KEEP AMERICA BEAUTIFUL, *supra* note 25, at 16; NATIONAL SOLID WASTES MAN-
AGEMENT ASSOCIATION, *supra* note 32, at 1.
    50.   These technologies are described in H. NEAL & J. SCHUBEL, *supra* note 8, at 81-114;
KEEP AMERICA BEAUTIFUL, *supra* note 25, at 16-20; EPA BACKGROUND DOCUMENT, *supra*
note 3, at 2.D-1 to 2.D-17.
    51.   KEEP AMERICA BEAUTIFUL, *supra* note 25, at 16.
    52.   *See* H. NEAL & J. SCHUBEL, *supra* note 8, at 85-89; EPA BACKGROUND DOCUMENT,
supra note 3, at 1-35 to 1-38.

oil.[53] Rubber, leather, textiles, wood, paper, and paperboard generate approximately half this amount of energy per pound.[54] Food wastes, yard wastes, and inorganic wastes such as glass and metals have little or no heating value.[55]

Incineration, however, presents two significant environmental concerns: potentially dangerous air emissions and ash residues.[56] Incinerators burning municipal solid waste contribute to air pollution problems by emitting carbon monoxide, sulfur dioxide, and particulate matter.[57] Of greater concern, incineration of municipal solid waste can produce emissions of a variety of heavy metal compounds and other hazardous air pollutants.[58] Moreover, incineration of municipal solid waste produces large quantities of residual ash.[59] Depending upon the composition of the wastes burned, incinerator ash can contain high concentrations of toxic metals.[60]

Pollution control technologies have been developed to reduce human and ecosystem exposure to these environmental risks. Stack scrubbing[61] and filtering technologies can reduce air emissions of some gases and particulate matter by as much as ninety-nine percent.[62] The threats posed by toxic ash can be reduced by disposal in sanitary landfills. It is important to keep in mind, however, that the environmental risks of heavy metals and other toxic components of the solid waste stream, and the ability of existing technologies to control these risks, are not completely understood. Thus, in the long run, the environmental costs of incineration might be significant even with the use of the best available technologies.[63]

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53. EPA BACKGROUND DOCUMENT, *supra* note 3, at 1-36; EPA APPENDIX, *supra* note 23, at A.C-14.
54. EPA BACKGROUND DOCUMENT, *supra* note 3, at 1-36.
55. *Id.*
56. For an overview of the various problems with incineration, see EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.D-9 to 2.D-17.
57. *See, e.g.,* C. BRUNNER, *supra* note 6, at 109-21.
58. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.D-10.
59. The ash may retain 10% to 40% of the original waste volume. KEEP AMERICA BEAUTIFUL, *supra* note 25, at 16. *See generally* EPA APPENDIX, *supra* note 23, at B.A-1 to B.A-40.
60. *See* EPA APPENDIX, *supra* note 23, at B.A-34 to B.A-35.
61. Dry scrubbers remove gases and particulate matter by passing emissions through a watery mixture containing lime. This produces a dry powder that is then collected by an electrostatic precipitator, which uses high voltage to produce a negative charge on the particles and then collects them on positively charged plates. *See* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 18. *See generally* C. BRUNNER, *supra* note 6, at 123-65.
62. NATIONAL SOLID WASTES MANAGEMENT ASSOCIATION, *supra* note 32, at 3; KEEP AMERICA BEAUTIFUL, *supra* note 25, at 18.
63. *Cf.* Denison & Silbergeld, *supra* note 6, at 24-25 (predictions of incinerator emissions rely on limited emissions testing data which does not account for the full range of operating conditions).

The economic viability of incineration depends upon a variety of factors, including the capital costs of furnaces and pollution abatement equipment, the costs of siting,[64] operating costs, the tipping fees which can be charged, the market for energy produced, and the quality of the wastes available. Many of these factors vary significantly from one region of the country to another.[65] Some also vary significantly from locality to locality. For example, a community with a successful paper and plastic recycling program will generate mixed wastes with a low heating value.[66] By contrast, separation of glass, metal, food, and yard wastes tends to raise the average heating value of the waste stream.[67] Facilities now being planned will need to charge tipping fees in the range of $50 to $65 per ton in order to be economically viable.[68] Currently, such fees would be competitive with landfilling only in the Northeast.[69]

3. Recycling

Recycling refers to the multitude of means of converting used products and packaging into useful raw materials and products. In 1986, the United States recycled approximately 25% of aluminum, nearly 23% of paper, and 8.5% of glass wastes.[70] No other components of the solid waste stream were recycled at a rate greater than 5%.[71]

Recycling generally consists of three distinct activities. First, wastes must be separated.[72] Until a few years ago, consumers had to bring separated wastes to collection centers.[73] Today, in more than 1000 communities throughout the United States, refuse removers collect one or a few separated items at the curbside.[74] In a few communities, separation oc-

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64. As with landfills, concerns about the environmental risks of incineration have fueled opposition to the siting of incinerators in many communities. *See, e.g., Massachusetts: State Announces 10-Point Waste Plan, Moratorium on New Garbage Incinerators,* 19 Env't Rep. (BNA) 1436 (Nov. 11, 1988) [hereinafter *Massachusetts Plan*].

65. *See, e.g., Biocycle Survey, supra* note 1, at 37 (noting that tipping fees at incinerators vary from $15 to $98 per ton across the United States); Pettit, *supra* note 44, at 80 (describing similar pattern).

66. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 1-37.

67. *See id.* at 1-37 to 1-38.

68. *Id.* at 2.D-7.

69. *See supra* notes 46-48 and accompanying text.

70. Franklin Associates, Ltd., Characterization of Municipal Solid Waste in the United States, 1960 to 2000, Final Report 21 (1988) (unpublished report prepared for EPA Office of Solid Waste and Emergency Response).

71. *Id.*

72. Plastics separation can be particularly difficult because different types of plastic are indistinguishable in appearance. *See* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 8. Aluminum separation may soon become more difficult because of the reintroduction of steel and bi-metal cans. *See* Pedigo, *The Resurgence of the Bi-Metal Beverage Can,* RESOURCE RECYCLING, Mar.-Apr. 1989, at 22.

73. *See* Halgren, *Recycling and Resource Recovery: State and Municipal Impediments,* 7 COLUM. J. ENVTL. L. 1, 6, 20-21 (1980).

74. *Biocycle Survey, supra* note 1, at 38.

curs at central transfer stations, landfills, or RDF incineration plants.[75] The costs of collection and separation represent a significant portion of the costs of recycling.[76]

Waste processing is the second stage of recycling. Depending on the type, quality, and purity of material, the processing required can range from simply sterilizing reusable containers to melting, shredding, or pulverizing the material and reconstituting new products, to wetting and turning biodegradable materials to produce compost.[77] The most widely used recycling technologies convert waste paper into newsprint, construction materials, and paperboard; aluminum wastes into can sheet; and empty glass bottles into new containers and fiberglass insulation.[78] Other significant recycling technologies convert ferrous metal wastes to scrap metal products, used lead-acid batteries into lead products and new batteries, scrap tires into new rubber, and used oils into lubricating oils.[79] In addition, technologies have recently been developed for converting empty plastic containers into carpet backing, fiberfill for sleeping bags and ski jackets, rigid foam, and automobile bumpers.[80]

The third stage of recycling consists of locating or creating a market for recycled materials.[81] Recycled materials have some important cost advantages over virgin raw materials. Manufacturing based on recycled materials requires far less energy and causes much less pollution than use

75. *See, e.g.,* Salimando, *'Divert As Much As Possible,'* WASTE AGE, Sept. 1988, at 54 (describing a recycling/transfer facility that successfully sorts commercial waste; such waste can more easily be divided into loads with valuable recyclable components, as can be seen with office wastes, which often contain large amounts of high quality paper). High powered magnets are used at some disposal facilities to remove metallic wastes. Hand sorting is used to separate other wastes. *See* Ryan, *The High Cost of Living,* STATE GOV'T NEWS, Sept. 1988, at 6 (estimating that hand sorting, while labor intensive, can be cheaper than landfill disposal).

76. *See* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 11-13. For a report on the costs of various aspects of recycling, see EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.B-20 to 2.B-24.

77. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.B-15 to 2.B-18, 2.C-2 to 2.C-3; KEEP AMERICA BEAUTIFUL, *supra* note 25, at 4-15.

78. *See* O'Leary, Walsh & Ham, *supra* note 28, at 39.

79. *See* OTA REPORT, *supra* note 1, at 156-68.

80. KEEP AMERICA BEAUTIFUL, *supra* note 25, at 7. For detailed reports on secondary plastics processing, see C. RENNIE & A. MACLEAN, SALVAGING THE FUTURE: WASTE-BASED PRODUCTION 53-78 (Institute for Local Self-Reliance, 1989) [hereinafter SALVAGING THE FUTURE]; OTA REPORT, *supra* note 1, at 168-84.

81. *See generally* ENVIRONMENTAL DEFENSE FUND, COMING FULL CIRCLE 89-123 (1988) [hereinafter COMING FULL CIRCLE]; EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.B-24 to 2.B-37.

of their virgin counterparts.[82] Nonetheless, recycled materials must often compete against subsidized virgin raw materials.[83] Moreover, market prices often do not reflect the differences in environmental costs between recycled and virgin materials.[84] Recycled materials face other difficulties as well, including the absence of well-developed markets,[85] high transportation costs to manufacturing plants (which are often located where virgin raw materials are extracted or can be easily imported),[86] and the variable quality of many recycled materials.[87] As a result of these factors, spot prices for recycled materials vary significantly from place to place and over time.[88]

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82. The benefits of substituting recycled materials for virgin resources are delineated in the following table:

Reduction of:	Paper	Glass	Steel	Aluminum
Energy Use	23-74%	4-32%	47-74%	90-97%
Air Pollution	74%	20%	85%	95%
Water Pollution	35%	—	76%	97%
Mining Wastes	—	80%	97%	—
Water Use	58%	50%	40%	—

C. POLLACK, *supra* note 20, at 22 (citing Letcher & Sheil, *Source Separation and Citizen Recycling,* in THE SOLID WASTE HANDBOOK (W. Robinson ed. 1986)). Recycling can, however, cause adverse environmental effects. Composting facilities generate waste waters that must be treated. EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.F-10. In addition, recycling plants handling toxic materials can create disposal problems, as the presence of some recycling facilities on the Superfund National Priorities List demonstrates. *Id.* For a summary of pollution problems that may arise from recycling processes, see OTA REPORT, *supra* note 1, at 190-94.

83. Various government policies subsidize the extraction of virgin raw materials. *See infra* text accompanying notes 316-21.

84. *See* OTA REPORT, *supra* note 1, at 197-202.

85. *See* Cutler, *Recycling Markets: Is Mandated Recycling Possible?,* SOLID WASTE & POWER, Aug. 1988, at 54 (arguing that recycling is limited more by the demand for separated materials than by the supply). *See generally* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.B-24 to 2.B-36; COMING FULL CIRCLE, *supra* note 81, at 89-97.

86. *See, e.g.,* OTA REPORT, *supra* note 1, at 145 (describing how "most [paper] mills are located close to sources of wood pulp, so it is unlikely that it would be cost-effective to transport large amounts of [old newsprint] to be used as [secondary fiber] instead").

87. For example, recycled newsprint has been more prone to tearing and discoloring than virgin newsprint. Holusha, *Old Newspapers Hit a Logjam,* N.Y. Times, Sept. 10, 1989, at F4, col. 1. *See generally* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 6 (demonstrating general problems of product quality in paper recycling).

88. *See, e.g.,* Luoma, *Trash Can Realities,* AUDUBON, Mar. 1990, at 86, 90. As a result of the rapid increase in separated wastes in parts of the United States that have recently instituted curbside collection programs, many markets for recycled materials have virtually collapsed. *See, e.g., Success Hits Paper Recycling,* Chicago Tribune, Sept. 10, 1989, at D14, col. 1 (noting a drop in recycled newsprint prices in some cities from $25 per ton to less than zero, meaning that municipalities were having to pay for removal of separated newspapers).

II

THE LITTERED LANDSCAPE OF FEDERAL, STATE, AND LOCAL SYSTEMS OF MUNICIPAL SOLID WASTE REGULATION

This part first describes what has been the predominant system of solid waste regulation in the United States. It then discusses recent changes at the federal, state, and local levels, as well as proposals for further changes to address the solid waste crisis.

A. The Traditional System of Solid Waste Regulation

Municipal solid waste regulation in the United States has traditionally been handled at the local level. Until the 1970's, most municipalities operated a trash collection operation and a landfill, or more accurately, a dump.[89] The major costs of trash disposal were the costs of collecting and transporting wastes to the town dump.[90] In many areas, wastes were carelessly deposited and then covered with dirt.[91] The costs of collection, transportation, and dumping were (and in many cases still are) paid out of property taxes or other general tax revenues.[92] Once garbage was out of sight, it was out of mind. Solid waste disposal was rarely a major local government issue.[93]

The federal government entered the field in a limited way in 1965 with the passage of the Solid Waste Disposal Act.[94] The Act provided federal funds to state and local officials for research and planning and gave the Department of Health, Education, and Welfare advisory powers over local solid waste regulation.[95] The new federal presence has not, however, changed the status of local governments as the entities primarily responsible for solid waste regulation.

B. New Approaches to Solid Waste Regulation

The mechanics of waste disposal regulation have changed significantly since the mid-1970's. EPA now tightly regulates waste disposal technologies under the Resource Conservation and Recovery Act (RCRA).[96] As a result of rising disposal costs, many local governments now have separate annual or monthly waste disposal charges, tipping fees, or a combination of the two to cover the operating costs of land-

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89. P. POPP, N. HECHT & R. MELBERTH, DECISION-MAKING IN LOCAL GOVERNMENT: THE RESOURCE RECOVERY ALTERNATIVE 34 (1985).

90. *See id.* at 4.

91. *Cf.* H. NEAL & J. SCHUBEL, *supra* note 8, at 3-4 (discussing the history of dumping practices).

92. D. WILSON, *supra* note 10, at 31.

93. *See* P. POPP, N. HECHT & R. MELBERTH, *supra* note 89, at 3.

94. Pub L. No. 89-272, tit. II, §§ 201-210, 79 Stat. 992, 997-1001 (1965) (replaced by the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901-6992k (1988)).

95. *Id.* §§ 204-206, 79 Stat. 992, 998-99.

96. 42 U.S.C. §§ 6901-6992k (1988).

fills.[97] Another change has been the privatization of waste disposal. Many communities now contract with private firms for refuse collection and disposal.[98]

Although the names and faces in solid waste regulation have changed, the incentive structure for consumers has remained largely the same. In most communities, the cost of waste disposal to any particular household is still unrelated to the quantity or composition of the waste generated.[99]

Not all communities fit this pattern. A few states, notably New Jersey, Rhode Island, Florida, Connecticut, and California, have recently enacted sweeping changes in their regulatory systems. Many other states are considering similarly dramatic measures. In addition, many localities have developed innovative approaches to solid waste regulation. This section first describes the major changes in federal regulation of solid waste and the prospects for further federal regulation. It then describes the major changes already adopted and under serious consideration at the state and local levels.

1. Federal Regulation of Municipal Solid Waste

As a result of the vast expansion of federal environmental regulatory authority in the 1970's, EPA now has extensive regulatory authority over municipal solid waste, particularly the design and operation of landfills and incinerators. RCRA is principally aimed at the disposal of hazardous materials; it largely leaves the management of solid waste to state and local authorities.[100] Nonetheless, it offers states financial and technical assistance if they submit a satisfactory solid waste management plan.[101] Among other things, each plan must require that solid waste be disposed of in sanitary landfills.[102] No new open dumps are allowed under state plans, and each plan must provide for the closing or upgrading of existing open dumps.[103] EPA is required to establish criteria for

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97. Approximately 30% of landfills rely solely on tipping fees for revenue, 35% depend exclusively on taxes, and 35% receive funding from both sources. EPA BACKGROUND DOCU-MENT, *supra* note 3, at 2.E-13. For a discussion of tipping fees versus taxes, see *id.* at 2.E-14 to 2.E-16.

98. More than 60% of municipal solid waste is managed by private enterprise. P. POPP, N. HECHT & R. MELBERTH, *supra* note 89, at 4; *see also* NATIONAL SOLID WASTES MAN-AGEMENT ASSOCIATION, PRIVATIZING MUNICIPAL WASTE SERVICES: SAVING DOLLARS AND MAKING SENSE (1983) (arguing that private waste management is cheaper and more efficient than direct municipal control).

99. *See* OTA REPORT, *supra* note 1, at 58; Beck, *supra* note 25, at 75.

100. H.R. REP. No. 1491, 94th Cong., 2d Sess. 3, *reprinted in* 1976 U.S. CODE CONG. & ADMIN. NEWS 6238, 6247.

101. RCRA §§ 4007-4008, 42 U.S.C. §§ 6947-6948 (1988). The one federal management standard is a blanket prohibition on open dumping. *Id.* § 4005(a), 42 U.S.C. § 6945(a).

102. *Id.* §§ 4003(a)(2), 4004(b), 42 U.S.C. §§ 6943(a)(2), 6944(b).

103. *Id.* §§ 4003(a)(2)-(3), 4005, 42 U.S.C. §§ 6943(a)(2)-(3), 6945.

determining which facilities shall be classified as sanitary landfills.[104] A facility may be classified as a sanitary landfill "only if there is no reasonable probability of adverse effects on health or the environment from disposal of solid waste at such facility."[105] In addition, RCRA requires the development of procurement policies to promote greater use of recycled materials by federal agencies.[106]

Notwithstanding this great expansion of federal authority, the EPA has been slow in setting policy objectives and promulgating regulations implementing RCRA. EPA first issued criteria for sanitary landfills in 1979,[107] and Congress directed EPA to tighten these regulations in 1984.[108] Proposed regulations issued in August 1988[109] are still awaiting final action.[110] As a result of delays in issuing regulations, as well as lax enforcement, many landfills remain inadequately regulated. As of November 1986, only 35% of landfills had groundwater monitoring systems and only 7% had methane monitoring systems.[111] Approximately 40% of municipal solid waste went to nonpermitted facilities.[112]

Incinerator designs and emissions are regulated under the Clean Air Act.[113] EPA is currently developing regulations to govern emissions of heavy metal and other toxic pollutants from incinerators.[114] EPA is also in the process of developing regulations under RCRA governing the disposal of incinerator ash.[115]

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104. *Id.* § 4004(a), 42 U.S.C. § 6944(a).

105. *Id.*

106. *Id.* § 6002, 42 U.S.C. § 6962.

107. 40 C.F.R. § 257 (1990); *see* Criteria for the Classification of Solid Waste Disposal Facilities and Practices, 44 Fed. Reg. 53,438 (1979).

108. Hazardous and Solid Waste Amendments of 1984, Pub. L. No. 98-616, § 302(a)(1), 98 Stat. 3221, 3268 (codified at RCRA § 4010, 42 U.S.C. § 6949a (1988)); *see* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.E-6 to 2.E-7.

109. EPA, Solid Waste Disposal Facility Criteria, 53 Fed. Reg. 33,314 (1988) (proposed rule).

110. In addition to EPA's efforts, a number of states have enacted regulatory requirements for landfill siting, design, and operation. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.E-8 to 2.E-9.

111. ENVIRONMENTAL AND ENERGY STUDY INSTITUTE, MUNICIPAL SOLID WASTE MANAGEMENT: ISSUES FOR THE 101ST CONGRESS 4 (1989).

112. OTA REPORT, *supra* note 1, at 301.

113. Newly constructed or modified incinerators are regulated under Clean Air Act § 111(b), 42 U.S.C. § 7411(b) (1988). Existing incinerators are regulated under *id.* § 111(d), 42 U.S.C. § 7411(d).

114. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.D-10. Interim regulations require the use of "good combustion practices" and scrubbers combined with electrostatic precipitators, or fabric filters and flue gas treatment if necessary. *Id.* Because of uncertainty about the environmental effects of incineration, a number of states have taken further steps. *See, e.g., Massachusetts Plan, supra* note 64, at 1436.

115. EPA, Land Disposal Restrictions for First Third of Scheduled Wastes, 53 Fed. Reg. 11,742 (1988) (proposed regulations); *see* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.D-16. Several states are developing their own standards for managing incinerator ash. *Id.* EPA has also proposed regulations which would require removal of recyclable materials before incineration. Emission Guidelines: Municipal Waste Combustors, 54 Fed. Reg. 52,209 (1989)

The third main area of federal regulatory responsibility has been promoting greater use of recycled materials. Despite strict statutory deadlines,[116] however, EPA has been extremely slow to issue procurement guidelines to encourage the use of recycled material by federal agencies.[117] Moreover, the Department of Energy largely failed to meet its (now repealed) statutory mandate[118] to encourage the greater use of recycled materials as a means of promoting energy conservation.[119]

Despite the lethargy of the federal government in promulgating regulations, the solid waste crisis has renewed interest in solid waste regulatory policy both at EPA and in Congress.[120] In January 1988, EPA set a national goal of twenty-five percent source reduction and recycling by 1992.[121] Furthermore, Congress has recently considered bills that would have the following effects: require most consumer packaging to be biodegradable; impose a tax on virgin materials used to make packaging; establish a recycling information clearinghouse within EPA; encourage use of degradable plastics derived from agricultural commodities; set emission standards for incineration of refuse; and require labeling of products that cannot be recycled or have not been made from at least ten percent recycled materials.[122]

(proposed rule for existing incinerators); Standards of Performance for New Stationary Sources: Municipal Waste Combustors, 54 Fed. Reg. 52,251 (1989) (proposed rule for new sources); *see EPA Proposes New Air Emission Limits, Material Removal for Existing Trash Burners,* 20 Env't Rep. (BNA) 1445 (Dec. 29, 1989) (discussion of existing source regulations); *Standard for New Trash Burners Proposed; EPA Includes Material Separation Requirement,* 20 Env't Rep. (BNA) 1508 (Jan. 5, 1990) (discussion of regulations for new incinerators).

116. The 1980 amendments to RCRA directed the EPA Administrator to prepare procurement guidelines for three product categories, including paper, by May 1, 1981, and for two additional product categories, including construction materials, by September 30, 1982. Pub. L. No. 96-482, § 22(6), 94 Stat. 2334, 2346 (1980). In 1984 Congress extended the deadlines to May 8, 1985, for paper and October 1, 1985, for "three additional product categories (including tires)." Hazardous and Solid Waste Amendments of 1984, Pub. L. No. 98-616, § 501(b)(2), 98 Stat. 3221, 3275-76 (codified at RCRA § 6002(e), 42 U.S.C. § 6962(e) (1988)); *see* Kovacs, *supra* note 11, at 547 & n.59.

117. *See* Kovacs, *supra* note 11, at 546-60.

