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The Municipal Solid Waste "Crisis" in Retrospect: A Success Story for Market-Based Mechanisms

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In the late 1980s and early 1990s, it was not uncommon to read that a municipal solid waste crisis loomed in the United States.[1] These news reports warned that landfill space was soon to be exhausted and that new capacity would not become available in time due to regulatory constraints, Not In My Backyard (NIMBY) opposition, and Not in My Term of Office (NIMTOO) politics. As a result, tipping fees, the per ton disposal fees at landfills, were rising at an unprecedented rate.

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[1] See Church, Garbage, Garbage, Everywhere, Time, Sept. 5, 1988, at 81; H. Neal & J. Schubel, Solid Waste Management and the Environment: The Mounting Garbage and Trash Crisis (1987); Beck, Buried Alive – The Garbage Glut: An Environmental Crisis Reaches Our Doorstep, Newsweek, Nov. 27, 1989, at 66. See generally Natural Resources Defense Council, Cities & Green Living: Recycling, ch. 4 (Feb. 1997) ("In 1986, more than two hundred articles appeared in major newspapers and magazines throughout the United States quoting local public works officials throughout the country who found that polluting landfills, rising waste disposal costs, and fights over dangerous waste incinerators were among the two or three greatest public-policy problems they had to deal with.") <http://www.nrdc.org/cities/recycling/recyc/recyinx.asp> See also Solid Waste: Public Concern About Garbage Tops Polic, Fire, Affordable Housing, Poll Shows, 19 Env't Rep (BNA) 1247 (Oct. 28, 1988); 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); Office of Solid Waster, Environmental Protection Agency, The Solid Waste Dilemma: An Agenda for Action (1989) (final report of the Municipal Solid Waste Task Force); Office of Technology Assessment, U.S. Congress, Facing America's Trash: What Next for Municipal Solid Waste? (1989) [hereinafter cited as "OTA Report").

Incineration, the other major disposal option, was seen as a threat to air quality[2] and new capacity also faced NIMBYism. Recycling, the third waste management option, was unable to gain much traction. The United States trailed far behind Europe and Japan in recycling rates.[3] Environmental advocates chastised Americans as the "throwaway society." This was a moral issue, and Americans either did not care enough or were too lazy to protect the environment. This "crisis" was perhaps most poignantly symbolized in 1987 by the two-month odyssey of the Mobro, a trash laden barge that was unable to find any place to unload its fetid cargo along the eastern seaboard.[4] The futility of this voyage, broadcast frequently on national news reports, brought attention to environmental problems surrounding the municipal solid waste (MSW) stream and awakened government officials at all levels to the need for action. But what action was called for?

In 1989, the Office of Technology Assessment issued a detailed report calling for government

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[2] Incineration contributes to air pollution by emitting carbon monoxide, sulfur dioxide, and particular matter, as well as heavy metal compounds and other hazardous air pollutants. Various pollution control technologies – such as stack scrubbing and filtering – can reduce these emissions significantly. See generally C. Brunner, Hazardous Air Emissions from Incineration (1985). In addition, solid waste incineration produces large quantities of residual ash, which can contain high concentrations of toxic metals.

[3] See J. E. McCarthy, Recycling and Reducing Packaging Waste: How The United States Compares to Other Countries, 2 (Washington, D.C.: Congressional Research Service, Library of Congress, 1991); National Solid Waste Management Association, Resource Recovery and the Environment 1 (1990); Keep America Beautiful, Overview: Solid Waste Disposal Alternatives (1989).

[4] The Mobro owes its 15 minutes (or more precisely, two months) of fame in part to Salvatore Avellino, a reputed mob boss who thought he could find a lower disposal fee than Islip, Long Island's prevailing tipping fee of $86 per ton. See Jane Katz, What a Waste, Regional Quarterly Q1 2002 (Federal Reserve Bank of Boston) 22, 30. He identified a landfill in Louisiana that would charge only $5 per ton. Problems arose when it turned out that his partner had not closed the deal after the barge set off down the coast. The partner then decided to cut a deal with a landfill in North Carolina, but state regulators vetoed the transaction out of concern that the trash aboard the barge might be concealing hazardous waste, a ruse associated with organized crime. Once this story hit the news wires, no jurisdiction wanted to do business with Avellino. After being rejected by six states, Mexico, and Belize, the barge eventually returned to New York, where the trash was incinerated in Brooklyn and the ash disposed in a landfill near Islip, Long Island. See U.S. EPA Website, Milestones in Garbage: A Historical Timeline of Municipal Solid Waste Management. <http://www.epa.gov/epaoswer/non-hw/muncpl/timeline_alt.htm> Later that year, Mr. Avellino went to prison after pleading guilty for conspiring to kill two trash haulers, although neither appeared to be connected to the Mobro. See Katz, supra.

intervention, but the recommendations of the report can aptly be described as a shotgun approach.[5] OTA offered numerous recommendations, but relatively little in the form of coherence or clear priorities. Environmental groups and ultimately the public called for aggressive action to address what was often presented as a national problem. Many states adopted recycling goals and mandatory recycling laws, a few passed deposit-refund laws for beverage containers, and one even went so far as to ban drink boxes because they are difficult to recycle after consumer use.

Economists tended to react in a less alarmist and scattershot manner. In their view, the cause of the so-called "crisis" lay in the failure to confront decisionmakers with the social cost of their choices: the marginal cost to most households of disposing waste in landfill was effectively zero, whereas the cost of recycling or reducing waste generated was positive – the inconvenience of separating recyclable materials and transporting them to a recycling depot.[6] In almost every municipality in the United States, households paid for waste disposal through their property taxes. The cost per household was the same regardless of how much or