118. National Energy Conservation Policy Act, Pub. L. No. 95-619, § 461(c), 92 Stat. 3206, 3273-74 (1978) (formerly codified at 42 U.S.C. § 6344(a) (1988)), *repealed by* Pub. L. No. 99-509, § 3101(b), 100 Stat. 1874, 1888 (1986).

119. *See* Kovacs, *supra* note 11, at 553-57.

120. *See Solid Waste: After 10-Year Break, EPA Plans to Re-focus on Municipal Solid Waste Programs, Research,* 19 Env't Rep. (BNA) 2058 (Feb. 3, 1989) [hereinafter *EPA Plans to Re-focus on Municipal Solid Waste Programs*].

121. EPA AGENDA, *supra* note 1, at 22.

122. *See* Kovacs, *supra* note 11, at 558 n.150. More than 100 bills addressing solid waste issues were introduced in the first session of the 101st Congress. *Congress Sees Bumper Crop of Solid Waste Management Bills,* EPA REUSABLE NEWS, Spring 1990, at 2 (EPA Office of Solid Waste and Emergency Response).

2. Regulatory Developments at the State and Local Levels

With the solid waste crisis emerging as a major local issue in many areas of the United States, an exhaustive survey of legislative and regulatory provisions and proposed changes would be voluminous, not to mention tiresome and quickly obsolete.[123] Rather than present such a compilation, this subsection digests the major solid waste regulatory developments at the state and local levels.

These provisions can be divided usefully according to the means by which they seek to affect consumers' and manufacturers' incentives with respect to generation and disposal of solid waste. Disposal regulations seek to directly regulate consumers' disposal decisions. Packaging regulations attempt to control the types of products that consumers purchase and the types of packaging that manufacturers offer. Deposit-refund systems combine elements of both packaging regulation and disposal regulation. Recycling demand regulations seek to promote the use of recycled materials by manufacturers.

a. Disposal Regulations

Some of the most profound regulatory changes have been in the collection of solid waste at the curbside. Beginning in the 1970's, a number of communities began to collect a few types of separated materials at the curbside. Oregon's Recycling Opportunity Act,[124] the first comprehensive curbside separation law, requires cities of more than 4,000 people to provide at least monthly collection of separated materials.[125] Oregon's program, like other early programs, encourages but does not mandate citizen participation.[126] Laws in other states require communities and disposal facilities to provide dropoff recycling centers.[127] More recently, New Jersey, Rhode Island, Connecticut, Maryland, and Pennsylvania have enacted mandatory separation laws.[128] In addition to requiring local communities to regularly collect designated categories of wastes at

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123. In 1988 alone, approximately 2,000 bills dealing with municipal solid waste were proposed in state legislatures. Memorandum from Terry L. Serie and Ann H. Mattheis, Government Relations, American Paper Institute, Inc. (API), to API Government Relations Committee 1 (Oct. 6, 1988), *cited in* Kovacs, *supra* note 11, at 563 n.163. An admirable survey of state laws is provided by Kovacs, *supra* note 11, at 560-91.

124. OR. REV. STAT. §§ 459.165-.200, 459.250 (1989).

125. *Id.* § 459.165; *see* COMING FULL CIRCLE, *supra* note 81, at 65-66 (examining Oregon statute).

126. Oregon's law does provide for the imposition of mandatory recycling requirements if voluntary participation does not achieve the goals of the Act. OR. REV. STAT. § 459.188 (1989).

127. *See, e.g.,* COMING FULL CIRCLE, *supra* note 81, at 66 (outlining recycling programs in Washington and Wisconsin).

128. N.J. STAT. ANN. § 13:1E-99.13 (West Supp. 1990); R.I. GEN. LAWS § 23-18.9-1 (1990); CONN. GEN. STAT. ANN. § 22a-241b (West Supp. 1990); MD. HEALTH-ENVTL. CODE ANN. § 9-1703 (1990); PA. STAT. ANN. tit. 53, § 4000.1501 (Purdon Supp. 1990).

the curbside, these statutes require residents to separate such wastes. At least fifteen states have considered similar requirements.[129] In 1988, more than 1000 communities had some form of curbside collection program, fifty-one percent of which mandated resident participation.[130]

A few communities regulate disposal by imposing curbside charges for collection of unseparated refuse. Seattle, Washington began experimenting with variable charge programs in the late 1970's.[131] Under its current program, Seattle provides households with the number of garbage cans that they expect to use during typical collection periods.[132] Households pay $10.70 per month for a nineteen-gallon can and $13.75 per month for a thirty-gallon can, with each additional thirty-gallon can costing $9.00 per month.[133] Residents are not charged for removal of various types of separated wastes.[134] The Borough of Perkasie, Pennsylvania has instituted a similar program under which residents must dispose of unseparated trash in special twenty- and forty-pound trash bags that are sold by the town for 80¢ and $1.50, respectively.[135] In addition, Perkasie requires its residents to separate aluminum beverage cans, glass, cardboard, and newspapers in buckets provided by the town.[136]

In order to conserve landfill space and promote recycling, a number of communities and a few states have imposed bans on the disposal of certain materials.[137] Some communities prohibit disposal of yard wastes at their landfills.[138] Minnesota has banned the incineration of recyclable materials.[139] Connecticut prohibits disposal or incineration of any materials designated recyclable.[140]

As a guidepost for separation and other recycling programs, many states have explicitly set deadlines for achieving specific resource recovery objectives. For example, California's new comprehensive solid waste

129. *See* Kovacs, *supra* note 11, at 560 n.156.
130. *See Biocycle Survey, supra* note 1, at 38.
131. *See* SCS Engineers, Seattle Solid Waste Pilot Programs: Source Separation and Variable Rate (Jan. 1980) (final report).
132. *See Recycling of Municipal Solid Waste: Hearings Before the Subcomm. on Transportation and Hazardous Materials of the House Comm. on Energy and Commerce,* 101st Cong., 1st Sess. 137 (1989) [hereinafter *Hearings*] (testimony of J. Ruston, Environmental Defense Fund); INSTITUTE FOR LOCAL SELF-RELIANCE, *supra* note 30, at 115.
133. *Hearings, supra* note 132, at 137.
134. *Id.*
135. *See* INSTITUTE FOR LOCAL SELF-RELIANCE, *supra* note 30, at 48.
136. *Id.*
137. *See* COMING FULL CIRCLE, *supra* note 81, at 51-53 (discussing existing disposal bans on easily recycled materials such as newspaper and yard waste).
138. *See id.* (communities include Portland, Oregon and Broome County, New York).
139. MINN. STAT. ANN. § 115A.95 (West Supp. 1990).
140. CONN. GEN. STAT ANN. § 22a-241f (West Supp. 1990) (prohibition effective January 1991).

law requires cities and counties to recycle (or otherwise reduce) twenty-five percent of their solid waste by 1995 and fifty percent by 2000.[141]

b. Packaging Regulations

As a means of altering the composition of solid waste generated, a number of states have proposed charges on products sold in certain types of packaging.[142] New Jersey's legislature proposed a two cent tax on certain nondegradable or nonrefillable packaging and containers.[143] A Massachusetts proposal would have imposed a packaging tax of three cents per nonrecyclable beverage container, two cents per container made of recyclable materials, and one cent per reusable container.[144]

As an alternative means of solid waste regulation, a number of states and localities have imposed bans on a variety of types of packaging materials and products.[145] At least eleven states have banned nondegradable plastic six-pack loops.[146] Minnesota and Connecticut have banned plastic beverage containers.[147] A local ordinance in Suffolk County, New York bans plastic grocery bags and the use of polystyrene foam and polyvinyl chloride packaging for food products.[148] At least three states have considered banning the sale of disposable diapers.[149] A recent Minneapolis ordinance requires that food and beverage packaging be "environmentally acceptable," which is defined as recyclable, returnable, or degradable.[150]

As a more general approach to packaging regulation, a number of states are considering the establishment of product and packaging review boards.[151] These bodies would have the power to ban products that

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141. CAL. PUB. RES. CODE § 41780 (West Supp. 1990); *see* Gunnison, *Recycling Measures: Deukmejian Signs Trash Bills*, San Francisco Chron., Sept. 30, 1989, at A6, col. 1.

142. *See* COMING FULL CIRCLE, *supra* note 81, at 81-82 (Washington, New Jersey, and Nebraska already impose a variety of relatively small taxes on products and packaging to fund litter control programs).

143. EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.A-10.

144. *See id.* at 2.A-11.

145. *See* OTA REPORT, *supra* note 1, at 315. In Minnesota v. Clover Leaf Creamery Co., 449 U.S. 456 (1981), the United States Supreme Court upheld, against a challenge based on the Commerce Clause and the Equal Protection Clause of the Fourteenth Amendment, a Minnesota law prohibiting the sale of milk in plastic, nonreturnable, nonrefillable containers despite the fact that the law permitted the sale of milk in other nonreturnable, nonrefillable containers. *See generally* Kovacs, *supra* note 11, at 583-88 (examining the legal basis for packaging bans).

146. *See* COMING FULL CIRCLE, *supra* note 81, at 83.

147. CONN. GEN. STAT. ANN. § 22a-255a (West Supp. 1990); MINN. STAT. ANN. § 325E.042 (West Supp. 1990); *see* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.A-11.

148. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.A-10.

149. *See* OTA REPORT, *supra* note 1, at 315.

150. MINNEAPOLIS, MINN. ORDINANCE 89-Or-060 (1989); *see* Cramer, *Minneapolis Adopts Precedent Setting Packaging Ordinance*, NATION'S CITIES WEEKLY, Apr. 17, 1989, at 1.

151. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.A-11 (discussing proposed state legislation); Snow, *Plastics and Other Packaging under Attack*, WASTE AGE, July 1988, at

would interfere with achievement of the state's solid waste regulatory goals.[152]

c. Combined Packaging and Disposal Regulations: Deposit-Refund Laws (Bottle Bills)

Bottle bills, which impose a retail deposit charge on beverage containers that can be redeemed by returning empty containers to redemption centers, combine elements of packaging regulation and disposal regulation. The earlier versions of these laws, some of which date back to 1971, were enacted primarily to address litter problems.[153] Recent mandatory deposit laws have been expressly directed at the more general solid waste disposal problem.[154] Under Florida's new solid waste law,[155] for example, an "advance disposal fee" of one cent per container will be charged beginning October 1, 1992 for all containers made of plastic, glass, plastic-coated paper, or other materials that are not recycled at a rate of at least fifty percent.[156] This charge plus the market value of the recycled container will be redeemable at recycling centers.[157]

d. Recycling Demand Regulations

Since separation is only the first stage of recycling,[158] many states have enacted a variety of provisions to bolster the demand for recycled materials. Many states and localities have procurement policies that require or encourage state agencies to purchase products containing recycled materials.[159] Connecticut has taken the further step of requiring in-state newspaper publishers, and out-of-state publishers with a Connecticut circulation of 40,000 or more, to use 20% recycled paper by 1993; the recycled content must increase to 90% by 1998.[160] While not willing to go this far, as many as fourteen other states have passed or are

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131.

152. *See* COMING FULL CIRCLE, *supra* note 81, at 84; *see, e.g.*, MINN. STAT. ANN. § 116.F.06(2) (West Supp. 1990) (empowering Minnesota's pollution control agency to review new packaging and containers).

153. *See* Note, *The Bottle Bill: Progress and Prospects*, 36 SYRACUSE L. REV. 759, 759-61 (1985). Between 1971 and 1982, nine states passed bottle bills. *See id.* at 761-64 (summarizing bottle bills).

154. *See, e.g.*, CAL. PUB. RES. CODE §§ 14500-14591 (West Supp. 1990). *See generally* COMING FULL CIRCLE, *supra* note 81, at 69-75 (reviewing bottle deposit legislation).

155. FLA. STAT. ANN. § 403.7197 (West Supp. 1988).

156. *Id.* § 403.7197(2)-(3); *see* Preston & DeRose, *The 1988 Solid Waste Management Act — Facing Up to the "Garbage" Component of Florida's Burgeoning Growth*, 16 FLA. ST. U.L. REV. 597 (1988).

157. FLA. STAT. ANN. § 403.7192(6a) (West Supp. 1990).

158. *See supra* text accompanying notes 70-88.

159. *See* COMING FULL CIRCLE, *supra* note 81, at 99 (summarizing state and local procurement programs); *see also* Kovacs, *supra* note 11, at 573-76.

160. *See Publishers Oppose Laws on Recycled Paper*, N.Y. Times, Sept. 22, 1989, at B20, col. 5.

considering legislation to tax the use of virgin paper or to grant tax credits for the use of recycled paper.[161] A number of states have also used investment tax credits and other tax incentives to promote recycling.[162]

C. Summary

The United States is at an important crossroad in the evolution of its solid waste regulatory policy. The dominant characteristic of the traditional policy — the failure to directly and systematically charge consumers for the disposal costs of their decisions — largely remains, although many states and municipalities have developed a wide range of devices to influence purchasing decisions and disposal practices. There seems to be a clear resolve to address the solid waste crisis, although there is no clear consensus on how best to do so. The next part sheds new light on both the weaknesses and strengths of the recent initiatives. More importantly, it highlights the regulatory policies that would most effectively resolve the solid waste crisis.

III

AN ECONOMIC ANALYSIS OF POLICIES REGULATING
MUNICIPAL SOLID WASTE

This part develops a framework for analyzing policies regulating the generation and disposal of municipal solid waste. Although no model of human behavior can be completely descriptive without becoming intractably complex, an economic framework is well suited to the task at hand. The objective of economic policy analysis, to maximize social welfare (net of social cost), is largely coextensive with the objectives of solid waste regulation: to remedy the solid waste crisis at lowest social cost[163] and to impose the costs of solid waste disposal on those responsible for its creation.[164] In addition, economic models of consumer and producer behavior provide particularly useful insights into the three principal decisions that determine the size and composition of the solid waste stream: (1) *the product design decision* — the design and types of products and packaging offered by manufacturers; (2) *the product choice decision* —

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161. *Id.*

162. *See* OTA REPORT, *supra* note 1, at 322-31; *see also* Kovacs, *supra* note 11, at 576-78.

163. Costs must be kept reasonably low in order to obtain public support for a solid waste regulatory program. For example, only 15% of persons questioned in a 1988 survey were willing to pay a direct tax or fee to support recycling programs that do not break even. NATIONAL SOLID WASTES MANAGEMENT ASSOCIATION, AT A GLANCE: RECYCLING SOLID WASTE 3 (1990).

164. *Cf. Developments in the Law — Toxic Waste Litigation,* 99 HARV. L. REV. 1458, 1478 (1986) ("In enacting [RCRA and CERCLA] Congress evinced clear interests both in minimizing the costs that hazardous wastes impose on society . . . and in reallocating those costs toward the parties responsible for them and away from innocent victims. . . .") (citing H.R. REP. No. 1016, pt. 1, 96th Cong., 2d Sess. 20, *reprinted in* 1980 U.S. CODE CONG. & ADMIN. NEWS 6119, 6123).

the products and packaging chosen by consumers; and (3) *the disposal decision* — the manner in which consumers dispose of their refuse, including disposal with general refuse, separation for recycling, reuse, or composting.

Furthermore, one of the principal objections to the use of economic analysis in analyzing environmental issues — the difficult practical and ethical problems involved in valuing human life and nature — is largely separable from the problem of solid waste regulation. Although many disposal methods involve some risk to human health and nature, the principal objective of solid waste regulation is to achieve the optimal level of utilization of each of these methods, taking as given their social risks, however valued.[165] It is important to keep in mind that the use of economics in analyzing methods of solid waste regulation does not necessarily require the use of economic analysis to value the social costs of alternative disposal methods. This valuation can be informed by other modes of analysis without undermining the use of an economic framework to study the three principal decisions noted above.

This is not to suggest that economic analysis is without limitations in analyzing solid waste regulation. The model employed here is based upon a utilitarian philosophical perspective and therefore may not adequately address other conceptions of justice. For example, the model does not explicitly consider the effects of the various policies on the distribution of income in the society.[166] As will be discussed later, however, the policy prescriptions that flow from the economic framework would not necessarily exacerbate distributional concerns or seriously conflict with nonutilitarian conceptions of justice.[167]

This part develops an economic framework for analyzing solid waste regulation and examines a wide range of regulatory policies. Section A presents the economic framework.[168] Section B describes the principal incentive effects of the range of policies. Section C then compares the incentive and welfare effects of these policies in the absence of transaction costs. The theoretical analysis demonstrates the superiority of economic incentive systems over both the traditional mode of solid waste regulation and recent policy initiatives such as mandatory separation, product bans, and traditional deposit-refund systems. Section D introduces transaction costs into the analysis and describes how these costs affect the choice of the optimal policy. It shows that the economic incen-

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165. *See infra* notes 338-53 for discussion of the problems of determining the social costs of different methods of disposal.

166. Although rough adjustments could be made to incorporate distributional parameters, such changes would severely limit the tractability of the model.

167. *See infra* text accompanying notes 270-72.

168. A more rigorous development of the framework is presented in Menell, A Two-Tier Model of Solid Waste Regulation (Dec. 1989) (unpublished manuscript available from the author) [hereinafter Two-Tier Model].

tive systems continue to outperform the other policies for a wide range of assumptions about the magnitude of transaction costs. It then discusses the magnitude of transaction costs and describes advancements in monitoring technology that will continue to reduce the transaction costs of economic approaches to solid waste regulation. Section E discusses the generality and limitations of the economic analysis.

A. An Economic Framework for Analyzing Solid Waste Regulation

In order to highlight the problems of solid waste generation and disposal, this section constructs a simple economy comprised of three sectors: a production sector, a consumer sector, and a disposal sector. For ease of exposition, the consumer sector is limited to residential households, although the analysis would apply similarly to commercial and industrial contexts. The disposal sector comprises the entities performing the entire range of disposal services, including recycling, landfilling, and incineration.[169]

Admittedly, many of the assumptions of the model do not precisely mirror human behavior. The purpose of the model is to provide a sufficiently accurate picture of human behavior to facilitate identification of the principal incentive effects of the various policies examined. Once these effects are identified, the Article will discuss the sensitivity of the results to changes in the assumptions.

1. Production Sector

In order to focus the analysis, the model deals with only one product, which we will refer to as sparkling water. We will assume that sparkling water is competitively supplied, so that producers charge the marginal social cost of producing the product and its packaging.[170] Sparkling water can be packaged in either liter-sized plastic containers or liter-sized glass containers. The difference in price between water in plastic and water in glass reflects the different costs of producing the containers.[171]

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169. The mathematics of the model are given in footnotes paralleling the text. Readers who are less interested in the technical derivations may wish to concentrate on the intuitive explanations provided in the text.

170. The assumption that products made of virgin materials are supplied at their social marginal cost is not necessarily accurate. Distortions in other parts of the economy can cause virgin materials to be incorrectly priced. For example, subsidies to timber producers are often cited as a reason why virgin paper may be at a competitive advantage relative to recycled paper. See infra text accompanying notes 316-21. The implications of these types of problems are discussed in part IV.

171. Sparkling water packaged in plastic is denoted X_1. Sparkling water packaged in glass is referred to as X_2. The price of water in plastic is P_1, and the price of water packaged in glass is P_2.

Manufacturers' incentives to produce new packaging materials depend on consumer demand for better packaging and on the intellectual property system. To focus the analysis on environmental policy, the model assumes that patent law enables manufacturers to reap an adequate rate of return on innovations in packaging design.[172] Thus, manufacturers will develop packaging materials with lower costs of disposal only if consumers are willing to pay a premium for products embodying such innovations.

2. *Consumer Sector*

Consumers in this economy make two important decisions which affect the solid waste stream. The model assumes that all consumers purchase the same amount of sparkling water. Consumers decide which of the two water containers to purchase and how to dispose of the empty containers. Consumers can either include their containers with their mixed refuse or, if the municipality picks up separated bottles, leave them in a separate bin at the curbside. If the municipality does not pick up separated trash, the consumer can deliver separated containers to recycling centers, but this option is less convenient.

Consumers choose the packaging material that yields them the highest net utility or satisfaction. For example, a consumer may prefer plastic packaging because of its lighter weight and greater resistance to breakage. Alternatively, she may value the clean taste of water from glass containers. The utility a consumer derives from a container of sparkling water is equal to the satisfaction received from consuming the contents plus the satisfaction from the particular type of packaging less the cost of the product and any disposal costs that the consumer bears.[173]

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172. Patent law will introduce some inefficiencies in the production sector by creating temporary monopoly power. *See* F. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 442-54 (2d ed. 1980). To the extent these inefficiencies could not be overcome through the design of intellectual property policies, the optimal overall policy would reflect considerations of the theory of the "second best." *See* R. TRESCH, PUBLIC FINANCE: A NORMATIVE THEORY 296-473 (1981). These issues are beyond the scope of the present Article.

173. To simplify the analysis, the model assumes that each consumer receives the same level of satisfaction from consuming sparkling water from a plastic container. This level of satisfaction is expressed as U_0. The satisfaction from consuming water from a glass container is represented by $U_0 + r$. r represents the extent (in cents per container) to which a consumer prefers glass to plastic. A consumer is of "type j" if her extra satisfaction from consuming water from glass containers is r^j.

The model assumes that r^j is uniformly distributed between r_l ("low") and r_h ("high"). In a continuous uniform distribution, an equal number of people will fall within any two intervals of equal size. *See generally* A. MOOD, F. GRAYBILL & D. BOES, INTRODUCTION TO THE THEORY OF STATISTICS 105-06 (3d ed. 1974). As mathematicians are well aware, it is not technically correct to say that there exist discrete types within a continuous distribution. The text refers to specific types to avoid the inconvenience of having to explain consumer types in terms of intervals.

Since the consumer faces only two choices, a negative value for r^j means that the con-

In order to highlight the disposal decision and reflect the heterogeneity of consumers, the model assumes that consumers differ in their willingness to separate containers from other refuse. For example, environmentally conscious consumers may be willing to go to great lengths to ensure that a container is recycled, while others may consider separating refuse to be an inconvenience. In economic terms, consumers have different costs of separation; these costs include the inconvenience of separation plus the costs of transporting wastes to the collection point, either a recycling facility or, where the trash collectors pick up recyclables, the curbside.[174] Consumers separate containers when the benefit that they derive from doing so (including any refunds or other financial benefit as well as the satisfaction of protecting the environment) exceeds their cost of separation. To simplify the analysis, the model assumes that recycling plastic containers is not economically viable.[175]

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sumer prefers plastic containers. Thus, our use of U_o and r^j to describe consumer preferences does not reflect any inherent preference for either type of container. Since there are only two packaging choices available to the consumer, r^j merely reflects the consumer's relative preference.

174. The total cost of separating a glass container for a consumer of type k, TCS^k, equals a constant, d, plus a random variable, CS, uniformly distributed between CS_l ("low") and CS_h ("high"). CS reflects a variety of factors including some consumers' lack of storage space for separated wastes, the odor from storing empty refuse containers, and the general inconvenience to some people of separating. The model assumes that the distribution of CS is independent of the distribution of r.

The value of constant d depends on whether or not the municipality picks up separated glass containers at the curbside: if the municipality does, then d equals zero; if it does not, then d equals a positive constant d_o. The value of d_o can be thought of as the base additional cost of transporting separated glass containers to a recycling center. Thus, if curbside collection of separated glass occurs and there are no disposal charges directly borne by consumers, then consumers of type k will separate their trash so long as CS^k is less than zero. If there is no curbside collection of separated glass, then only those consumers with CS^k less than $-d_o$ (plus any fee paid for returned bottles) will take separated glass to recycling centers.

A consumer with CS^k less than zero might be thought of as someone who feels some personal responsibility or social obligation for the solid waste crisis, and who wishes to alleviate it in what little ways he can. The significance of this segment of the population is clear from the viability of voluntary recycling efforts in many U.S. communities. *See* COMING FULL CIRCLE, *supra* note 81, at 49 (presenting data showing an average participation rate of 45% in selected voluntary weekly curbside separation programs, but only 31% for biweekly or monthly programs). In communities offering only centralized collection of separated refuse at recycling centers, however, participation rates are lower than when a curbside program is offered. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.B-13 to 2.B-14; COMING FULL CIRCLE, *supra* note 81, at 18.

175. Although recent technological innovations have made plastic recycling possible, *see supra* note 80 and accompanying text, few curbside collection programs pick up plastic. *See, e.g.,* INSTITUTE FOR LOCAL SELF-RELIANCE, *supra* note 30, at 12-13 (noting that only 1 of 15 curbside collection programs surveyed picked up separated plastic; by contrast 13 of the programs collected separated glass).

It is important to keep in mind that this specification of the model is merely illustrative and was chosen to simplify the exposition. A more general version of the model, in which both glass and plastic are considered recyclable, leads to the same qualitative results. *See infra* text accompanying notes 245-49. The important factor is the difference in social disposal costs between the two materials.

3. Disposal Sector

The model assumes that the municipal authority collects mixed refuse. Under some of the policies being analyzed, the municipality also collects separated glass containers at the curbside. Even if the municipal authority does not collect separated glass containers at the curbside, the consumer can bring glass containers to a recycling center.

The municipal authority also disposes of mixed refuse and recycles separated glass containers. In order to focus upon purchasing and disposal incentives, the model assumes that the municipal authority uses the best disposal and recycling technologies available, i.e., those resulting in the lowest net social cost. The relevant social disposal costs are, therefore, the cost of disposing of glass containers included in mixed refuse, the cost of disposing of plastic containers included in mixed refuse, and the net salvage value of glass containers, i.e., the market price of recycled glass less the costs of collecting and recycling separated glass.[176]

B. Incentive Effects Produced by Solid Waste Regulatory Policies

As the description of the solid waste stream in part I suggests, the regulation of municipal solid waste is particularly difficult because solid waste generation and disposal decisions are made by heterogeneous actors at numerous points between production and ultimate disposal. Manufacturers decide what products and packaging materials to develop and offer based on the costs of production and consumers' demand. Consumers' demand for products and packaging is based on product prices, their preferences for particular packaging materials, and the disposal costs that they directly bear. Consumers' disposal decisions depend on their propensity to use particular disposal methods (e.g., how bothersome it is for them to separate) and the direct disposal costs imposed on them.

Public policies can influence these decisions in a variety of ways. The most direct way of influencing disposal decisions is to regulate consumers' disposal practices, either by charging a fee based on whether they separate their wastes or by prohibiting certain disposal options. An alternative method of influencing disposal decisions is to alter relative prices at the retail level, thereby influencing what products enter the municipal solid waste stream. A third type of policy combines both of these approaches. This section analyzes all three classes of solid waste regulatory policies.

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176. The marginal social disposal costs (including collection, treatment, processing, and/or disposal) are DC_1^n for a nonseparated plastic container, DC_2^n for a nonseparated glass container, and DC_2^n for a separated glass container. DC_2^n will be negative if the reuse value of a glass container exceeds the costs of collection, processing, and marketing. DC_2^s must be less than DC_2^n for glass recycling to be economically viable.

As benchmarks for comparing the incentive effects of the various regulatory policies, this section first describes the optimal allocation of resources, what economists refer to as the "first-best," and the incentive effects of the traditional solid waste policy in the United States, which we will refer to as the "status quo." It then describes a broad range of regulatory policies, analyzes their design, and compares the incentives they create to the first-best allocation of resources. Section C compares the incentive and social welfare effects of the policies. In order to isolate the ways in which the various policies affect product design, purchasing, and disposal incentives, consideration of the costs of implementing the policies is postponed until Section D.

As the analysis will reveal, a central problem of solid waste regulatory policy is essentially one of information.[177] It is difficult to know how a consumer will dispose of her refuse at the time she purchases the product — will she reuse it, throw it in a trash can, or separate it for recycling? Her choice affects the social costs of disposal. The various policies differ in their ability to elicit this information and influence consumers' actions. As a result, the incentive effects of the policies also differ.

1. Benchmarks for Analysis: The First-Best and the Status Quo

a. The First-Best Allocation of Resources

The first-best allocation of resources is that allocation which maximizes social welfare (or, equivalently, minimizes social costs) associated with solid waste generation and disposal. In order to determine the first-best allocation of resources in the context of our model, we need to answer the following questions: (1) Given consumer preferences (for packaging and disposal methods) and resource costs, which consumers should purchase glass containers and which should purchase plastic? and (2) Of those glass purchasers, which should separate their empty glass containers from the rest of their refuse?

Social welfare is defined as the sum of consumers' utility from consuming sparkling water (in the containers purchased), less production costs, costs of separation, and disposal costs. From the point of view of society as a whole, a consumer should purchase a glass container if the net increase in social welfare from doing so exceeds that from purchasing a plastic container.[178] A consumer's subjective preference for a glass container must be weighed against the difference in resource costs associ-

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177. The new "information economics" is explained in UNCERTAINTY IN ECONOMICS (P. Diamond & M. Rothschild eds. 1978).

178. The effect on social welfare of the purchasing decision includes: the consumer's personal satisfaction from consuming the product, the cost of producing the product, and the cost of the optimal disposal decision. A consumer of type (j, k) should buy a glass container if $U_o + r^j - P_2 - \min(CS^k + DC_2^s, DC_2^n) > U_o - P_1 - DC_1^n$.

ated with this choice. Therefore, the consumer should buy a glass container if her subjective preference for glass exceeds the difference in the production costs of glass and plastic containers added to the difference in the disposal costs of glass and plastic containers.[179]

For example, if the production cost of glass were one cent per container higher than that of plastic but the disposal cost were two cents per container lower (for that type of consumer), then the consumer should purchase a glass container even if she were inclined by one cent (or less) per container toward purchasing plastic, perhaps because of a desire to avoid breakage. The decision to purchase glass would save society one cent in resource costs, although it would cost up to one cent in consumer satisfaction. On the other hand, consumers who value the benefits of plastic by more than one cent per container should purchase plastic.

Turning next to the consumer's decision to separate refuse, the consumer who separates glass containers saves society the difference between the costs of disposal of nonseparated and separated glass containers.[180] Applying the same utilitarian calculus as above, a consumer who purchases glass should separate it from other refuse if his cost of separation is less than the difference between the social costs of disposing of nonseparated and separated glass containers.[181] Therefore, if the cost of disposing of an additional glass container as part of mixed refuse were four cents and the net social savings from recycling the same container were two cents, then glass purchasers who find the burden of separating less than six cents per container should separate and those who find the burden greater should not.

b. Status Quo

The traditional solid waste regulatory policy in the United States, which imposes no direct charge on solid waste disposal, provides a second benchmark for comparing solid waste regulatory policies. Under the traditional policy, the costs of solid waste disposal are paid through fixed periodic disposal fees, property taxes, or some other source of general revenues. Even though property taxes and fixed user fees do impose disposal costs on consumers, they have no effect on consumer behavior because they do not affect the marginal cost of disposal. Thus, if a consumer decided to dispose of an extra container, the additional social

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179. Rearranging the expression set out *supra* note 178, a consumer should purchase glass if: $r^j > (P_2 - P_1) + [\min(CS^k + DC_2^s, DC_2^n) - DC_1^n]$.

180. This difference is equal to $DC_2^n - DC_2^s$.

181. Assuming that the municipality collects separated containers at the curbside (i.e., $d = 0$), the consumer of type k should separate if $CS^k < DC_2^n - DC_2^s$. If the municipality does not collect separated containers, the consumer should separate if $d_o + CS^k < DC_2^n - DC_2^s$.

cost would be spread over all consumers in the community; the effect on her individual costs would be minuscule.

The status quo provides no direct incentive for consumers to separate. Thus, consumers will separate only if the satisfaction that they derive from separating a container exceeds the cost of transporting it to a recycling center.[182] The status quo also provides no incentive to consider disposal costs in purchasing decisions.[183] Moreover, because it does not internalize any of the social costs of waste disposal, the status quo does not encourage the development of more environmentally sound products and packaging.

2. Curbside Charges

From an economic perspective, consumer behavior can be affected by altering the relative prices faced by the consumer. The most direct way of systematically altering relative prices is by charging the consumer for the "external" social costs he or she imposes on society, i.e., the social costs not already reflected in market prices.[184] In the solid waste context, the most direct means of tying these charges to disposal decisions is to exact a fee at the curbside based on what the consumer disposes of and how she disposes of it. We will consider three versions of this approach: (1) a perfect curbside charge; (2) an optimal proportional curbside charge; and (3) mandatory separation.

a. Perfect Curbside Charge

Under a perfect curbside charge policy, the consumer is charged the full social cost of disposal of the refuse placed at the curbside. Therefore, the consumer chooses to separate any item for which the difference between mixed and separated disposal costs exceeds the cost of separation.[185] This separation decision produces the first-best allocation of resources.[186]

Consumers will also take these disposal charges into consideration when deciding which container type to purchase. In the context of our model, a consumer will prefer a glass container if her net utility from purchasing a glass bottle of sparkling water, consuming its contents, and disposing of it exceeds her net utility from purchasing a plastic container,

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182. That is, $CS^k < -d_o$.
183. Thus, a consumer of type (j, k) will purchase glass if: $U_o + r^j - P_2 - \min(CS^k + d_o, 0) > U_o - P_1$; or equivalently if: $r^j > (P_2 - P_1) + \min(CS^k + d_o, 0)$.
184. Economists often refer to such charges as Pigouvian taxes, after A.C. Pigou, who suggested that externalities could be "internalized" in this straightforward manner. A. PIGOU, THE ECONOMICS OF WELFARE (1920).
185. That is, if $CS^k < DC_2^n - DC_2^s$, the consumer will separate.
186. Compare the expression *supra* note 184 to that in note 181.

consuming its contents, and disposing of it with mixed refuse.[187] Again, this is the same tradeoff as the first-best allocation of resources.[188]

The perfect curbside charge policy achieves the first-best incentives because it internalizes the externality problem. Consumers pay the production cost associated with taking a bottle of sparkling water off the grocery store rack, and also the cost of landfilling, incinerating, or recycling the container. Furthermore, full cost internalization provides product manufacturers with strong incentives to develop products and packaging that are less costly to dispose of or recycle.

With many types of trash in the real world, some separated and some not, the perfect curbside charge policy would be implemented by having a trash inspector identify and assign a charge (based on the social disposal costs) for each item in the consumer's trash. Obviously, such a policy would be extremely expensive (not to mention extremely messy) to implement.

b. Optimal Proportional Curbside Charge

A more feasible approach, which is currently in use in some communities, is to charge a fee for refuse disposal proportional to one readily measurable parameter such as weight or volume.[189] In order to encourage consumers to separate recyclable items, the proportional charge would be assessed only for mixed refuse; specified categories of separated trash would be collected for free.

The optimal proportional curbside charge is the fee (in cents per pound or per volumetric measure of mixed refuse) that maximizes social welfare.[190] Where the charge is proportional to the weight of mixed refuse, the optimal proportional charge, although somewhat complicated to derive, is positively correlated with the difference in disposal costs of separated and unseparated glass, as well as the disposal cost of plastic. Where the charge is proportional to volume, the optimal charge is simply the sum of the following: the percentage of people who purchase plastic containers multiplied by the disposal cost of plastic, and the percentage of people who purchase glass multiplied by the difference in disposal costs of separated and unseparated glass.[191] This charge reflects the best

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187. Thus, a consumer of type (j, k) will purchase glass if: $U_o + r^j - P_2 - \min(CS^k + DC_2^s, DC_2^n) > U_o - P_1 - DC_1^n$.

188. The previous expression is algebraically equivalent to: $r^j > (P_2 - P_1) + [\min(CS^k + DC_2^s, DC_2^n) - DC_1^n]$, which is the same tradeoff as the first-best allocation of resources. *See supra* note 179.

189. For example, regulatory policies in Perkasie, Pennsylvania and Seattle, Washington make use of this approach. *See supra* text accompanying notes 131-36.

190. The optimal proportional curbside charge is derived in Two-Tier Model, *supra* note 168, app. at A-29.

191. This result is based on the assumption that both plastic and glass have the same volume at the time of disposal, i.e., consumers do not differentially compact their trash. The

estimate of the social costs of consumers' disposal decisions given the limitation, imposed for practical reasons, that the municipality can only measure the volume (or weight) of the unseparated refuse.

Under the optimal proportional curbside charge policy, glass purchasers will separate their glass containers if their subjective cost of separation is less than the additional disposal charge for unseparated glass.[192] If they separate their glass containers, their direct disposal cost is simply their cost of separation. If they choose not to separate, then their direct disposal cost is the proportional fee multiplied by the volume (or weight) of the containers that they throw away. Since plastic can only be disposed of as unseparated refuse, the consumer's disposal charge for plastic is always the proportional fee multiplied by the volume (or weight) of the containers thrown away.[193]

Given these direct disposal costs, consumers will purchase glass rather than plastic if their subjective preference for glass exceeds the difference in production costs between glass and plastic added to the difference in disposal costs for glass and plastic.[194] Since the optimal fee is a weighted average of the social disposal costs of the various categories of refuse, disposal incentives under this policy will reflect the true costs of disposal, although only imperfectly because the fee is based on a single parameter, the weight or volume of mixed refuse. Furthermore, the internalization of disposal costs through the optimal proportional curbside fee moves purchasing incentives toward those under the first-best. However, because the optimal proportional charge is based on the average disposal decisions of the community and only imperfectly monitors the decisions of each specific consumer, this policy will not in general create first-best incentives.

The optimal proportional curbside charge provides strong incentives for manufacturers to develop products and packaging that conserve on the parameter that the municipality uses to assess the curbside charge. Since this parameter is chosen not only because it is easily measured but also to approximate the social disposal costs — for example, both weight and volume measures reflect the amount of space that will be taken up in a landfill — the product design incentives will be positively correlated with the social (and environmental) good. However, because the charge

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optimal charge (α per liter) can be expressed mathematically as follows:

$$\alpha = \frac{(P_2 - P_1 - r_l) * DC_1^n}{(r_h - r_l)} + \frac{(r_h - P_2 + P_1) * (DC_2^n - DC_2^s)}{(r_h - r_l).}$$

192. That is, if $CS^k < \alpha * w_2$, where w_2 is the weight of glass. Thus, the consumer's disposal cost if she purchases glass is the minimum of CS^k and $\alpha * w_2$.

193. The disposal cost of plastic is always $\alpha * w_1$, where w_1 is the weight of plastic.

194. That is, the person of type (j, k) will buy a glass container if: $r^j > (P_2 - P_1) +$ [min(CS^k, $\alpha * w_2$) $- \alpha * w_1$].

is unlikely to be perfectly correlated with social disposal costs, the innovation incentives it produces will not in general be perfect.

c. Mandatory Separation

A third way to affect consumers' disposal behavior directly is to require separation of specific types of containers. This mandatory separation policy is being implemented in many communities.[195] In economic terms, it is equivalent to charging each purchaser of a glass container a curbside fee just greater than her cost of separation, thereby making all glass purchasers prefer to separate.[196]

Assuming complete enforcement, consumers faced with a mandatory separation policy will always separate empty glass containers. Since consumers pay no direct disposal charge under this policy, their disposal cost for glass will be equal to their cost of separation. Since plastic cannot be separated (by assumption), this policy imposes no disposal costs on consumers of plastic containers.

Under this mandatory separation policy, therefore, consumers will purchase glass containers only if their preference for glass exceeds the difference in cost between glass and plastic added to their cost of separation.[197] This policy will not yield the first-best incentives. Whenever the cost of separation for at least some consumers exceeds the social gains from separation, mandatory separation will overencourage separation of glass containers. This excessive incentive to separate, in turn, will discourage the purchase of glass containers, resulting in excessive purchases cf plastic containers.

Mandatory separation policies might also create perverse incentives for innovation.[198] Government policy should create appropriate incentives for the development not only of better products and packaging but also of new and better technologies for recycling and resource recovery. Under a mandatory separation policy, manufacturers who create new recycling technologies for their packaging materials risk having mandatory separation requirements imposed on their products. Given consumers' costs of separation, these requirements could hurt product sales. On the other hand, the potential for government-created markets for recycling might spur other innovators to develop recycling technologies. However, product manufacturers' specialized knowledge of the product may give them a superior capability to develop recycling technologies.

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195. *See supra* text accompanying notes 128-30.
196. Of course, if enforcement of the mandatory separation requirement were lax, then the effective curbside charge would be less and some consumers might not separate glass.
197. That is, if: $r^j > (P_2 - P_1) + CS^k$.
198. For a general discussion of the effects of regulatory policies on innovation, see Stewart, *Regulation, Innovation, and Administrative Law: A Conceptual Framework*, 69 CALIF. L. REV. 1256 (1981).

3. Retail Charges

The relative prices faced by consumers can also be altered by imposing charges at the retail level based on expected disposal decisions. Retail charges are less precise than curbside charges because the government cannot know at the time that a consumer purchases a product how she will dispose of the refuse. If the consumer separates the packaging from other refuse, the social cost of disposal will be less than if she does not. If she decides to reuse the packaging herself, assuming the container is durable, the social disposal cost would be still less. Nevertheless, it is possible to choose a retail charge, based on average purchasing and disposal behavior, that approximates the social cost of the consumer's purchasing decision. We will examine two types of product charges: an optimal retail charge and a product ban.

a. Optimal Retail Charge

In the absence of specific and reliable information on how a particular consumer will dispose of her refuse, the optimal retail charge, that charge which maximizes social welfare, is simply the expected disposal cost of the container chosen.[199] Since plastic purchasers have only one disposal option, the social disposal cost for plastic containers is simply the social cost of including a plastic container in mixed refuse. Glass containers, on the other hand, can be separated and recycled. The expected social disposal cost of a glass container depends on the proportion of consumers that separate. For example, if twenty percent of glass purchasers ultimately separate their containers, then the total expected social disposal cost for glass containers is 0.2 times the net salvage value of recycled glass plus 0.8 times the disposal cost of an additional landfilled glass container.[200] The charge can be altered over time as average disposal choices change.

The optimal retail charge policy provides no direct incentive for consumers to separate their refuse because their disposal decisions impose no direct costs. Thus, consumers will separate only if the satisfaction that they derive from separating exceeds the cost of transporting separated containers to a recycling center.[201]

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199. The optimal retail charges for glass and plastic in this model are fully derived in Two-Tier Model, *supra* note 168, app. at A-28. The intuition behind this set of charges is related to the information limitations of the retail charge policy. The municipality knows with certainty that consumers of plastic will dispose of their containers with unseparated refuse because they have no other options. Glass purchasers, however, might or might not separate, depending on their costs of separation, which are not revealed at the time of purchase. Therefore, the best estimate of the disposal cost is the expected value of disposal costs, which reflects the average separation decisions of the community.

200. The optimal retail charges for plastic and glass (t_1 and t_2, respectively) would thus be: $t_1 = DC_1^n$, and $t_2 = 0.2 * (DC_2^s) + 0.8 * (DC_2^n)$.

201. That is, only if $CS^k < -d_o$.

Social disposal costs do, however, affect consumers' purchasing decisions under the optimal retail charge policy because they raise the relative cost of containers with high expected disposal costs. Consumers will buy glass containers if their subjective preference for glass exceeds the difference in the retail price of glass and plastic containers (including optimal retail charges) less any added satisfaction they derive from separating glass containers.[202] Since the optimal retail charges are based on expected social disposal costs, purchase incentives under this policy will reflect the costs of disposal, although only imperfectly.

Optimal retail product charges provide strong incentives for manufacturers to develop products with lower social disposal costs and to encourage consumers to separate refuse that has significant net salvage value. Both of these activities would lower the retail fees imposed on the manufacturers' products.

b. *Product Ban*

Another retail policy is to impose a ban on materials with high social disposal costs. In the context of the model, plastic packaging, which cannot be recycled, could be banned. A product ban can be seen, in economic terms, as a retail product charge. The effective charge imposed by the ban on plastic packaging slightly exceeds any consumer's preference for sparkling water packaged in plastic containers.

By dictating purchasing decisions, a ban on plastic packaging fails to provide proper purchasing incentives. Furthermore, like the optimal retail charge policy, a product ban provides no incentives for consumers to separate glass containers when they dispose of their refuse.

The product ban also provides imperfect incentives for innovation in packaging materials. Product bans would encourage manufacturers to develop products from other materials that provide the same advantages to consumers as the banned materials. For example, a ban on plastic containers might create incentives to develop lightweight, shatter-proof glass containers. This might, in the end, result in development of products with lower social disposal costs. However, since the attributes consumers seek in different packaging materials are not systematically related to social disposal costs, it is unlikely that the incentives for innovation would be optimal.

4. *Two-Tier Charges*

A third set of policies combines a disposal charge with a retail charge. This might be desirable if one charge, by itself, fails to reflect the total social cost of disposal. For example, a curbside charge can often

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202. That is, consumers of the type (j, k) prefer glass to plastic if: $r^j > (P_2 - P_1) + (t_2 - t_1) + \min(CS^k + d_o, 0)$.

only be feasibly based on a single parameter (such as weight) even though multiple factors (such as weight, volume, and toxicity) affect social disposal costs. By monitoring both purchasing and disposal behavior, such policies elicit more complete information about consumers' purchasing and disposal decisions and therefore produce a better estimate of the social cost of each consumer's decisions.

a. Perfect Deposit-Refund

An important type of two-tier charge is a deposit-refund system.[203] A perfect deposit-refund scheme would impose a retail charge on all commodities equal to their disposal costs as part of mixed refuse. A refund would then be calculated at the curbside for separated materials. The refund would be equal to the difference between the social disposal costs of the items unseparated and separated. A consumer who chose not to separate would receive no refund. Whatever disposal decision the consumer made, therefore, she would bear the full social costs of that decision.

By fully internalizing social disposal costs, the perfect deposit-refund policy produces first-best purchasing and disposal incentives.[204] Furthermore, the price system transmits the disposal costs to manufacturers, creating optimal incentives for product and packaging innovation to reduce social disposal costs. Because of the extensive monitoring required, however, this policy would be expensive to implement.

b. Optimal Two-Tier Charge

A more feasible two-tier system would combine the optimal proportional curbside charge policy with the optimal retail charge policy. The optimal charges imposed under this system are similar to those derived under the straight retail and curbside charge policies, although they are adjusted to take into consideration the effect of the additional level of regulation.[205]

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203. *See generally* P. BOHM, DEPOSIT-REFUND SYSTEMS: THEORY AND APPLICATIONS TO ENVIRONMENTAL, CONSERVATION, AND CONSUMER POLICY (1981).

204.   The consumer will separate glass so long as $CS^k < DC_2^n - DC_2^s$, which corresponds to the first-best tradeoff. *See supra* note 181. A consumer of type (j, k) will purchase glass if: $U_o + r^j - P_2 - DC_2^n - \min[CS^k - (DC_2^n - DC_2^s), 0] > U_o - P_1 - DC_1^n$. By adding DC_2^n to both arguments in the minimum term and simplifying, this equation can be expressed as: $r^j > (P_2 - P_1) + [\min(CS^k + DC_2^s, DC_2^n) - DC_1^n]$, which is identical to the purchasing decision which produces the first-best allocation of resources. *See supra* note 179.

205.   The optimal two-tier curbside charge based on weight is given by: $\alpha = (DC_2^n - DC_2^s) / w_2$. *See* Two-Tier Model, *supra* note 168. If this curbside charge is used, the optimal retail charges for plastic (t_1) and glass (t_2) respectively are:

$$t_1 = DC_1^n - \alpha * w_1$$
$$t_2 = (\% \text{ of separators} * DC_2^s) + (\% \text{ of nonseparators} * (DC_2^n - \alpha * w_2)).$$

t_2 simplifies to DC_2^s.

The optimal two-tier charge policy achieves the first-best allocation of resources under the assumptions of this model because, with both a curbside charge and retail charges, it can precisely adjust the relative prices of products at the two critical points — the purchasing decision[206] and the glass separation decision.[207] This strong result, however, holds only when there are two packaging types and only one is recyclable. When there are more than two packaging types or more than one recyclable packaging, the two-tier charge policy continues to provide desirable, although not necessarily first-best, incentives.[208] Because the curbside charge is based on average disposal costs and not those of each consumer, it is not possible to adjust disposal charges perfectly. A partial adjustment can be made, however, through the retail charges, which are different for every product.

c. *Traditional Deposit-Refund*

A third type of two-tier system, currently in use in many parts of the United States, charges consumers a deposit fee at the time of purchase. This fee can be recovered by returning the empty container to a redemption location.[209] The same deposit is usually charged for all containers. Consumers will separate either glass or plastic if their costs of separation are less than the refund.[210] Consumers will purchase glass if their preference for glass exceeds the cost differential between glass and plastic.[211]

Unlike the perfect deposit-refund policy, the traditional deposit-refund policy does not replicate the first-best allocation of resources because the deposit and refund amounts are not based directly on social disposal costs. The constraint that the deposit charged must equal the refund given prevents the traditional deposit-refund policy from providing correct incentives for disposal of particular containers. Moreover, because the deposit-refund amount is generally the same for both packaging types, the traditional deposit-refund policy has no net effect on *rela-*

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206. Consumers of type (j, k) will purchase glass if their satisfaction from consuming a glass container of sparkling water less the retail cost less the cost of disposal exceeds the utility from consuming a plastic container of sparkling water less the retail cost and the cost of disposal: $U_o + r^j - P_2 - t_2 - min(CS^k, \alpha * w_2) > U_o - P_1 - \alpha * w_1$. By rearranging and substituting in the optimal values of α, t_2, and t_1, this expression simplifies to: $r^j > (P_2 - P_1) + [min(CS^k + DC_2^s, DC_2^n) - DC_1^n]$, which is the same as the first-best. *See supra* note 179.

207. Consumers will separate glass if: $CS^k < \alpha * w_2$. Thus, the consumer's disposal cost if she purchases glass is the minimum of CS^k and $\alpha * w_2$. Substituting in the optimal value of α $((DC_2^n - DC_2^s) / w_2)$, this is equivalent to $CS^k < DC_2^n - DC_2^s$, which is the same as the first-best. *See supra* note 181. Since plastic can only be disposed of as unseparated refuse, the consumer's disposal charge for plastic is $\alpha * w_1$.

208. The sensitivity of the two-tier charge policy to multiple packaging types and multiple recycling technologies is discussed below. *See infra* text accompanying notes 245-53.

209. In the model, the deposit amount, in cents per container, is expressed as dr.

210. That is, if: $(CS^k + d_o) < dr$.

211. A consumer will purchase glass if: $U_o + r^j - P_2 - dr - min(CS^k + d_o - dr, 0) > U_o - P_1 - dr - min(CS^k + d_o - dr, 0)$, which reduces to: $r^j > P_2 - P_1$.

tive purchase prices.[212] Furthermore, by requiring consumers to deliver separated containers to redemption centers rather than providing curbside pickup, the traditional deposit-refund policy results in higher transportation and collection costs.[213] Since the municipality must already collect unseparated refuse at the curbside, municipal collection of separated items at the curbside benefits from economies of scale.[214]

The traditional deposit-refund system also does not give manufacturers appropriate incentives for product and packaging innovation. The principal incentive that it creates is for containers that are easier to carry.

C. *Comparison of Solid Waste Regulatory Policies*

This section compares the incentive and social welfare effects produced by the range of solid waste regulatory policies discussed above. It first explains some general conclusions about the relative efficacy of the policies and then presents a simulation of the model in order to provide further insight into the choice among policies.

1. *General Results*

In order to assess the various regulatory policies, we must evaluate the combined effects on society of the disposal and purchasing decisions they produce. Within the utilitarian philosophical framework, total social welfare serves as this composite measure of well-being. It accounts for the full social benefits and costs accruing to the community. As such, it provides a single measure for comparing alternative policies.[215]

The economic model described above yields a straightforward measure of social welfare. In the absence of transaction costs, the total social welfare generated by a particular solid waste policy is the sum of consumers' utility from the products and packaging that they purchase less the production and disposal costs of these products, as well as the consumers' costs of separation where applicable.[216]

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212. The use of different deposit-refund amounts for different container types (based on social disposal costs) alleviates, but does not fully remedy, this distortion because it still artificially imposes the constraint that the deposit amount equal the refund amount for each container type. Ideally, we would want to choose separate deposit and refund amounts for each container type based on their social disposal costs. This policy would be more in the nature of a retail charge and a refund, which is akin to the perfect deposit-refund policy.

213. *Cf.* Porter, *A Social Benefit-Cost Analysis of Mandatory Deposits on Beverage Containers*, 5 J. ENVTL. ECON. & MGMT. 351, 366 (1978) (discussing the social costs involved in mandatory deposit programs).

214. *See* COMING FULL CIRCLE, *supra* note 81, at 19.

215. Although the utilitarian framework is an important perspective from which to evaluate social decisions, it is by no means the only philosophical framework for making social decisions. For a discussion of the extent to which the results of the economic analysis are consistent with other philosophical perspectives, see *infra* notes 270-74 and accompanying text.

216. For convenience, we assume that any retail tax revenues and curbside charge reve-

Policies that produce the first-best allocation of resources will, by definition, generate the maximum social welfare. The previous section demonstrated that the perfect curbside charge policy and the perfect deposit-refund policy always achieve the first-best allocation of resources. Furthermore, the optimal two-tier charge policy also achieves the first-best allocation of resources under the assumptions of the model — two packaging types, only one of which is recyclable.[217] Therefore, these policies perform at least as well as each of the other policies under the assumptions of the model.

It is also straightforward to show that the optimal proportional curbside charge and the optimal retail charge policies are preferable to the status quo.[218] These results follow from the fact that the status quo is equivalent to these optimal charge policies, except that under the status quo the retail and curbside charges are both constrained to be zero. Since the optimal charges, by definition, are chosen to increase social welfare, total social welfare under these policies must exceed that under the status quo policy. Furthermore, the optimal two-tier charge policy and the optimal retail charge policy outperform the product ban because they more accurately adjust relative retail prices to reflect social disposal costs.[219]

By contrast, the mandatory separation policy, the product ban policy, and the traditional deposit-refund policy are not always preferable to the status quo.[220] By dictating particular modes of behavior for a heterogeneous consumer community, the mandatory separation and product ban policies can result in highly inefficient disposal and purchasing decisions, thereby resulting in lower social welfare than the status quo. The traditional deposit-refund policy can also result in worse purchasing decisions than the status quo. Furthermore, depending upon the costs of

nues are distributed in lump-sum form to consumers. Equivalently, given the specifications of the model, we could assume that these revenues are applied to disposal costs. *See* Two-Tier Model, *supra* note 168 (describing in detail how the social welfare functions are constructed).

217.   The optimal two-tier charge policy does not in general achieve the first-best allocation of resources when plastics recycling is economically viable, *see* Two-Tier Model, *supra* note 168, app. at A-11 to A-15, although it continues to perform well. *See infra* notes 245-49 and accompanying text. The perfect curbside charge and perfect deposit-refund policies achieve the first-best allocation of resources even when plastics recycling is economically viable. *See* Two-Tier Model, *supra* note 168, app. at A-7 to A-11.

218.   These propositions are formally demonstrated in Two-Tier Model, *supra* note 168, app. at A-15 to A-17.

219.   Whenever the product ban is overinclusive, i.e., when there is some group in society that is willing to pay more than the full disposal cost to obtain the packaging, a retail charge policy that allows that consumer type to purchase such packaging yields higher social welfare than the product ban. Alternatively, if no consumers are willing to pay the full social disposal costs for a particular type of packaging, then retail charges can be set above everyone's willingness to pay, resulting in an allocation of resources equivalent to that produced by a product ban. Thus, the optimal retail charge policy can always perform at least as well as a product ban under the assumptions of the model. *See* Two-Tier Model, *supra* note 168, app. at A-33.

220.   *See id.*

separation and net salvage values for recycled containers, the traditional deposit-refund policy can result in inefficient transportation of separated refuse.

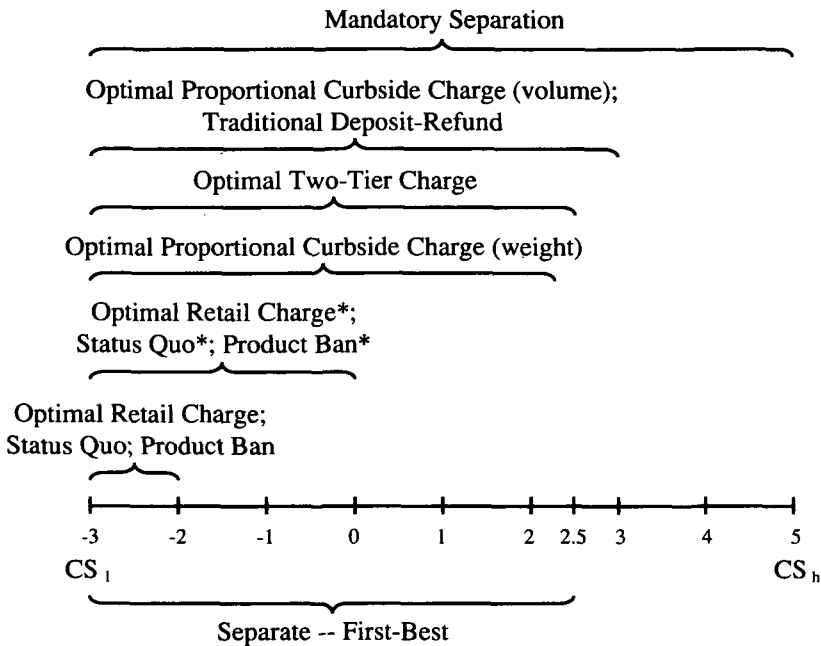## 2. A Simulation of Solid Waste Regulatory Policies

In order to obtain a more complete ranking of the various policies, we must make some assumptions about the parameters of the model. As a plausible, illustrative example, consider the following parameter values.[221] To simplify the calculations, we assume that the production costs (including raw materials, labor, capital, distribution, and marketing) for glass and plastic one liter bottles of sparkling water are both 80 cents. Each consumer derives the same level of satisfaction from consuming the sparkling water. Half of the consumers, however, prefer glass containers because of their clean taste and recyclability; half prefer plastic because it is lighter and less breakable. Those consumers most inclined to purchase glass are willing to pay as much as 5 cents extra for glass containers; the same is true for those most inclined toward plastic. We assume that consumers are evenly distributed between these two extremes. With regard to separating containers with significant net salvage values, the most environmentally conscious consumers are willing to separate even if it costs them 3 cents (in travel cost and/or storage space) per container to do so. Those least willing to separate would pay up to 5 cents to avoid this burden. As above, consumers are distributed evenly between these extremes. We further assume that bringing empty containers to a recycling center costs each consumer 2 cents per container in travel expenses and additional inconvenience. Based on collection cost estimates, tipping fees, and recycling spot prices, we assume the following social disposal costs per container: 3 cents for nonseparated plastic (DC_1^n); 2 cents for nonseparated glass (DC_2^n); and net salvage value of 0.5 cents for separated glass (DC_2^s).[222] For purposes of computing the optimal proportional

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221. These parameter values are based on the limited hard data available (such as collection costs, tipping fees, and salvage values) and casual empiricism (e.g., grocery store prices). In view of the obvious limitations of this approach, the sensitivity of this analysis using a wide range of parameter values is discussed below. *See infra* text accompanying notes 251-53.

222. One report found that collection represents 50-65% of total disposal cost, transport represents 3-15%, and treatment (including landfilling) represents 20-40%. ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT, ECONOMIC INSTRUMENTS IN SOLID WASTE MANAGEMENT 14 (1981). Given the extraordinary increase in treatment costs since this report was prepared, owing to the rapid depletion of available landfill space and concerns about landfill safety and the risks of incineration, treatment is likely to be a much more substantial portion of total disposal costs today. Disposal costs range from as low as $3.15 per ton in Boise, Idaho (landfill tipping fee in 1987) to as high as $110 per ton in the Northeast. *See supra* notes 47-48 and accompanying text. In constructing our range of disposal costs, we must also consider the fact that plastic containers, although lighter than glass, may consume more landfill volume per container. *See supra* note 23 and accompanying text. Separated clear glass is currently being sold for between $50 and $80 per ton (price at buyer's dock), *see The Markets Page*, RECYCLING TIMES, May 23, 1989, at 3, which is between 2.5 cents and 4 cents

FIGURE 1
Disposal Incentives

Mandatory Separation

Optimal Proportional Curbside Charge (volume);
Traditional Deposit-Refund

Optimal Two-Tier Charge

Optimal Proportional Curbside Charge (weight)

Optimal Retail Charge*;
Status Quo*; Product Ban*

Optimal Retail Charge;
Status Quo; Product Ban

|———|———|———|———|———|———|—|—|———|———|
-3   -2   -1   0   1   2 2.5 3   4   5
CS $_l$ CS $_h$

Separate -- First-Best

*Assuming voluntary curbside collection of separated glass containers.

curbside charge (α) based on weight of unseparated refuse, we assume
weights for plastic and glass containers of 0.3 pounds and 1 pound per
liter container, respectively. We assume equal volumes for computing
the optimal proportional curbside charge based on volume of mixed
refuse.

Based on the analysis described in section B, figure 1 shows the in-
centives to separate glass produced by each policy for these parameter
values. Given a disposal cost of 2 cents per unseparated glass container
and a net salvage value of 0.5 cents per separated glass container, con-
sumers with costs of separation less than or equal to 2.5 cents should
separate their empty glass containers. As demonstrated by the earlier
analysis, the perfect curbside charge, perfect deposit-refund, and optimal
two-tier charge policies produce these incentives. The optimal propor-
tional curbside charge policy (using weight or volume) comes relatively
close to the first-best separation incentives — it produces slightly too lit-
tle separation under the weight measure (α = 2.4 cents) and too much

per one pound glass container. Taking into consideration the costs of collection, initial
processing, and the costs of operating a recycling facility, we assume a net salvage value for
separated glass (DC$_2^s$) of 0.5 cents.

separation under the volume measure (α = 3 cents). The traditional deposit-refund policy also performs well under these parameter values. This reflects the coincidence that the difference between the deposit charge (5 cents) and the fixed cost of transporting separated items to a recycling center (2 cents) is close to the social gain of recycling (2.5 cents). With the cost of separation of the least inclined group at 5 cents, the mandatory separation policy leads to excessive separation of glass; glass purchasers with costs of separation between 2.5 cents and 5 cents will separate, even though the gain to society (2.5 cents) is less than their cost of separation. On the other hand, the optimal retail charge, the product ban, and the status quo yield much too little separation of glass containers, especially when there is no voluntary curbside collection of separated glass containers.

Turning to the purchasing incentives, figure 2 graphs the critical values for consumers' subjective preferences for packaging (r^j), i.e., the preference value below which consumers purchase plastic and above which they choose glass, over the range of costs of separation under each of the policies. Given the large differential between the costs of disposing of separated glass and nonseparated plastic (3.5 cents), all consumers with low costs of separation (i.e., between -3 cents and -1.5 cents) should purchase glass. They save society 3.5 cents in disposal costs while benefitting (between 1.5 and 3 cents) from being able to reduce environmental degradation. As costs of separation rise above -1.5 cents, it becomes optimal for those consumers with the strongest preference for plastic packaging (i.e., low r^j) to purchase plastic. Therefore, in this range the critical value for the subjective preference for packaging increases one-for-one with increases in the costs of separation. This occurs until the consumer's cost of separation reaches 2.5 cents. At and above this level, it is optimal for consumers who purchase glass not to separate their glass containers. Consequently, the critical value of the subjective preference for packaging remains at -1 cent, the difference in the disposal cost of plastic and nonseparated glass, for costs of separation between 2.5 cents and 5 cents. The shaded area in figure 2 represents the percentage of consumers who should purchase plastic under the first-best allocation of resources.

The purchasing incentives of the other policies can readily be assessed by comparison to this shaded area. The optimal proportional curbside charge policy (based on volume) and the optimal retail charge policy (assuming curbside pickup of separated as well as mixed refuse) come relatively close to the first-best purchasing incentives because they systematically internalize the social disposal costs of purchasing options. The mandatory separation policy results in greatly excessive purchases of plastic containers across the range of costs of separation. By contrast, the packaging ban results in too little purchasing of plastic. The tradi-

FIGURE 2
Comparison of Purchasing Incentives*
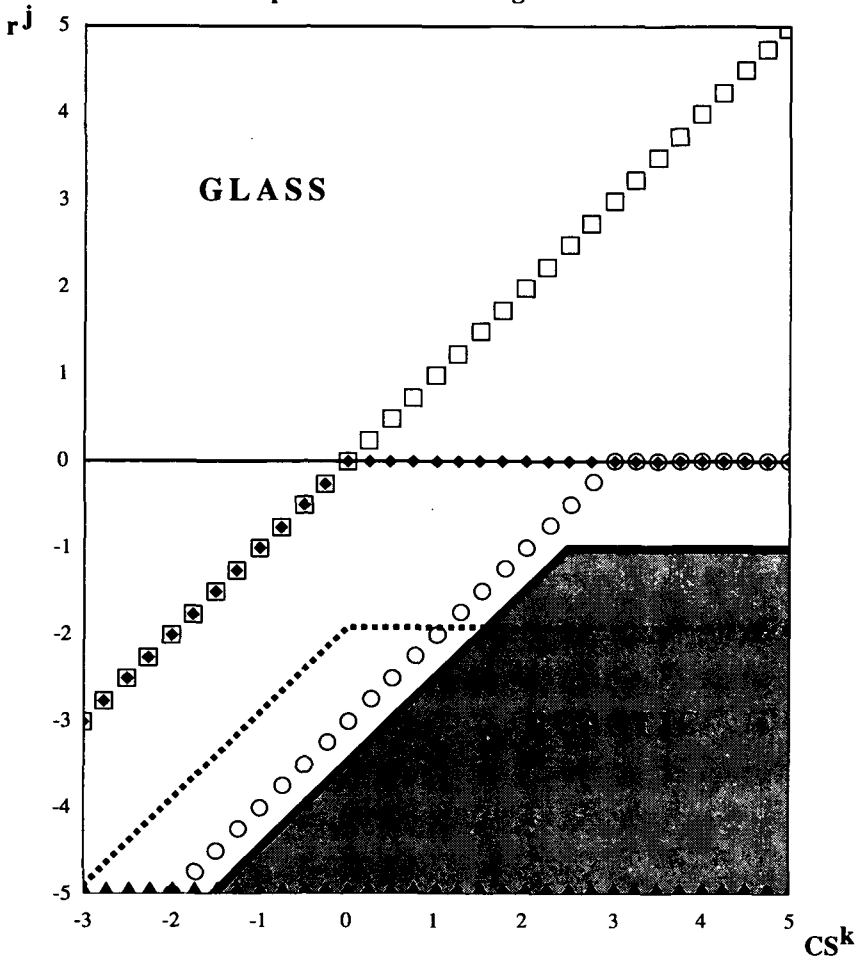
Symbol	Policy
▬▬▬	First-Best
□□□□	Mandatory Separation
———	Traditional Deposit-Refund
◆◆◆◆◆	Status Quo
○○○○○	Optimal Proportional Curbside Charge
■■■■■	Optimal Retail Charge
▲▲▲▲▲	Product Ban

*Selected parameter values:

Parameter	Value
$P_2 - P_1$	$0\cent$
(r_l, r_h)	$[-5\cent, 5\cent]$
(CS_l, CS_h)	$[-3\cent, 5\cent]$
d_0	$2\cent$
dr	$5\cent$
DC_1^n	$3\cent$
DC_2^n	$2\cent$
DC_2^s	$-.5\cent$
v_1, v_2	1 liter

tional deposit-refund policy causes consumers to base their purchase decisions solely on their subjective preference for packaging. Consumers who prefer glass purchase glass; those who prefer plastic purchase plastic.

Table 2 summarizes the social welfare effects of these solid waste regulatory policies. The first-best policies result in 21.1% of consumers purchasing plastic and 78.9% of consumers purchasing glass. Of the glass purchasers, 76.2% separate and 23.7% do not. The optimal proportional curbside charge policy achieves slightly too many plastic purchases and slightly too much separation by the glass purchasers. The optimal retail charge policy with voluntary curbside collection of separated glass containers comes quite close to the optimal purchasing decisions, but results in far too little separation. The status quo, the traditional deposit-refund policy, and especially the mandatory separation policy result in far too much purchasing of plastic; in the case of mandatory separation, almost three times the optimal amount. The product ban results in far too little purchasing of plastic. The mandatory separation policy results in too high a percentage of separation by glass purchasers. The status quo, optimal retail charge policy, and product ban policy result in far too little separation. The traditional deposit-refund policy, while coming close to the optimal percentage of glass separation, results in wasteful efforts to separate plastic and encourages many consumers who should purchase and separate glass to purchase plastic instead.[223]

The optimal two-tier charge, under the conditions of the model, achieves the first-best allocation of resources. The optimal curbside charge policy (based on volume) comes within 0.2% of the level of social welfare achieved under the first-best. The optimal retail charge policy with curbside collection achieves almost 98% of the first-best. Mandatory separation produces approximately 95% of the first-best level. The status quo achieves 91.6% of the first-best level. The product ban and the traditional deposit-refund policies perform the worst, generating 87.5% and 86.3% of the first-best level of social welfare, respectively.[224]

Although this simulation was based upon plausible parameter values, the method of estimation was quite crude. In order to be confident about these results, it is important to know whether the effects identified

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223. *Cf.* Porter, *supra* note 213, at 365-67 (finding that the social desirability of mandatory deposit laws depends critically on the average value of the time it takes consumers to return empty containers).

The analysis given in this Article suggests a straightforward means of improving the efficacy of deposit-refund systems. Purchasing and disposal incentives could be improved by basing deposit-refund amounts on actual social disposal costs. Under this approach, the deposit and refund amounts for a particular container could be different; deposits would also vary for different types of containers.

224. It must be kept in mind that these results are based on the particular assumptions underlying the model and the parameter values selected. Among the effects not considered are the social benefits of reducing litter and the possibility that someone other than the consumer will recycle an empty container, both of which occur with the traditional deposit-refund policy.

TABLE 2

Comparison of Social Welfare Effects*

Regulatory Policy	Social Welfare (% of First-Best)	Purchasing		Glass Separation	
		percent plastic	percent glass	percent separated	percent not separated
First-Best Allocation	100	21.1	78.9	76.2	23.7
Optimal Two-Tier Charge	100	21.1	78.9	76.2	23.7
Optimal Curbside Charge**	99.8	27.5	72.5	82.8	17.2
Optimal Retail Charge***	97.8	25	75	42.2	57.8
Mandatory Separation	94.7	60	40	100	0
Status Quo	91.6	49.4	50.6	13.6	86.4
Product Ban	87.5	0	100	12.5	87.5
Traditional Deposit-Refund	86.3	50	50	75****	25****

* This simulation is based on the following parameter values:

Parameter	Value	Parameter	Value	Parameter	Value
P_2, P_1	80¢	DC^n_1	3¢	v_1	1 liter
(r_l, r_h)	[-5¢,5¢]	DC^n_2	2¢	v_2	1 liter
(CS_l, CS_h)	[-3¢,5¢]	DC^c_2	-.5¢	dr	5¢
U_o	95¢	d_o	2¢		

** Based on volume.

*** With voluntary curbside collection of separated glass containers.

**** Applies to both plastic and glass containers.

continue to hold for a wide range of parameter values. Since consumers are primarily interested in the contents of the container and not the container itself, it seems plausible to assume that consumers' relative preference for a glass or plastic container is no greater than 10% of the retail cost of the product (i.e., $-8 \leqq r^j \leqq 8$ for a retail price of 80 cents). Based upon current retail prices of approximately 80 cents for a liter of generic sparkling water, we assume a range for the difference in the prices of glass and plastic containers of sparkling water ($P_2 - P_1$) of 8 cents in either direction. Price differences much greater than this might result in only one type of packaging being offered, given the range of preferences for glass and plastic assumed. For the cost of separation, we assume that the most any substantial group of consumers would be willing to pay to separate glass containers is between 6 and 0 cents per container ($0 \leqq CS_l \leqq 6$) and that the most that the group most inconvenienced by separating would have to be paid is between 2 and 8 cents per container ($2 \leqq CS_h \leqq 8$). Furthermore, we assume that the inconvenience of bringing empty containers to a recycling center adds between 1 and 3 cents per container for all consumers ($1 \leqq d_o \leqq 3$).

Using rough estimates of disposal costs based on collection cost estimates, tipping fees, and recycling spot prices, we can assume the following ranges for social disposal costs: 1 to 5 cents for nonseparated plastic (DC_1^n); 1 to 3 cents for nonseparated glass (DC_2^n); and -2 cents to 1 cent for separated glass (DC_2^s).[225]

Table 3 summarizes the predominant incentive effects of the various policies for various permutations of a wide range of the parameter values. Because of their flexibility and responsiveness to social disposal costs, the economic incentive approaches outperform the command-and-control type policies for substantially all permutations of the parameters.

D. Comparison of Regulatory Policies in the Presence of Transaction Costs

The desirability of a particular policy depends on its costs of implementation as well as its efficacy in correcting distortions. This section first describes how transaction costs can be incorporated into the economic framework. It then discusses the magnitude of transaction costs for the various regulatory policies.

1. Incorporating Transaction Costs into the Analysis

Within the utilitarian framework, transaction costs are just another set of resource costs that must be subtracted from total social welfare. In order to highlight the principal effects of transaction costs on the ranking of policies, these costs can be incorporated into the policy analysis in the following straightforward manner.[226] Curbside pickup of mixed refuse imposes some cost per household (β_0). Collecting separated items adds an additional cost per household (β_1). Weighing (or measuring the volume of) mixed refuse and assessing a charge imposes yet another cost per household (β_2).[227] The transaction costs associated with retail surcharges are assumed to have a similarly simple structure. There is a per item cost for assessing a retail charge (τ_1), and, in the case of the deposit-refund policy, a processing cost per redeemed item (τ_2). The model assumes that a product ban would be costless to implement.[228]

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225. *See supra* note 221-22.

226. The structure of transaction costs can influence the design of the particular types of regulatory policies. . *See* Polinsky & Shavell, *Pigouvian Taxation with Administrative Costs*, 19 J. PUB. ECON. 385 (1982). Such effects, however, are likely to be of secondary significance.

In addition to the direct costs of implementation discussed in the text, all of the incentive approaches described require policymakers to determine the social costs of disposal. Although this involves some difficult analytical and philosophical questions, there are significant economies of scale in making these valuations. *See infra* note 309 and accompanying text.

227. Adoption of a curbside charge might also create problems such as illegal dumping or, where credits are available for separated refuse, theft. Such problems would raise the enforcement costs, which are a type of transaction cost, for such policies. *See infra* notes 362-65 and accompanying text (discussing ways of addressing enforcement problems).

228. Since the perfect curbside charge and perfect deposit-refund policies would be ex-

TABLE 3

Summary of Incentive Effects for a Range of Parameter Values[*]

Policies	Disposal Incentives	Purchasing Incentives	Product Design Incentives
Curbside Charges: Perfect Curbside Charge	optimal incentives (i.e., same as First-Best)	optimal incentives	optimal incentives
Optimal Proportional Curbside Charge (volume or weight)	close to optimal incentives	somewhat less glass than optimal for most plausible values	incentive to innovate packaging with lower volume or weight
Mandatory Separation	excessive separation	excessive purchase of plastic	significantly distorted incentives
Retail Charges: Optimal Retail Charge	much too little separation	close to optimal (especially with voluntary curbside collection)	close to optimal incentives
Product Ban	much too little separation	greatly excessive purchase of glass	significantly distorted incentives
Two-Tier Policies: Perfect Deposit-Refund	optimal incentives	optimal incentives	optimal incentives
Optimal Two-Tier Charge	optimal incentives	optimal incentives	optimal incentives
Traditional Deposit-Refund	depends on relation among dr, d_o and DC's	excessive purchase of plastic	weak incentives to innovate better packaging
Status Quo	much too little separation	excessive purchase of plastic	little or no incentive

[*] This comparison is based on the predominant tendencies of the model for a broad set of "plausible" parameter values. The following ranges were simulated:

Parameter	Range		Parameter	Range		Parameter	Value
P_2-P_1	-10,10¢		DC_1^r	1,5¢		w_1	.3 lbs.
r_i	-8,0¢		DC_2^r	1,3¢		w_2	1 lb.
r_b	0,8¢		DC_2^c	-2,1¢		v_1	1 liter
CS_i	-6,0¢		d_o	1,3¢		v_2	1 liter
CS_b	2,8¢		dr	5¢			

The optimal regulatory policy in the presence of transaction costs is simply the policy that yields the highest net social welfare. In general, where both curbside and retail transaction costs are low, the optimal two-tier charge policy performs best because it provides optimal incentives for both disposal and purchasing decisions. For low values of curbside transaction costs and high values of retail transaction costs, the optimal proportional curbside charge policy performs best.[229] Inversely, for low retail transaction costs combined with relatively high curbside transaction costs, the optimal retail charge policy is preferable to the others. Where both curbside and retail transaction costs are high, the status quo tends to be preferred.

As an illustration of these effects, figure 3 shows how the optimal policy varies with changes in transaction costs for the parameter values used in the previous section. For a community in which the average household consists of four persons who consume one bottle of sparkling water per day, the optimal two-tier charge policy is preferred when the additional cost of measuring the amount of mixed refuse is below 10.6 cents per household per week and the cost of assessing a retail charge is below .03 cents per item.[230] As the transaction cost of measuring the volume of mixed refuse increases, the retail charge policy (with voluntary curbside collection of separated glass containers) becomes most cost-effective. The optimal proportional curbside charge policy becomes preferable as the cost of implementing the retail surcharge rises. When the additional transaction costs of the retail charge policy and the proportional curbside charge policy rise above .15 cents per item and 13.9 cents per household per week respectively, then the status quo (with voluntary curbside collection of separated glass containers) becomes preferred because the implementation costs of any other policy outweigh the social and environmental benefits of more complete regulation.[231]

This pattern helps explain why the United States has moved slowly in developing better solid waste policies, as well as why change is imminent. Until recently, the perceived (although not actual) cost of landfill

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tremely expensive to implement, the analysis in this section focuses upon the other policies.

229. If β_1 is low and β_2 is high, mandatory separation can become the preferred policy. As the next section shows, however, there are good reasons for believing that β_2 can be kept reasonably low. *See infra* notes 235-37 and accompanying text.

230. We assume that refuse is collected on a weekly basis and that the cost of collecting mixed refuse (β_0) is 50¢ per household and the additional cost of collecting separated refuse (β_1) is 10¢ per household. τ_2 is assumed to be .5¢ per container.

231. It should be emphasized that this example is based on only a small portion of the solid waste stream. The break-even transaction costs for the various economic incentive policies (relative to the status quo) would be substantially higher for the entire waste stream. Precise estimation of these breakeven points requires a more detailed analysis of the various constituents of the waste stream. As noted below, *see infra* text accompanying notes 250-53, expanding the analysis along this dimension increases the attractiveness of economic incentive approaches relative to the status quo and command-and-control policies.

FIGURE 3

Optimal Solid Waste Regulatory Policies

for Selected Transaction Costs*
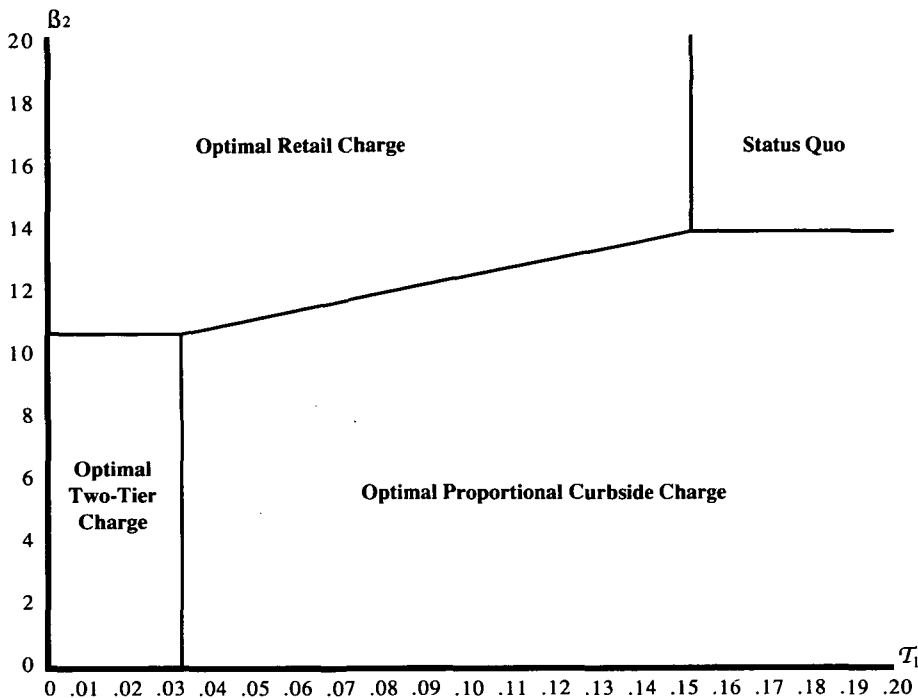
*β_0= 50¢ per household; β_1 =10¢ per household; T_1= .5¢ per container returned

disposal was very low.[232] Moreover, the costs of weighing unseparated refuse at the curbside or using systematic retail charges were high relative to these perceived costs.[233] The time is ripe, however, for a switch from the status quo to the incentive-based policies. The true costs of landfill disposal are increasingly becoming recognized.[234] And, as the next section discusses, technological advancements have substantially reduced the transaction costs of incentive-based policies.

2. The Magnitude of Transaction Costs

The principal transaction costs of economic incentive systems relate to monitoring. Recent technological advances have substantially reduced these costs. This section discusses these advances and suggests

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232. *See supra* notes 44–48 and accompanying text.
233. *See, e.g.,* KEEP AMERICA BEAUTIFUL, *supra* note 25, at 12.
234. *See supra* notes 43–47 and accompanying text.

that as social disposal costs continue to rise and the costs of monitoring disposal decisions continue to fall, economic incentive approaches will become the preferred policies for more and more communities.

The transaction costs of implementing the optimal proportional curbside charge policy are similar to the costs of charging for electricity, natural gas, and water use. In the context of these traditional public utilities, the principal transaction costs are meter reading and billing. These costs have been substantially reduced with the advent of advanced data processing and mailing technologies.

With the proportional curbside charge policy, trash collectors would have to measure the weight or volume of the mixed refuse and load separated items into a few categorized bins (e.g., paper, glass, metal, plastic). With traditional garbage truck design, this separation would be quite costly. It is possible, however, to design vehicles with multiple bins for separated materials[235] and scales (or other devices) for measuring the weight or volume of unseparated refuse.[236] Onboard computers could calculate the refuse charge for each household as the refuse was collected. At the end of a daily run, this data could be "dumped" into a main computer which would prepare individualized customer bills. As technologies continue to develop, it will be possible to move toward a perfect deposit-refund scheme in which households would be credited for the value of separated items based on actual resource recovery values.

As the programs in Perkasie, Pennsylvania and Seattle, Washington attest, the transaction costs of curbside charges can be reduced in even simpler ways. Perkasie's plan of requiring households to purchase special trash bags and Seattle's system of charging on a monthly basis for the use of receptacles of particular sizes creatively minimize transaction costs.[237] The technologically sophisticated system described above would provide more flexibility and convenience than these approaches, but would result in higher implementation costs, especially at the outset.

At first glance, it would appear that the cost of implementing a system that accurately adjusts relative retail prices to reflect social disposal costs would be prohibitively expensive. The typical large grocery store

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235. *See, e.g.*, INSTITUTE FOR LOCAL SELF-RELIANCE, DIRECTORY OF WASTE UTILIZATION TECHNOLOGIES IN EUROPE AND THE UNITED STATES 6-7 (1989) (describing the Eager Beaver refuse collection vehicle, which features four compartments for collecting separated wastes). The magazines BIOCYCLE and RESOURCE RECYCLING regularly advertise a variety of refuse collection vehicles designed to collect separated wastes.

236. For landfilled refuse, the most appropriate measure is compacted volume. Since the compactness of household refuse can vary significantly, especially if some households use trash compactors, weight may be the best feasible measure.

237. *See supra* text accompanying notes 131-36. The Perkasie "per bag" approach is more effective than the Seattle "per can" charge because consumers are not registered for a specific number of cans per week. Whereas Seattle households have an incentive to fill each can to the brim (because the additional charge is zero), Perkasie households can save money by putting out fewer bags in a given week.

sells 10,000 to 15,000 products.[238] If clerks had to individually mark the added charge for each item, the transaction costs would indeed be exorbitant. Transaction costs would be even higher if social disposal costs change over time, as they are likely to do with the development of new disposal technologies or changes in consumer separation behavior.

Recent advances in scanning technology, coupled with the widespread adoption of the Universal Product Code (UPC) system (also known as bar codes),[239] however, suggest the possibility of implementing a surprisingly low cost yet highly flexible system of adjusting relative retail prices to reflect social disposal costs. Many retail outlets currently use optical scanners, which read UPC's to identify the product being purchased. A computerized cash register looks up the price assigned to each product, as well as any applicable taxes, and rings the amount up on the consumer's bill.[240] If data on the amount of disposable materials in each product, recycling rates for different materials, and the true social disposal costs of different materials were input into the computer, this system could be used to assign individualized disposal charges to retail products.

Widespread use of scanning technology makes this approach feasible now or in the very near future. The use of UPC's and scanning technology has grown from less than one percent of retail grocery sales in 1977 to more than sixty percent today.[241] This increase is expected to continue.[242] Moreover, scanning technology is now being introduced in the food service industry, hardware stores, automotive parts stores, and other retail establishments.[243]

These technological advances have significantly reduced the costs of implementing sophisticated systems of monitoring disposal and purchasing decisions.[244] Consequently, the theoretical advantages of the economic incentive approaches described earlier can now be realized through feasible regulatory policies.

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238. *See* Thayer, *Solid Waste: The Problem You Can't Ignore*, PROGRESSIVE GROCER, Mar. 1989, at 80.

239. The Universal Product Code (UPC) is an 11-digit numeric code that identifies consumer products. It was established by the Uniform Code Council (UCC), an organization that is open to all retailers, wholesalers, and manufacturers. The first character of the UPC denotes the category of product (e.g., regular grocery item, random weight item such as produce, drug item). The next five-digit number is the code for the particular manufacturer (assigned by the UCC). The final five-digit number is the unique item code for each consumer package. *See* Ernst, *The Mechanization of Commerce*, SCI. AM., Sept. 1982, at 133, 138-41.

240. *See id.*

241. *See* Groves, *Behind Bars*, L.A. Times, Mar. 27, 1989, § IV, at 5, col. 1; Taylor, *The Great Scanner Face-Off*, SALES AND MARKETING MGMT., Sept. 1986, at 45.

242. *See, e.g.,* Frederick, *Hot Topics at Food Marketing Institute*, DRUG STORE NEWS, May 28, 1990, at 3; Steinberg, *Brave New World,* BOSTON BUS., Dec. 1989, at 42.

243. Ernst, *supra* note 239, at 140.

244. Government policies can aid significantly in the development and diffusion of these technologies. *See infra* notes 306-08 and accompanying text.

E.   Generality and Limitations of the Economic Analysis

Any model of a process as complex as the American household's purchasing and disposal decisions cannot capture all of the relevant factors and interactions. Moreover, the use of a utilitarian framework may introduce significant biases into the conclusions. This section first discusses the extent to which the model can be generalized to a wider range of products and packaging types. It also discusses the sensitivity of the results to the choice of the proportional curbside charge. Next, it examines the ways in which the model may understate or overstate the advantages of economic incentive systems. Finally, it discusses limitations of the economic framework.

1.   Generality of the Model

For ease of exposition, the model employed in this Article has assumed that only one of the two competing types of containers is recyclable. While there were good empirical reasons for making this assumption,[245] there is no general reason why the analysis should be limited in this way. Many competing packaging types are recyclable, such as glass and aluminum soft drink containers. Moreover, plastics recycling is becoming economically viable for some applications.[246]

As demonstrated elsewhere,[247] the analysis of the optimal policies is largely the same when both packaging types are recyclable. Under these conditions, the optimal retail charges have a very similar structure to those for the more specialized version of the model.[248] Furthermore, the optimal retail charge, proportional curbside charge, and optimal two-tier charge policies all continue to outperform the status quo.[249] Although the optimal two-tier charge policy does not always achieve the first-best allocation of resources when consumers choose among multiple recyclable packaging materials, it nonetheless continues to outperform the other regulatory policies for a wide range of parameter values.

The model also makes the assumption that only one product and two packaging types exist. The solid waste stream, however, reflects tremendous diversity of product and packaging types. Modeling consumer decisions for all products simultaneously would be extremely difficult. While such a modeling effort might be useful, the basic assumptions of the simpler model used here capture the essential aspects of consumer decisionmaking. To a large extent, consumers, even in a multiproduct

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245.   *See supra* note 174 and accompanying text.

246.   *See supra* note 80 and accompanying text; PLASTICS RECYCLING FOUNDATION, CENTER FOR PLASTICS RECYCLING RESEARCH, PLASTICS RECYCLING: AN OVERVIEW 1 (n.d.); Feder, *Giving Polystyrene Another Chance*, N.Y. Times, July 25, 1990, at D1, col. 3.

247.   *See* Two-Tier Model, *supra* note 168.

248.   *See id.* app. at A-15 to A-16, A-28 to A-29.

249.   *See id.* app. at A-17, A-30.

world, first determine what products they would like to purchase. After this decision is made, they select a packaging type. While the availability of packaging types may sometimes influence product selection, in general it seems reasonable to model the packaging choice as independent from the product choice. Moreover, as noted in the next subsection, the fact that consumers make decisions about many products actually strengthens the case for using flexible policy instruments that directly adjust relative retail and curbside prices.[250]

Nonetheless, municipalities will not be able to set an optimal curbside charge based only on disposal costs for two packaging types. If a single curbside charge is used, it will have to be an average for many waste types, including other packaging, food waste, and yard debris, among other things. The need to produce a single averaged curbside charge means the charge selected will inevitably overstate the disposal costs of some materials while understating the disposal costs of others.[251] Therefore, it is important to analyze the sensitivity of total social welfare under the optimal two-tier and proportional curbside charge policies to deviations from the optimal value for the curbside charge.[252] Because the two-tier charge policy has a flexible retail charge component, the social welfare produced by this policy is less sensitive to deviation from the optimal curbside charge. If the curbside charge is set at one-third its optimal value, social welfare drops slightly less than 1% from the first-best level. When the charge is raised 50% above its optimal value, social welfare declines less than 0.5% from the first-best.[253]

Because the curbside charge policy does not have the counterbalance of adjustable retail charges, it is more sensitive to variations from the optimal curbside charge. Even for this policy, however, the sensitivity to deviations from the optimal value is fairly low. When the charge is one-third of its optimal level, social welfare is still within 2% of the first-best. When the curbside charge is 50% above its optimal value, social welfare is about 1.2% less than the first-best. Even when curbside charges are inaccurately set, therefore, the two-tier charge and curbside charge policies still perform well relative to the other policies.

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250. *See infra* text accompanying notes 254-57.

251. If disposal costs are perfectly correlated with compacted volume for all materials and weight is perfectly correlated with compacted volume, then curbside charges can perfectly reflect social disposal costs.

252. The sensitivity to distortions in α depends on the absolute magnitude of the optimal α.

253. This analysis is based on the same parameter values used to generate table 2, with the optimal curbside charge based on weight. Note that social welfare under the traditional deposit-refund policy, which performs worst under these assumptions, is approximately 14% less than under the first-best.

2. Limitations of the Economic Model and Robustness of the Results

In many ways, economic incentive approaches are even more desirable than suggested by the above model. As framed, the model focuses solely on the choice between two containers of the same size. Economic incentive approaches also encourage better decisionmaking with respect to other factors which affect disposal costs, including container size, product durability, and product choice.[254] Larger capacity containers will in general produce a lower disposal cost per unit of volume.[255] Therefore, economic incentive systems create an incentive for consumers to purchase higher capacity containers. Similar logic applies to product choice. Where substitute products exist, economic incentive systems will discourage the use of products that produce more expensive solid waste. Thus, consumers will be more inclined to purchase reusable containers, products with less packaging, and more durable products. These consumer incentives will in turn encourage manufacturers to develop and offer both containers with lower disposal costs per unit volume and more durable products.

These factors underscore the intuition underlying the advantages of economic incentive approaches over less flexible regulatory policies.[256] Economic incentive systems adjust relative prices to reflect social costs, thereby enabling consumers to decide, on the basis of their own preferences and costs, what products to purchase and how to dispose of them.[257] By contrast, mandatory separation and product ban policies specify uniform modes of behavior for all people. Given the diversity of consumers, these policies are prone to over- and underinclusiveness. The traditional deposit-refund system avoids the stringency of the mandatory separation and product ban policies, but also fails to provide correct in-

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254. *See* OTA REPORT, *supra* note 1, at 122-26.

255. This is true because the volume of a container increases with the cube of the linear dimension, while the surface area, which determines the amount of disposable material, increases with the square. Thus, for containers of a similar shape, the larger the container the lower the ratio of surface area to volume.

256. The general conclusions of the analysis presented here are consistent with other commentators' analyses of other environmental problems. Policies that more accurately price environmental costs have long been recommended to address air and water pollution. *See generally* R. STEWART & J. KRIER, ENVIRONMENTAL LAW AND POLICY 555-615 (2d ed. 1978). A major problem in pursuing these policies, however, has been the lack of established markets for air and water resources. Since markets already exist for pricing consumer products and municipal services, the proposed optimal charge policies can be adopted, designed, and implemented relatively easily.

257. Policy analysts and some members of Congress recognized the advantages of directly correcting consumer and manufacturer prices many years ago. *See To Consider the Effects of Product Disposal Charges on Municipal Waste Recovery and Reuse: Hearings Before the Panel on Materials Policy of the Subcomm. on Environmental Pollution of the Senate Comm. on Public Works*, 94th Cong., 2d Sess. (1976) [hereinafter *Senate Hearings*] (especially testimony of William J. Baumol).

centives because it fails to base deposit charges and refunds on true social costs.

Perhaps the greatest oversimplification of the model is its treatment of transaction costs. Because there may be economies of scale in collection of separated materials, curbside separation may not be feasible unless some minimum participation rate is achieved. The need to reach a target participation rate provides some justification for a mandatory separation policy, but also seems to favor the optimal two-tier charge or proportional curbside charge policies. Although the mandatory separation policy did achieve a higher separation rate among glass purchasers in our example,[258] the optimal charge policies actually resulted in separation of a greater number of glass containers because many more households purchased glass and seventy-five percent of those households separated their glass containers.

Another factor not taken into account by the model is that certain disposal options may not be available unless particular types of materials are removed from the waste stream. For example, incineration may not be possible if certain toxic materials are found in the waste stream. A community for which incineration is an attractive disposal option might, therefore, decide to impose a deposit-refund system or a product ban. On the other hand, the optimal two-tier charge and optimal retail charge policies could also effectively reduce the amount of toxic materials in the waste stream.

A further shortcoming of the model is its assumption that consumer preferences for different materials and consumer separation costs are uniformly distributed and essentially fixed over time. A uniform distribution may not be the most likely scenario. However, so long as the distribution is continuous, most of the results of the model, in terms of the ranking of different policies, continue to hold.[259] However, the distribution would certainly affect the amount by which the various policies differ from the first-best, because it would affect the proportion of consumers who fall within the region in which each policy gives appropriate incentive effects. Thus, in the presence of transaction costs, different distributions could potentially produce different orderings of policies. Policymakers should therefore seek information on the distribution of consumer preferences and separation costs.

The assumption that consumer preferences do not change over time is also problematic, especially given the responsiveness of households to pilot education and separation programs.[260] The mandatory separation policy might quickly educate people about the ease of separation. Curb-

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258. *See supra* table 2 and accompanying discussion.
259. *See generally* Two-Tier Model, *supra* note 168.
260. *See infra* note 377.

side charges would probably have a similar effect, although perhaps less pronounced. Because consumer preferences and separation costs apparently can be modified, education has an important role to play in a comprehensive solid waste regulatory strategy.[261]

A related limitation of the model is its assumption that separation costs and preference for packaging types are not systematically related. It seems likely that people who are environmentally sensitive have low costs of separation (because they get satisfaction from reducing the waste stream) and also prefer packaging types that are easily and completely recyclable. This correlation, however, would merely mean that there is a distinct subgroup within the population that does the "right thing." The model would still apply to the group policymakers should seek to influence, those who are not already sensitive to the environmental consequences of their decisions.

The promise of economic approaches to solid waste regulation need not be judged solely on the basis of the theoretical predictions of the model. Although experimentation with novel approaches to solid waste regulation is relatively recent, the Perkasie, Pennsylvania example, involving a suburban community of 6500 people, provides strong support for the general conclusions of the analysis.[262] From 1987 (the year before the program was implemented) to 1988, the total amount of unseparated solid waste collected in Perkasie fell from 2573 tons to 1038 tons, a 59% reduction.[263] This resulted in a saving of more than $90,000 in direct disposal costs, based on Perkasie's 1988 tipping fee of $59 per ton.[264] In addition, the town earned $15,456 from the sale of aluminum and paper.[265] On the cost side, the 1988 worker-hours for loading separated and unseparated wastes (2781 hours) increased by only 18% over the average for 1985 to 1987 (2273 hours).[266] The full capital cost of the program (including a recycling trailer, modifications to the refuse vehicle, and recycling buckets) was less than $25,000.[267] Aside from the

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261. *See infra* text accompanying notes 370-78 for further discussion of the role of education.

262. The Perkasie program is briefly described *supra* text accompanying notes 135-36. The Perkasie program includes a mandatory separation component, the effects of which are difficult to distinguish from the effects of the economic incentives. A study of Seattle's pilot program also provides empirical support for the advantages of curbside charges. *See* SCS Engineers, *supra* note 131.

263. INSTITUTE FOR LOCAL SELF-RELIANCE, *supra* note 30, at 48.

264. *See id.* at 47.

265. *Id.* at 53.

266. *Id.*

267. *Id.* at 52.

costs of separation borne by residents,[268] the program is an overwhelming success both financially[269] and in terms of reducing solid waste.

3. Limitations of the Economic Framework

Implicit in the economic framework is the notion that all preferences should count in some commensurable way. This assumption has been questioned in many environmental contexts.[270] In the context of solid waste regulatory policy, one might ask why society should care if some people find it inconvenient to separate their refuse. Under some egalitarian and rights-based conceptions of justice,[271] a policy of mandatory separation might be seen as an equitable means of distributing society's solid waste disposal burden.

While the concern for equitable sharing of social responsibility clearly has validity, it is important to recognize that the notion of equitably sharing burdens quickly becomes ambiguous when a wide range of people and circumstances is considered. For example, elderly people may find recycling more burdensome than those who are more physically able. Similarly, a poor family living in tight quarters will find it difficult to store separated trash. When the economic analysis indicates that mandatory separation achieves "too much" separation, it means that such members of society are bearing disproportionately high costs under that policy.

Furthermore, unless both purchasing and disposal decisions are directly regulated, the burden of solid waste cannot be shared "equally." Product choice, as well as the disposal decision, determines the social costs of solid waste. Focusing solely on the separation decision, as mandatory separation does, can lead to perverse results.[272] The utilitarian framework seeks a regulatory system that reduces the burden at lowest total social cost. When transaction costs are relatively low, this is best accomplished by imposing the true social costs on decisionmakers.

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268. There is no data measuring this cost. Since the borough requires separation, separation costs borne by residents may be significant.

The revenues raised through the sale of garbage bags are not social costs (except for the resource cost of the bags) because they are used to pay for the waste disposal and resource recovery operation.

269. Prior to 1988, Perkasie simply charged each household an annual fee of $120 for refuse removal. In 1988, after implementation of the economic incentive program, the town paid 40% less for garbage disposal than a year earlier. Paul, *Pollution Solution: Pennsylvania Town Finds Way to Get Locals to Recycle Trash*, Wall St. J., June 21, 1989, at 1, col. 1.

270. *See generally* S. KELMAN, WHAT PRICE INCENTIVES? (1981) (arguing that using price incentives to discourage polluters fails to stigmatize polluter behavior); M. SAGOFF, THE ECONOMY OF THE EARTH (1988).

271. For a discussion of egalitarian and rights-based conceptions of justice, see R. DWORKIN, A MATTER OF PRINCIPLE 205-13 (1985); R. DWORKIN, TAKING RIGHTS SERIOUSLY 180-83, 227 (1977); J. RAWLS, A THEORY OF JUSTICE (1971).

272. *See supra* text accompanying notes 197-98; Figures 1-2.

In this sense, the utilitarian framework can be seen as spreading the social burden equitably.

Command-and-control policies (such as mandatory separation requirements and product bans) might be seen as more consistent with notions of environmental ethics.[273] Those adopting this view consider fostering appreciation of and sensitivity to the balance within nature to be an important role of environmental policy. It is not clear, however, that such ethics can simply be imposed upon the population. Rather, it seems that they must be nurtured. The relevant question, therefore, is whether command-and-control policies or economic incentive systems would better nurture environmental ethics. Economic incentive systems, in combination with education programs, provide an effective means of sensitizing the public to the environmental consequences of their decisions.[274] Given the complexity of the solid waste stream, accurate information is essential to making environmentally sound choices. Command-and-control policies tend to be based on crude approximations of the social tradeoffs, while economic incentive policies can be tailored to the variety of materials and decisionmakers that determine the composition of the solid waste stream. Furthermore, by needlessly restricting choices, command-and-control strategies might produce a backlash against environmental consciousness-raising.

Perhaps the greatest practical objection to the use of economic incentive systems would be political — that such approaches increase taxes.[275] As the Perkasie example illustrates, however, this objection is based on a misperception.[276] Curbside and retail charges could replace the traditional means of funding solid waste disposal through property and other taxes. Since well-designed incentive-based systems will improve the efficiency of waste disposal and resource recovery, they will in

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273. *Cf.* Latin, *Ideal Versus Real Regulatory Efficiency: Implementation of Uniform Standards and "Fine Tuning" Regulatory Reforms*, 37 STAN. L. REV. 1267 (1985) (arguing that a uniform command-and-control system which balances regulated industries' interest in reducing compliance costs and society's interest in preserving the environment is more promising than a "fine tuning" approach to regulation). *But see* Ackerman & Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985) ("fine tuning" system would result in a more intelligent and democratically accountable dialogue on environmental policy). For a general discussion of the concept of environmental ethics, see S. KELMAN, *supra* note 269; R. NASH, THE RIGHTS OF NATURE (1989); M. SAGOFF, *supra* note 269.

274. *See infra* notes 370-78 and accompanying text.

275. It is not clear, however, that Americans would object too strenuously to imposition of charges targeted at improving solid waste disposal practices. A recent survey found that 41% of Americans would favor a tax on packaging materials that are difficult or impossible to recycle and that 96% of Americans are willing to pay product surcharges designed to reduce environmental harms. *See* Otto, *10 Reasons to Recycle*, PREPARED FOODS, Mar. 1989, at 40, 41-42; *Public Concern, supra* note 8, at 1247.

276. Adoption of incentive systems in Perkasie led to a significant reduction in disposal costs. *See supra* note 269.

fact *reduce* the solid waste bill.[277] Thus, application of the currently popular political slogan "no new taxes" across the board could effectively increase some tax burdens.[278]

A more legitimate concern about economic incentive systems is that they might shift a greater portion of the burden of waste disposal onto poorer members of society.[279] There are important reasons, however, why economic incentive systems might be beneficial for lower income people. First, the amount of solid waste generated per person tends to increase with income.[280] Wealthy people tend to buy more goods. Moreover, they tend to purchase more convenience goods,[281] which have a larger amount of packaging per contents.[282] Secondly, economic incentive systems provide more opportunities to economize on waste disposal charges. Thus, incentive systems could potentially lower total disposal costs for the poor.

Nonetheless, there may be circumstances in which the use of charges could impose disproportionate burdens on the poor. For example, because of the difficulty of curbside collection in high density urban areas, many of which are poor, such communities might have to rely more heavily upon retail charges than lower density, higher income suburban areas where curbside charges and curbside separation are feasible. Such effects, however, could be alleviated if not reversed by targeting some of the charge revenues to adversely affected lower income areas. Alternatively, since the key concern of economic incentive systems is to affect the relative prices of purchasing and disposal decisions, communities could use optimal subsidies rather than optimal charges.[283]

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277. Incentive-based systems might not actually reduce the costs paid by taxes if landfill and other disposal methods underprice the resources they consume. *See infra* note 343 (discussing the underpricing of the environmental costs of landfilling). Although consumers did not bear these costs directly prior to the institution of a charge system, they (or future generations) will eventually bear these costs through future cleanup costs and increased health risks from leaking landfills.

278. This observation reflects an important economic misconception in popular political discourse. While taxes designed to raise revenues (such as income taxes) do increase tax burdens, taxes on externalities ("Pigouvian" taxes) reduce social burdens by reducing socially harmful conduct. Where the costs of such social harms are paid through other taxes, as in the solid waste context, this can actually result in a decrease in the tax burden. Where harms are externalized, such as with air pollution, the price of not internalizing harm is "paid for" via lower visibility, higher morbidity and mortality, and adverse ecosystem effects.

279. *Cf. Senate Hearings, supra* note 257, at 17 (statement of William J. Baumol) (discussing studies conducted for a 1976 bill that would have imposed a wholesale waste charge on sales of containers, packaging, and paper; the studies concluded that the bill would have a slight regressive impact).

280. *See* COMING FULL CIRCLE, *supra* note 81, at 40.

281. *Id.*

282. *Id.*; OTA REPORT, *supra* note 1, at 124.

283. A case can be made that redistributive objectives are best handled through taxation and welfare programs specifically designed to achieve an equitable distribution of income rather than through substantive environmental policies. *See* Hylland & Zeckhauser, *Distribu-*

IV

TOWARD A COHERENT SYSTEM OF MUNICIPAL SOLID WASTE REGULATION

This part proposes an integrated system for designing and implementing an incentive-based solid waste regulatory policy. In moving from the realm of normative policy analysis to actual policy, it is necessary to take into consideration the complex political institutions responsible for designing and implementing policy. The first section discusses the proper roles of local and federal authorities in promoting an incentive-based solid waste regulatory system. The remaining sections discuss important design and implementation issues that arise in pursuing an incentive-based regulatory approach.

A. Federalism Issues: Environmental, Economic, and Political Determinants of Optimal Jurisdictional Authority

The optimal allocation of regulatory authority for municipal solid waste depends upon the nature of the environmental concerns and the capacities and limitations of the political institutions. The first section explains why the major policy choices regarding solid waste planning and management should be vested in the hands of local government. Nonetheless, there are important responsibilities that the federal government is best suited to handle; these are discussed in the second section.[284] The role of state authorities is discussed in the third section.

1. The Importance of Local Decisionmaking Authority

The optimal choice of disposal and resource recovery technologies depends significantly upon the attributes of the municipal solid waste stream and the hydrogeological, environmental, and industrial characteristics of the particular community. The proper design of incentive-based regulatory policies depends upon these same variables, as well as living patterns, demographic characteristics, social attitudes toward the envi-

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tional Objectives Should Affect Taxes But Not Program Choice or Design, 81 SCANDANAVIAN J. ECON. 264 (1979); Shavell, *A Note on Efficiency vs. Distributional Equity in Legal Rulemaking: Should Distributional Equity Matter Given Optimal Income Taxation?,* 71 AM. ECON. REV. 414 (1981). In view of the current concern for reducing state and federal budget deficits and the lack of consensus on the proper level of redistribution, however, legislative coalitions favoring redistribution might block better solid waste policies that have adverse redistributive effects. Therefore, the ability of economic incentive systems for solid waste regulation to alleviate adverse redistributive effects may be important in the political realm.

284. Another federalism issue that arises in the context of solid waste regulation concerns the transshipment of waste across jurisdictional lines. *Compare* City of Philadelphia v. New Jersey, 437 U.S. 617 (1978) (holding that a New Jersey law forbidding import of solid waste from out of state unconstitutionally burdens interstate commerce) *with* Evergreen Waste Systems, Inc. v. Metropolitan Service District, 820 F.2d 1482 (9th Cir. 1987) (holding local ordinance banning disposal of out-of-region waste at Portland landfill valid despite effect on out-of-state refuse haulers). This issue is beyond the scope of this Article.

ronment, and the mix of disposal and resource recovery technologies available.[285] For example, the curbside charge policy is best suited to relatively homogeneous, single-family residence communities. It is problematic, however, in communities with many large apartment buildings.

The attributes and characteristics which affect the choice of disposal technologies and regulatory policies vary tremendously across the United States.[286] In the Northeast, where the solid waste crisis is most acute, population density is greatest and groundwater, an important source of drinking water for many communities, is particularly vulnerable to damage from landfill leachate.[287] By contrast, the West, with lower population density, vast land areas unsuitable for human habitation, and slower groundwater systems, faces very different solid waste concerns.[288] Even within regions, there is enormous variation in many of these factors. For example, population patterns — urban, suburban, and rural — vary in every state. Solid waste planning and management must be tailored to these local variations in order to be both sensitive to environmental concerns and cost-effective.

The past two decades of federal regulation of air and water pollution suggest that the federal government would be unable to adequately tailor a solid waste regulatory policy to the diverse characteristics of local communities.[289] Political and administrative constraints in federal decision-making often lead to excessive reliance on uniform approaches to regulation. Among the factors contributing to excessive federal reliance upon uniform standards are the difficulty of achieving legislative consensus on geographically varying standards, legislators' reluctance to delegate broad regulatory authority over significant policies, the costliness of acquiring adequate information on the many relevant local variables, and the administrative economies of uniform measures.[290] Consequently, the federal government is ill-suited to micromanage municipal solid waste regulation.

Moreover, a comprehensive federal program would inhibit innovation in regulatory policy by limiting the ability of states to serve as local "laboratories" experimenting with alternative approaches to solid waste

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285. *See* OTA REPORT, *supra* note 1, at 64.

286. *See supra* notes 28-88 and accompanying text; OTA REPORT, *supra* note 1, at 300-03.

287. *See* GROUNDWATER CONTAMINATION, *supra* note 40, at 7, 18, 80-83.

288. *See id.* at 7, 48 fig. 3-3.

289. W. BAUMOL & W. OATES, ECONOMICS, ENVIRONMENTAL POLICY, AND THE QUALITY OF LIFE 212-14 (1979) (describing inefficiencies of national uniform water pollution standards); R. CRANDALL, CONTROLLING INDUSTRIAL POLLUTION 32-57 (1983) (estimating inefficiencies caused by federal air pollution regulations); *see* Ackerman & Stewart, *supra* note 273.

290. Stewart, *Pyramids of Sacrifice? Problems of Federalism in Mandating State Implementation of National Environmental Policy,* 86 YALE L.J. 1196, 1219-20 & n.89; *see* Zerbe, *Optimal Environmental Jurisdictions,* 4 ECOLOGY L.Q. 193, 210-14 (1974).

regulation.[291] Many localities have already produced innovative solutions to their solid waste problems, from the use of curbside charges to the development of creative recycling strategies.[292] A preemptive federal regulatory program would threaten this experimentation.

In addition, comprehensive federal regulation of municipal solid waste would conflict with the democratic principle of self-government. The citizenry of different communities value environmental resources quite differently, as the variation in land-use controls across communities shows.[293] Comprehensive federal regulation of solid waste would frustrate local self-determination,[294] interfere with the traditional primacy of local government in land-use decisionmaking, and impair local authorities' ability to coordinate land-use planning. Leaving primary authority for municipal solid waste regulation at the local level would have the advantage of enabling one body to coordinate major land-use decisions.

There is, however, a possible countervailing justification for direct federal intervention in municipal solid waste planning and management. Public choice theory[295] suggests that local governments might not adequately represent the concerns of their citizenry on environmental issues. Public choice theorists model government bodies as being most responsive to the best organized interest groups.[296] Applying this approach to local government decisions concerning the environment, industrial firms, land developers, and trade unions have large and concentrated stakes in seeing that local government decisions promote industrial and commercial activities. Consequently, such entities are willing to devote substantial resources to lobbying efforts and political campaigns aimed at reducing the direct costs and regulatory burdens borne by these activities. Environmental regulation, therefore, is a prime target of these powerful interest groups. By contrast, the many individuals in the community who may favor improved environmental quality have a relatively small personal stake. Moreover, because they are a diffuse group, they face large impediments to organizing.[297] Therefore, local public

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291. The view of states as little "laboratories" was eloquently highlighted by Justice Brandeis. New State Ice Co. v. Liebman, 285 U.S. 262, 311 (1932), *noted in* Friendly, *Federalism: A Foreword,* 86 YALE L.J. 1019, 1034 (1977).

292. Keller, *Rhode Island Learns at the Curb,* WASTE AGE, July 1989, at 56 (describing innovative approaches to curbside collection); *see, e.g., supra* text accompanying notes 135-36, 262-62 (describing the Perkasie, Pennsylvania program). *See generally* INSTITUTE FOR LOCAL SELF-RELIANCE, *supra* note 30 (presenting fifteen case studies of innovative local solid waste programs).

293. *See generally* D. MANDELKER, ENVIRONMENTAL AND LAND CONTROLS LEGISLATION (1976).

294. *See* Stewart, *supra* note 290, at 1220-21.

295. For a discussion of public choice theory, see M. HAYES, LOBBYISTS AND LEGISLATORS (1981); M. OLSON, THE LOGIC OF COLLECTIVE ACTION (1971).

296. M. HAYES, *supra* note 295, at 7-8.

297. The "free rider" problem as well as other transaction cost impediments contribute to the difficulty of organizing. *See* M. OLSON, *supra* note 295, at 14-15, 21-23.

policy fora are prone to domination by well-organized and well-funded industrial interests. Public choice theory predicts, therefore, that industrial interests will have disproportionate representation in local government and a correspondingly disproportionate impact on local government decisions, particularly those affecting the environment.[298]

This disparity of influence between industrial and environmental interest groups is thought to be less significant at the national level because environmental organizations enjoy important economies of scale in fundraising, policy analysis, and lobbying.[299] For this reason, the federal government may better represent the full range of environmental concerns.[300]

The underrepresentation of environmental interests at the local level, however, is likely to be less severe with regard to solid waste concerns than in other environmental areas, such as air and water pollution. In the air and water pollution contexts, industrial and environmental interests are often diametrically opposed. By convincing the government not to regulate (or to regulate ineffectively), industrial lobbyists shift the costs of air and water pollution directly onto the people exposed to polluted air and water. By contrast, industrial, commercial, and household interests share many common goals in the municipal solid waste context. All three bear the costs of solid waste disposal: industrial and commercial interests through hauling and tipping fees, and households through property taxes (or other general tax impositions). Thus, they all stand to benefit if the community adopts better solid waste regulatory policies.

This does not mean that representation of environmental interests will be completely satisfactory in the context of setting municipal solid waste regulatory policies. Industrial interests could press for policies that impose a disproportionate share of costs on households. But given the relative ease of identifying the imposition of industrial waste disposal costs on residential consumers by, for example, monitoring tipping fees for industrial and household trash removal service, this problem is not likely to be severe. Another potential problem could be pressure to shift solid waste disposal costs onto future generations by utilizing substandard landfill technologies. This problem, however, should be largely checked by strict federal regulation of landfills under RCRA.[301]

Perhaps the greatest source of resistance to better solid waste policies will come from product manufacturers and retailers who see the retail charge approach as a significant added burden to their operations. If information on packaging composition was collected at the federal

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298. *Cf.* M. HAYES, *supra* note 295, at 7-18 (discussing the relationship between interest groups and Congress).

299. *See* Stewart, *supra* note 290, at 1213-14.

300. *See, e.g., id.* at 1213-15.

301. *See* RCRA §§ 4004-4005, 42 U.S.C. §§ 6944-6945 (1988).

level,[302] manufacturers would be less able to use the threat of withholding such information to exert political leverage on local decisionmakers. Retailers will experience some added burden from retail charges.[303] However, they will benefit to the extent that communities move away from traditional deposit-refund systems toward curbside charges and optimal two-tier charge systems.[304]

These considerations suggest that local governments can adequately represent their citizens in setting municipal solid waste regulatory policy. In view of the importance of tailoring the policy to local characteristics, therefore, local control over solid waste planning and management is preferable to a comprehensive federal program.

2. The Federal Role

Although local governments are in the best position to choose municipal solid waste regulatory policies for their communities, they often lack the resources and expertise to make informed choices. Moreover, because many product markets are national in scope, local governments may be unable to implement some desirable policies unilaterally. The federal government, therefore, has an important role to play in guiding regulatory policy because of its unique ability to regulate national markets, conduct research and process information centrally, and influence market development through procurement and other policies.

a. Fostering an Appropriate Mix of Resource Recovery and Disposal Technologies

As suggested in part II, our present market and regulatory structures systematically distort choices among resource recovery and disposal technologies. Landfilling and incineration of wastes tend to be underpriced because environmental regulation is inadequate. Moreover, the cost of landfilling is not transmitted to waste generators because many jurisdictions use average rather than marginal cost pricing. Thus, many households and businesses have little or no incentive to reduce the amount of waste that they send to landfills. On the other hand, recycling industries are hindered by having to compete with subsidized virgin materials, poor solid waste management policies that often do not enable them to realize the cost savings of diverting refuse from landfills, and

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302. *See infra* note 332 and accompanying text.

303. *See, e.g.,* Thayer, *supra* note 238 (noting the high administrative costs of implementing Washington State's 0.7% tax on toxic household products). Although differential taxes will require greater care in pricing items, the use of the UPC may substantially ease these administrative burdens. *Cf.* Ernst, *supra* note 239, at 141 (discussing administrative cost advantages of UPC technology).

304. *Cf.* Duff, *Solid Waste: Deposit Laws Don't Solve the Problem,* SUPERMARKET BUSINESS, Jan. 1989, at 48, 50 (highlighting the added burden imposed on supermarkets by traditional deposit-refund laws).

hesitancy on the part of manufacturers and consumers to use recycled materials and products. In order to achieve an appropriate mix of resource recovery and disposal technologies, government policies should ensure that the social costs of resource recovery and disposal technologies are properly reflected in market prices and promote the development of recycling markets.

i.   Correcting Distortions in the Pricing of Disposal and Resource Recovery Technologies

The federal government can play an important role in ensuring that landfill and incineration prices reflect true environmental costs through the use of its regulatory authority over disposal technologies. At present, however, federal environmental standards for landfill and incineration are inadequate.[305] Moreover, the standards that have been promulgated have not been adequately enforced.[306] Therefore, as a first step toward improving the pricing of disposal technologies, Congress should allocate adequate funds for standard setting and enforcement, and ensure that EPA fulfills these statutory mandates.

In addition, the federal government should play a significant role in assisting local and state agencies in planning for the availability of disposal and resource recovery technologies and setting prices to achieve the appropriate utilization of these technologies. Many municipal governments lack the resources and expertise required to conduct systematic and comprehensive research on the myriad environmental and economic issues involved in sound solid waste planning and management.[307] Since the benefits of such research and development will be enjoyed by many communities throughout the United States, it is both equitable and efficient for such costs to be borne broadly.[308] Furthermore, there are important economies of scale in these types of research and development.[309]

Congress, therefore, should expand EPA's budget for providing guidance on solid waste policy. EPA should fund research and collect information on the social costs of alternative disposal and resource recovery technologies in various hydrogeologic, land use, industrial, and demo-

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305.   *See supra* notes 100-19 and accompanying text.

306.   *Id.*

307.   *See* OTA REPORT, *supra* note 1, at 347.

308.   Due to the "public good" attribute of information, there may be too little investment in research and development if the costs are borne by only a subset of those who benefit. *See* P. SAMUELSON & W. NORDHAUS, ECONOMICS 48-49, 713-15 (12th ed. 1985); Arrow, *Economic Welfare and the Allocation of Resources for Invention,* in THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609-26 (1962); *cf.* Zerbe, *supra* note 290, at 195 (arguing that optimal scope of jurisdictional authority reflects the costs and benefits of jurisdictional arrangements).

309.   *See* Hahn, *An Evaluation of Options for Reducing Hazardous Waste,* 12 HARV. ENVTL. L. REV. 201, 222-23 (1988); Kovacs, *supra* note 11, at 551-52, 559, 611-17.

graphic settings and act as an information clearinghouse.[310] EPA should also develop a team of solid waste planning and management experts who would be available to advise state and local solid waste planning authorities.

As the cornerstone of its approach to guiding solid waste planning and management, the federal government should encourage the use of "avoided cost" pricing of resource recovery technologies.[311] At present, many municipalities expect recyclers to pay for separated wastes.[312] Because of limited processing capacity and lagging demand for recycled materials, however, some separated wastes have a negative value.[313] As long as this value is greater than the cost of disposal plus any additional cost of collecting separated wastes, municipalities should be willing to pay recyclers the disposal costs (net of added separation costs) that would be avoided by diverting wastes from landfill or incineration.[314] For example, if it would cost a community $100 per ton to landfill newspapers and an additional $20 per ton to collect separated newspapers, the community should be willing to pay as much as $80 per ton to a recycler to accept separated newsprint.[315] In this way, recycling industries would share in the social savings from reducing the use of disposal technologies, thereby lowering the cost of recycled materials.

ii. Promoting Recycling Markets

Even if the pricing of disposal and resource recovery technologies is corrected to reflect true social costs, recycling technologies still face another significant impediment to development: federal tax and resource development subsidies for virgin materials.[316] The federal government has subsidized the exploitation of natural resources as a means of foster-

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310. *Cf.* Hahn, *supra* note 309, at 222-23; Kovacs, *supra* note 11, at 551-52, 559, 611-17.

311. "Avoided costs" are the savings resulting from not incurring a particular cost. In the recycling context, waste recyclers could share in these cost savings. *See* OTA REPORT, *supra* note 1, at 31. The federal government has taken a similar approach in the public utilities arena. *See* Public Utilities Regulatory Policies Act, 16 U.S.C. § 824a-3 (1988) (requiring public utilities to purchase electricity from qualified small power producers at the utilities' cost of generation).

312. *See, e.g.,* Ball, *Price Drop Drives Away Recyclers of Newspaper,* L.A. Times, Aug. 19, 1990, at B4, col. 1.

313. *See* Lamb, Marron & Pilling, *The Economics of Solid Waste Recycling,* AERE NEWS-LETTER, May 1990, at 5.

314. *See id.* at 5, 9.

315. Since recycling markets are reasonably competitive, municipalities would probably not have to pay their full break-even price to divert separated wastes from disposal technologies.

Incentive-based regulatory policies should, of course, reflect the net salvage values of separated wastes, whether positive or negative, to the extent that it is administratively feasible. For example, if the competitive value of separated newspaper is close to the tipping fee for mixed refuse, then the municipality should not collect newsprint for free.

316. *See* OTA REPORT, *supra* note 1, at 197-201; Halgren, *supra* note 73, at 13-17.

ing economic growth and development. Depletion allowances for mining and petroleum production have increased the supply of virgin metals and petroleum products, thereby lowering their price.[317] The timber industry has enjoyed special tax treatment for capital gains from the sale of timber.[318] In addition, virgin paper has benefitted from substantial subsidies in the form of below-cost sales of federal timber[319] and Forest Service assistance programs, such as fire protection, insect control, and forest management.[320] Since such programs can no longer be justified on the basis of sound public policy,[321] the federal government should eliminate these distortions as expeditiously as possible.

Once the environmental costs of disposal are properly reflected in solid waste planning decisions and subsidies to competing materials are removed, market forces will be the principal driving force toward an appropriate mix of resource recovery and disposal technologies. Nonetheless, the federal government can still play an important role in improving the operation of recycling markets.

The growth of markets for recycled materials is slowed by the time required for dissemination of new information about recycled materials and the lag inherent in business planning cycles, including the time needed to alter manufacturing processes to better utilize recycled materials.[322] The environmental benefits of a better mix of disposal and resource recovery technologies, however, must await the increased use of recycled materials. The federal government, therefore, should implement a number of policies to expedite the transition to greater use of recycled materials.

The federal government, with its research and information processing capabilities, should provide manufacturers and consumers with current information about the relative merits of recycled and virgin materials. At present, many manufacturers and consumers are reluctant to purchase recycled materials because of concerns about inferior and inconsistent quality.[323] These concerns could be alleviated through the development of national quality standards for recycled materials.[324] The government should work with the recycling industries to develop these standards, through either industry consensus or the National Institute of

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317. EPA BACKGROUND DOCUMENT, *supra* note 3, at 3.F-3 to 3.F-6; *see* 26 U.S.C. §§ 611-617 (1988).

318. 26 U.S.C. § 631 (1988); *see* OTA REPORT, *supra* note 1, at 199-200.

319. *See* R. O'TOOLE, REFORMING THE FOREST SERVICE 32 (1988).

320. *Id.* at 86-88.

321. *See* OTA REPORT, *supra* note 1, at 197-201; R. O'TOOLE, *supra* note 319, at 28-37, 86-88.

322. *See* OTA REPORT, *supra* note 1, at 194-197.

323. *See id.* at 145-46, 148, 196.

324. For a discussion of the economics of standardization, see D. HEMENWAY, INDUSTRYWIDE VOLUNTARY PRODUCT STANDARDS (1975).

Standards and Technology.[325] In addition, EPA and the Department of Commerce should identify manufacturing sectors that would benefit from greater utilization of recycled materials and encourage them to adopt such materials. Limited funds could be made available to selected companies to cover the costs of conducting comparisons of virgin and recycled materials.

Along these same lines, because of its role as a major purchaser of raw materials and products,[326] the federal government should expeditiously implement procurement guidelines that place recycled materials and products on at least equal footing with virgin materials. The government guidelines should emphasize the functional quality of recycled materials, especially where their aesthetic quality can be expected to improve as recycling technologies advance. Although there currently exist statutory mandates to establish such procurement guidelines,[327] implementation of these provisions has been notably slow.[328] Congress should allocate funds to speed this process, and provide for prompt judicial review of the failure to issue proper guidelines.

In addition, Congress should establish effective enforcement mechanisms for ensuring compliance with these guidelines.[329] For example, the law could allow recycling companies that lose bids for purchases above some minimum size to challenge procurement decisions that favor virgin materials of comparable quality (based on the guidelines) and price. To further ensure compliance, those who make successful challenges should be entitled to damages for lost or delayed sales, attorneys' fees, and other appropriate costs.

Although regulatory policy should be directed primarily toward attaining economically viable recycling industries, a variety of factors justify implementing subsidies to encourage the use of recycled materials and products, especially during a transitional period. Where swift elimination of subsidies for virgin materials is politically infeasible, compensating subsidies for recycled materials should be established so as to place them on a level playing field with virgin materials. Subsidies for recycled materials are also justified by the fact that use of recycled materials in

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325. The National Institute of Standards and Technology is part of the Department of Commerce and was formerly called the National Bureau of Standards. The Institute develops and maintains national standards of measurement and assists in the development of technology and processes to improve quality and productivity. 15 U.S.C. §§ 271-282(a) (1988).

326. Government procurement represents 20-21% of the Gross National Product (GNP). Federal government purchases account for 7-8% of the GNP, with state and local purchasing accounting for the remainder. ENVIRONMENTAL AND ENERGY STUDY INSTITUTE, CREATING RECYCLING MARKETS: WHAT CONGRESS CAN DO TO HELP 13 (1989) [hereinafter CREATING RECYCLING MARKETS] (remarks of Richard Keller, Maryland Energy Office); ENVIRONMENTAL AND ENERGY STUDY INSTITUTE, supra note 111, at 16.

327. *See supra* note 116 and accompanying text.

328. *See* Kovacs, *supra* note 11, at 548-50.

329. *See* CREATING RECYCLING MARKETS, *supra* note 326, at 15.

manufacturing processes often consumes significantly less energy and water and results in less pollution than use of their virgin counterparts.[330] Carefully tailored subsidies for the use of recycled materials, therefore, would serve the goals of conserving energy and reducing pollution. Possible means of subsidizing recycling include incorporating a percentage price preference into selected federal procurement guidelines and providing direct percentage subsidies to consumers of specified recycled materials.

Any such subsidies, however, must not go beyond the principal objective of government policy: establishing economically viable and environmentally sound recycling industries. Recycling, like disposal and other resource recovery technologies, uses resources and contributes to pollution. Therefore, these subsidies should be carefully monitored and adjusted so as to prevent the replacement of one environmentally and economically wasteful set of disposal and resource recovery technologies with another.

b. Encouraging Environmentally Sound Household Purchasing and Disposal Decisions

The federal government should also implement policies designed to ensure that households recognize and respond to the environmental tradeoffs inherent in purchasing and disposal decisions. Since the mix of resource recovery and disposal options will vary significantly from community to community, local governments should have primary authority for choosing the appropriate incentive-based policy tailored to the specific attributes and values of their communities.[331] Nonetheless, the federal government has an extremely important role to play in efficiently gathering the information necessary to implement disposal surcharges, guiding local communities in choosing and designing regulatory policies, and educating consumers about environmentally responsible purchasing and disposal.

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330. *See supra* note 82 and accompanying text; OTA REPORT, *supra* note 1, at 197.

331. Uniform federal product charges might be more cost-effective than a decentralized system because of economies of scale in production and implementation. *See* Begley, *The Supply-Side Theory of Garbage*, NEWSWEEK, Nov. 27, 1989, at 76 (describing a proposal by the Environmental Defense Fund for a national sales tax on some disposable products). Given the heterogeneity of local disposal costs and other factors, however, it is unlikely that such economies would outweigh the benefits of better-tailored local regulatory programs. As evidenced by the use of local bottling companies and regional variation in product packaging by many national manufacturers, the efficient scale of operation for most production facilities is relatively small. The only areas in which there are significant national economies of scale are advertising and trademark. It is not at all clear, however, that such activities would be significantly affected by variation in product packaging incentives across regions.

i. Establishing a Database for Disposal Surcharges

A major impediment to implementing the retail charge policy is establishing a database of the refuse materials contained in consumer products. For any one community, this task would be daunting. Product manufacturers probably would not be willing to provide a breakdown of the disposable materials in their products to one or a few local governments. Moreover, the costs of assembling and updating this database would overwhelm the budgets of even large communities.

Given the national scope of product markets and the economies of scale in establishing a product composition database, the federal government is best situated to require manufacturers to disclose the composition of disposable materials in their products and packaging[332] and assemble a computerized database containing this information. Congress should require manufacturers to disclose the weight and volume of the major categories of disposable materials in each of their products to EPA. EPA should then prepare a computer file matched to the Universal Product Code that would enable municipalities to establish appropriate disposal surcharges simply by entering data on the expected social disposal costs of the various disposable materials.

ii. Guiding Community Incentive-Based Policies and Consumer Education

Local communities will also encounter difficulties in determining the social costs that should be reflected in curbside and retail disposal charges. In a community utilizing landfill, incineration, and resource recovery technologies, the following costs, among others, would have to be computed: the long-term environmental costs of disposing of each type of material in landfills, the net social costs of incinerating each type of material, and the net social costs of resource recovery technologies. Careful assessment of these costs is beyond the capacity of even large local governments.

In view of the economies of scale in conducting this research, Congress should require EPA to assemble the data necessary for local governments to design incentive-based regulatory policies. This data should be put into a computer system (and a reference book of social cost tables) that would enable local governments to generate appropriate charge parameters simply by entering data on relevant community-specific variables such as separation rates for various components of the waste stream, refuse collection costs, land costs (for landfill and incineration facilities), groundwater characteristics, population density near disposal facilities, and airflow patterns. In addition, EPA should conduct re-

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332. Such authority would be similar to that granted by the Fair Packaging and Labeling Act, 15 U.S.C. §§ 1451-1461 (1988) (requiring disclosure of the quantity of package contents).

search on improved technologies for monitoring solid waste disposal decisions, such as refuse removal vehicles and billing systems.

In concert with its advisory role on the choice of disposal and resource recovery technologies, EPA should also advise local governments on how to establish and operate incentive-based systems. In addition, EPA, as well as state authorities, can play an important role in coordinating the use of economic incentive systems among communities. EPA can promote the use of these systems and develop its own expertise by funding a variety of pilot programs throughout the country.

By making the environmental costs of purchasing and disposal decisions apparent, economic incentive systems will help to educate consumers about environmental protection. The federal government should also play a direct role in educating consumers about environmentally responsible purchasing and disposal. First, the federal government should require all federal offices to establish waste separation programs. Federal offices should also adopt cost-effective ways of reducing the amount of materials they consume.

The federal government should also develop guidelines for truth in advertising regarding the environmental effects of consumer products. Many manufacturers are currently making questionable, if not fallacious, environmental claims for their products.[333] For example, the assertion that biodegradable packaging is good for the environment is highly misleading.[334]

Certain types of labeling standards are uncontroversial and should be expeditiously implemented. Standardized designations for different plastic resins, which are already being encouraged by the plastics industry, will enable households and waste processors to separate scrap plastics into uniform types for recycling.[335] Similarly, standardized designations of recycled content will aid consumers who wish to favor the use of recycled materials.

More general designations of the environmental impact of particular materials would be more complicated to develop. Due to the heterogeneity of environmental costs across communities, national certification of "environmentally safe" products is unlikely to be reliable. For example, clean plastics (i.e., those made without heavy metal inks, fixatives, or other toxic materials) may be more environmentally sound than glass in communities using incineration because glass, if not separated, reduces incineration efficiency. The use of incentive-based regulatory systems at the local level will provide information tailored to local conditions. Fed-

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333. *See, e.g.,* Dold, *Muddle at the Market,* AUDUBON, Sept. 1990, at 114 (discussing various claims made by manufacturers and the need for industry standards).

334. *See supra* note 25.

335. *See* OTA REPORT, *supra* note 1, at 30-31.

eral labeling guidelines should be designed to complement these local price signals.

3.   *The State Government Role*

State governments also have a role to play in solid waste regulation. This role will vary depending upon the level of decentralization within the state and the extent of revenue sharing. At a minimum, states, like the federal government, should establish procurement policies that promote the use of recycled materials. States which place the responsibility for solid waste regulation on small local jurisdictions may need to provide technical assistance in establishing incentive-based programs. Of greater significance, coordination among localities may be necessary to facilitate implementation of optimal incentive policies and to make the best use of resource recovery plants.[336] In some cases, multistate jurisdictions should be established to guide municipal solid waste policy.[337]

B.   *The Design and Implementation of Incentive Systems*

A number of factors will affect the design and implementation of an ideal incentive system. The system must take into account the social costs of alternative disposal technologies. It must also be tailored to the demographic characteristics of the community. Some wastes may require special treatment. In addition, communities should develop education programs to increase the effectiveness of economic incentive programs.

1.   *Components of Social Disposal Cost*

The appropriateness of purchasing and disposal incentives produced by curbside and retail charges depends critically upon the accurate evaluation of social disposal costs. These costs vary with the method of disposal. In general, each material in the waste stream will have three possible social disposal costs: (1) the cost of littering or illegal disposal; (2) the cost of disposal with mixed refuse, which depends on the community's utilization of landfill and incineration technologies (and centralized separation); and (3) the cost of disposal with separated refuse, which may include recycling or resource recovery.[338]

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336.   Economies of scale in resource recovery technologies create a need for neighboring jurisdictions to coordinate their solid waste policies.

337.   *Cf.* Zerbe, *supra* note 290, at 231-39 (arguing that regional management of water rights and water quality is appropriate in some cases).

338.   For a more detailed description of some of these issues, see EPA APPENDIX, *supra* note 23, app. C (Factors Determining the True Costs of Solid Waste Management Technologies). EPA plans to develop a new methodology to aid localities in comparing solid waste technical alternatives. *See EPA Plans to Re-Focus on Municipal Solid Waste Programs, supra* note 120, at 2058.

a. Littering

Optimal retail charges should take into consideration the likelihood that a particular material or product will wind up as litter[339] and the social costs if it does. These costs depend upon the aesthetic and ecosystem effects of littering, which in turn depend upon where the littering occurs. In assessing the social costs of litter, photo- and biodegradability are important factors.[340] If wastes degrade quickly under natural conditions without altering the surrounding ecosystem, then the social costs will be slight. If, however, they degrade slowly or not at all (as in the case of many plastics) or in an environmentally destructive way, then the product charge should reflect the lesser of the costs of cleanup or the aesthetic blight and ecosystem damage caused by litter.

For example, if littering of plastic six-pack rings is common and costly to control (by cleanup or prevention) in a coastal region and will cause significant harm to marine life, then this type of packaging should bear a relatively heavy retail charge. This charge will both reduce purchases of such packaging and encourage manufacturers to develop environmentally benign biodegradable six-pack rings or substitute different types of packaging. On the other hand, if the extent of and harm from littering of plastic six-pack rings is slight in an inland region, then six-pack rings should bear little or no additional charge above that for similar plastics.

b. Landfilling

The total social cost of disposing of a particular material in a landfill includes the costs of collection and transportation; the general costs of building, operating, and closing a landfill; and the direct costs of disposal of the specific material. Collection and transportation costs are relatively straightforward. They include the cost of vehicles and other equipment, labor, transfer stations, air pollution, noise, traffic congestion, and fuel.[341]

The general costs of a landfill include the costs of siting, land acquisition, construction, operation, and closure, as well as such external costs as noxious odors[342] and the risk of groundwater contamination.[343] Many

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339. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 4.B-5 to 4.B-6 (estimating the composition of the litter stream).

340. *Id.* at 1-28 to 1-31 (describing the degradability characteristics of the major components of the waste stream).

341. *See generally* EPA APPENDIX, *supra* note 23, at C-19 to C-27.

342. *See* Hwang & Rudzitis, *The External Costs of Sanitary Landfills*, 7 J. ENVTL. SYSTEMS 301, 305 (1977-1978).

343. As a result of municipal subsidies and poor management, many of these costs have often been overlooked or undervalued in setting tipping fees. *See* Darcey, *Landfill Crisis Report*, WORLD WASTES, May 1987, at 24; Berkman & Dunbar, The Underpricing of Landfills (Feb. 13, 1987) (paper presented at the Third Annual Conference on Solid Waste Management and Materials Policy, New York) (available from National Economic Research Associates,

of these costs are in essence fixed costs, largely independent of the characteristics of the waste material. Therefore, they can be allocated across all wastes on the basis of compacted volume, weight, or whatever other parameter is best correlated with landfill capacity.[344] Other factors, such as noxious odors, the risk of groundwater contamination, and closure costs will vary for different materials. For example, yard wastes, with their higher moisture content and degradability, might have higher landfilling costs because they promote degradation, mixing of wastes, and leaching. Charges imposed on wastes containing toxic constituents should also reflect their higher social disposal costs.

c. Incineration

The full social cost of disposing of a particular material through incineration includes the costs of collection and transportation; the general costs of building and operating an incinerator; and the direct costs and energy benefits of incinerating the particular material and disposing of any resulting ash. Collection and transportation costs will be similar to those for landfilling.

The general costs of incineration include the costs of siting, land acquisition, construction, installation of emission control equipment, operation (including ash disposal), and closure, as well as external costs such as air pollution.[345] Revenues from energy sales should be offset against these costs. As with landfills, many of the costs of incineration are in essence fixed, largely independent of the characteristics of the material incinerated. Therefore, they can be allocated across all wastes on the basis of compacted volume, weight, or whatever other parameter is best correlated with the capacity of the incinerator. Other factors, such as the heating value of the material, the amount of hazardous constituents, the external costs of the residual ash and air pollution produced, and, in the case of RDF facilities, the costs of removing noncombustible materials, will depend upon the particular material. Thus, clean plastics and paper products have relatively low social costs of incineration and their incineration may even produce a net benefit.[346] By contrast, incin-

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Inc.).

344. *See supra* note 44.

345. Various economic methodologies for estimating the social costs of conventional and hazardous air pollutants are discussed in A. KNEESE, MEASURING THE BENEFITS OF CLEAN AIR AND WATER (1984); L. LAVE & E. SESKIN, AIR POLLUTION AND HUMAN HEALTH (1977); Haigh, Harrison & Nichols, *Benefit-Cost Analysis of Environmental Regulation: Case Studies of Hazardous Air Pollutants*, 8 HARV. ENVTL. L. REV. 395 (1984). For a general discussion and critique of these valuation methodologies, see R. STEWART & J. KRIER, *supra* note 256, at 97-197.

346. *See supra* text accompanying notes 52-54.

eration of yard and food wastes, glass, and metals results in relatively high social costs.[347]

d. Recycling

The social cost of recycling a particular material consists of the full social costs of collection and transportation of separated wastes minus the net social value of the resulting material or product.[348] This latter value is very sensitive to the value of virgin raw materials or products made from such raw materials.

The costs of collecting and transporting separated materials are likely to be somewhat higher than the costs of collecting and transporting unseparated wastes. Equipment costs and labor costs will be higher for separated materials and these materials may have to be transported longer distances to recycling facilities.[349]

The net social value of the material or product produced by recycling should be calculated the way economists ordinarily compute economic value from a business: marginal social benefit (i.e., revenue from selling the recycled material or product) less marginal social cost. The costs of recycling are similar to the costs of running any ordinary business.[350] The marginal social benefit, however, is difficult to calculate because many of the virgin raw materials against which recycled materials compete are subsidized[351] and their use in manufacturing often produces significant negative external effects, such as air and water pollution.[352] Unless these subsidies are eliminated and these external effects internalized, the social disposal costs calculated for separated materials will need to be adjusted to correct for these market distortions.[353]

2. Community Factors

The population characteristics of the community are critical to the design of an incentive-based solid waste policy. Curbside charges are likely to work best in communities where refuse is collected one house-

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347. *See supra* text accompanying note 55.

348. This assumes that the municipality is using avoided cost pricing for recycled materials. *See supra* text accompanying notes 311-15.

349. *See* EPA APPENDIX, *supra* note 23, at C-3 to C-4.

350. *See id.* at C-5 to C-6 (setting out the typical expenses of a recycling center).

351. A 1974 EPA Report estimated the tax advantages (as a percentage of product price) for virgin aluminum, pulpwood, iron ore, and glass sand to be 11%, 10%, 7%, and 3% respectively. *See* ENVIRONMENTAL PROTECTION AGENCY, REP. SW-122, RESOURCE RECOVERY AND SOURCE REDUCTION 33 (1974), *cited in* Baumol, *On Recycling as a Moot Environmental Issue*, 4 J. ENVTL. ECON. & MGMT. 83, 83-84 (1977). More recent studies suggest that these subsidies are still significant. *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 3.F-1 to 3.F-6; Halgren, *supra* note 73, at 2-5, 13-22.

352. *See supra* note 82; Halgren, *supra* note 73, at 2-5, 26-31.

353. For a general discussion of optimal taxation in the presence of externalities and other market distortions, see R. TRESCH, *supra* note 172, at 296-372, 429-42.

hold at a time, such as lower density urban neighborhoods, suburban areas, and rural communities. These communities are ideally suited to the optimal two-tier charge and optimal curbside charge policies.

On the other hand, curbside charges will be most difficult to implement where many households use common trash receptacles, as in most apartment dwellings. Unless extensive monitoring is employed or new disposal systems are designed, apartment residents will be able to dispose of refuse as they wish.[354] Perhaps the best way of directly regulating their disposal decisions would be through a combination of education programs, the provision of convenient bins for separated materials, and the fostering of a community spirit of conservation.[355] In neighborhoods where most people reside in large apartment complexes, retail charges combined with conveniently located recycling dropoff centers offering the salvage value for separated refuse are likely to be the best economic incentive system for regulating the solid waste stream.[356]

Most communities will have some small grocery stores that do not use scanners, due to a lack of either knowledge or resources. Requiring these establishments to adopt the retail charge system would impose an excessive burden on them. In order to prevent these stores from obtaining a competitive advantage from the imposition of an optimal retail charge system in larger establishments, the community could introduce a compensating uniform excise tax for stores unable to implement retail charges. Although differential price effects on particular products would remain, the average effect of a uniform excise tax on grocery bills would be similar to that of retail disposal charges. Moreover, since small stores typically charge higher prices in any case, it is unlikely that many consumers will selectively purchase from these locations. As scanning technology becomes more widely adopted, both because of government policies encouraging its use and cost-reducing technological innovations, more stores will have the capability to implement retail charges and this problem will diminish.

The disposal methods used by the community must also be considered in the designing of an optimal incentive system. The transaction costs of curbside collection of separated items, as well as residents' separation costs, rise with the number of items collected at the curbside, and

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354. These living groups face a form of the tragedy of the commons. *See* Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

355. Along these lines, the Environmental Action Coalition has successfully achieved high newspaper separation rates in many New York apartment buildings through education, assistance in the design of storage systems, and coordination between the building management and a private paper hauler. Similar programs are in place in San Francisco. In addition, these same approaches have worked well in office buildings. *See* COMING FULL CIRCLE, *supra* note 81, at 24-30.

356. Such a system is not much different from a deposit-refund system with the deposit and refund amounts for different packaging types based on true social disposal costs.

participation rates fall correspondingly. Therefore, only those items whose collection will be economically advantageous should be separated.[357] Selections should be made on the basis of the net value of separated materials and the costs or benefits of disposing of the materials through the community's normal disposal route.[358] In addition, communities will want to carefully consider the compatibility of disposal technologies.[359] For example, composting programs and incineration are quite complementary because food and yard wastes have a low heat content.[360] Communities with waste-to-energy incinerators might also wish to encourage households to separate out highly combustible, nontoxic wastes.[361]

3. *Enforcement*

Introduction of incentive-based systems will exacerbate some existing enforcement problems and create some new ones for municipal solid waste regulators. Many of these problems will be similar to enforcement difficulties in other areas of the law and can be handled using proven techniques. In some cases, however, enforcement problems may raise the transaction costs associated with some policies, making others relatively more desirable.

By raising the marginal cost of disposal, curbside charges create incentives not only for separation of wastes and waste reduction but also for illegal waste disposal and littering. These problems are not new and can be addressed by traditional means of enforcement, such as civil and criminal penalties.[362] These enforcement costs can be directly incorporated into the above analysis as transaction costs.[363] If these enforcement costs were high, retail charge policies would become relatively more desirable.

Waste theft might become a problem if communities reward consumers for separating valuable wastes at the curbside, as under the perfect deposit-refund system. Traditional civil and criminal sanctions

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357. *See* OTA REPORT, *supra* note 1, at 321-22; Lamb, Marron & Pilling, *supra* note 313, at 8-9.

358. For example, a community which relies upon incineration may wish to use curbside separation to remove glass, metal, and compostable wastes from the mixed waste stream, but may not wish to remove clean plastics. *See supra* text accompanying notes 52-55.

359. *Cf.* OTA REPORT, *supra* note 1, at 334-35 (discussing the debate over the compatibility of incineration and recycling).

360. *See supra* text accompanying note 55.

361. Most communities in Japan require households to separate combustible wastes. OTA REPORT, *supra* note 1, at 249, 322.

362. For example, some states have recently toughened their littering and illegal disposal laws. *See, e.g., Felony Conviction Hits Ton-of-Tires Dumpers,* WASTE AGE, July 1989, at 28 (noting Florida's new litter law which makes it a felony to dump more than 500 pounds of anything on public property).

363. They would be included in β_2, the additional costs of implementing curbside charges.

could be used to address this problem. Alternatively, recycling containers could be fitted with locks.[364] Either approach, however, would increase transaction costs.

A further enforcement problem could be created by differences between retail charges across jurisdictions. If these differentials were large, consumers might have incentives to transport large quantities of retail products across jurisdictional lines. Since optimal retail charges reflect social disposal costs in each jurisdiction, transportation of retail products across jurisdictional lines could undermine, at least in a limited way, their efficacy. This problem is analogous to that created by interstate sales tax differences. However, in view of the great number of municipal solid waste regulatory jurisdictions, the problem of interjurisdictional transportation of goods in this context may be more complicated than the differential interstate sales tax problem. The costs added by transshipment of goods could be incorporated into the analysis of regulatory policies as transaction costs.[365] Planning and coordination among communities could substantially reduce the incentive to transship, and hence reduce enforcement costs.

4. Special Waste Types

The optimal charge policies deal most effectively with nonhazardous materials which can be picked up at the curbside. Hazardous wastes and large durable wastes may be best handled through other approaches.

Because the social costs of disposal of hazardous wastes are so much higher than average, these wastes may require special regulatory policies.[366] For example, if the groundwater below a community's landfill is an important source of drinking water and is vulnerable to contamination, the community may wish to adopt policies to ensure that hazardous materials do not enter the landfill. Retail charges imposed on products containing toxic constituents should reflect the higher disposal costs. Alternatively, limited product bans might be appropriate in this situation. For some particularly hazardous products, such as lead batteries and used motor oil, however, deposit-refund systems (with appropriately high deposit values) might be most effective.[367]

Large durable wastes, such as automobiles and household appliances, might also require special treatment.[368] The traditional system for

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364. *Cf.* BIOCYCLE, Apr. 1989, at 10 (advertisement for closable recycling bins).

365. They would be included within τ_1, the costs of imposing a retail charge.

366. While many household products contain some small quantity of hazardous materials, only a very small portion of the municipal solid waste stream is hazardous. A study in Los Angeles estimated that less than 0.2% (by weight) of the municipal solid waste stream consisted of hazardous materials. *See* EPA APPENDIX, *supra* note 23, at B.E-2.

367. *See* Hahn, *supra* note 309, at 221; Russell, *Economic Incentives in the Management of Hazardous Wastes*, 13 COLUM. J. ENVTL. L. 257 (1988).

368. *See generally* EPA APPENDIX, *supra* note 23, at B.C-25 (noting that most consumers

discouraging abandonment of automobiles involves fining owners for illegal disposal. However, it is costly to hunt down owners, especially across state lines. The federal government might consider implementing a national deposit-refund system for automobiles and other large durable wastes.[369] If the deposit were set high enough, this system would create a strong incentive for proper disposal.

5. Education Programs

Education programs should be implemented along with economic incentive programs to create the most effective solid waste regulatory policy. Any policy designed to improve incentives relies on the assumption that consumers and manufacturers will make better choices if they bear the true social cost of those choices. Recent surveys show that consumers are particularly concerned about making environmentally sound purchasing decisions.[370] They cannot make sound decisions, however, without accurate information. Thus, consumer education is essential to improving solid waste disposal policies.

Many features typical of current municipal solid waste regulatory policies appear to reflect misperceptions about social disposal costs. For example, the great interest in promoting degradable materials seems to go well beyond concern for the litter problem, which can be remedied through fines and cleanup programs, and technological limitations on plastics recycling, which are fading. Few Americans seem to recognize that degradability is an undesirable attribute for properly disposed of materials.[371] Similarly, it would probably come as a surprise to many Americans that plastics are stable in landfills[372] (although they do take up a larger volume than equivalent weights of many other components of the waste stream)[373] and release enormous amounts of energy when incinerated (although there are concerns about their emissions and residual ash).[374]

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are unaware of the benefits of automobile recycling).

369. For example, Norway requires a deposit of one percent of the retail price on all new automobiles. The deposit is redeemable at any one of 100 redemption centers. *See* Russell, *supra* note 367, at 267-69.

370. Approximately 90% of U.S. consumers surveyed in July 1989 were "very concerned" or "somewhat concerned" about the environmental impact of the products they purchase. *See* Schwadel, *Retailers Latch On to the Environment*, Wall St. J., Nov. 13, 1989, at B1, col.3.

371. *See supra* note 25.

372. *See* EPA APPENDIX, *supra* note 23, at A.C-11.

373. *See supra* note 23. On the other hand, plastic packaging weighs substantially less than glass, metal, or paper packaging for most products. *Id.*

374. *Compare* EPA APPENDIX, *supra* note 23, at A.C-14 (noting a plastics industry study concluding that in at least one New York incinerator the amount of plastic in the waste did not affect levels of hazardous air pollutants or ash residues) *with* Denison & Silbergeld, *supra* note 6, at 11-15 (raising concerns about heavy metal residues from burning plastics).

Both better pricing and general educational programs designed to inform consumers about the science, technology, and economics of the municipal solid waste stream can encourage better choices.[375] The optimal retail charge policy provides an easy and effective way of conveying relative social disposal cost information to consumers. Grocers could be required to display retail disposal charges on store shelves beside product prices.[376] In addition, cash registers could be programmed to print the total disposal cost on the receipt. This would allow consumers to compare their total retail disposal charges from week to week.

General educational programs could be used to reduce consumers' effective costs of separation. Citizens of Japan and many European countries separate a significantly higher percentage of their waste than do Americans.[377] To some extent, this reflects devotion of some greater time and effort to these activities. However, the difference is also due in part to greater societal concern with conservation and knowledge of efficient separation techniques in these countries. While better pricing can contribute to changing behavior, direct educational programs would also be effective in fostering waste separation habits[378] and promoting an ethic of conservation, especially among younger persons.

CONCLUSIONS

When consumers purchase retail products, they typically pay something close to the social cost of producing such products. Yet they are often free to dispose of the empty container or packaging as they wish, incurring no cost. As growing solid waste problems have made many communities painfully aware, however, disposal is far from free. This Article has argued that for most communities the best way of addressing the solid waste crisis is to ensure that consumers bear the true costs of

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375. In many respects, the problem of incomplete and erroneous information in the municipal solid waste area resembles concern about consumers' insensitivity to the social value of greater energy efficiency in household appliances, despite the fact that greater energy efficiency can translate into enormous energy cost savings over the lifetime of an appliance. In order to improve consumer decisionmaking in this area and promote conservation, Congress enacted provisions in the Energy Policy and Conservation Act, Pub. L. No. 94-163, 89 Stat. 871, 920 (1975) (codified as amended at 42 U.S.C. §§ 6201-6422 (1988)), requiring the Federal Trade Commission to issue appliance efficiency labeling rules. *Id.* § 6294; *see* 16 C.F.R. § 305 (1990); Rule for Using Energy Costs and Consumption Information Used in Labeling and Advertising for Consumer Appliances Under the Energy Policy and Conservation Act, 44 Fed. Reg. 66,466 (1979).

376. Communities using the two-tier charge policy might also require posting of the curbside disposal charges in retail establishments.

377. For example, in the town of Zentsuji, Japan, residents separate 32 categories of waste and haul it to collection stations. Begley, *Teeing Off on Japan's Garbage*, NEWSWEEK, Nov. 27, 1989, at 70.

378. *See* INSTITUTE FOR LOCAL SELF-RELIANCE, TAKING RECYCLING SERIOUSLY: A PRIMER FOR ATLANTIC COUNTY, NEW JERSEY 45-46 (1989) (describing an encouraging pilot study of the effect of educational programs on waste reduction in West Berlin).

disposing of the refuse that remains after products are consumed. Accurate disposal charges create powerful incentives for consumers both to purchase products that generate less waste and to separate valuable components of their refuse for recycling.

Unlike production costs, however, the costs of disposal are difficult to determine when the consumer purchases a product. The consumer might drop the packaging on the ground, throw it in a trash can, or separate the valuable components, enabling the community to recycle them. Therefore, true disposal costs cannot readily be included in the retail bill. Thus, the most difficult problem in charging consumers for the costs of disposal is monitoring consumer disposal decisions. Hiring squadrons of "trash police" is one solution, but its administrative costs and Orwellian cast hardly make it one for serious consideration.

This Article has suggested a set of policies that would impose social disposal costs on consumers at relatively low administrative cost. One such policy would involve charging consumers a fee at the curbside based on the weight or volume of their mixed refuse. Alternatively, the municipality could exact a retail charge for each product that reflects the expected disposal costs for that product. In addition, the curbside and retail charge policies can be combined into a two-tier charge system to further refine the regulation of consumer decisions that affect the solid waste stream. For most communities, one of these policies in combination with educational programs would achieve the most cost-effective regulation of the solid waste stream by creating appropriate incentives to guide consumers' purchasing and disposal decisions.

Furthermore, this Article has suggested a coherent set of federal, state, and local roles in implementing such an incentive-based regulatory system. The federal government has the following important roles to play: internalizing the costs of landfill and incineration technologies by establishing and enforcing appropriate environmental regulations; correcting subsidies on virgin materials that inhibit recycling markets; establishing procurement and other policies that appropriately promote the use of recycled materials; requiring product manufacturers to provide data on the composition of the disposable materials in their products; funding research on the costs of disposal and technologies that reduce the transaction costs of implementing incentive-based approaches; advising communities on the design of incentive-based policies; and establishing an information clearinghouse. States have an important role to play in coordinating policies among municipalities. Local governments play the central role of selecting and implementing the incentive systems best tailored to the diverse and changing needs of their communities.

By contrast, the approaches that the federal, state, and local governments have chosen thus far to address the solid waste crisis either create perverse and counterproductive incentives or are destined to have little

effect. In the first category are the mandatory separation, product ban, and traditional deposit-refund policies being implemented or seriously considered by many state and local governments. Although these policies have some beneficial effects, they fail to provide appropriate incentives for solid waste reduction and disposal. In the category of policy approaches likely to have little or no effect are federal and state directives to achieve target waste reduction and recycling rates for specific components of the waste stream by specific dates. These approaches are reminiscent of the federal laws regulating air pollution and water pollution enacted in the early 1970's. As the inexorable delay in achieving the pollution reduction goals set by these statutes attests, it often takes substantially more than good intentions to achieve ambitious goals. Economic incentive approaches would achieve these goals quickly and in a cost-effective manner.

In 1976, the Resource Conservation and Recovery Act established the Resource Conservation Committee to study and recommend policies to conserve resources.[379] The Committee's only area of agreement was the unanimous endorsement of variable curbside charges to control disposal and encourage recycling.[380] The Committee supported further study of this option and the barriers to its implementation, but Congress took no action to implement this recommendation.[381] In light of the worsening solid waste crisis in many areas of the United States, the time is ripe to reconsider this recommendation and to consider other economic incentive approaches to solving the solid waste crisis.

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379.   RCRA, Pub. L. No. 94-580, § 2, 90 Stat. 2795, 2833-34 (1976) (codified at RCRA § 8002(j), 42 U.S.C. § 6982(j) (1988)).

380.   *See* RESOURCE CONSERVATION COMMITTEE, CHOICES FOR CONSERVATION: FINAL REPORT TO THE PRESIDENT AND CONGRESS (1979).

381.   *See* EPA BACKGROUND DOCUMENT, *supra* note 3, at 2.A-5.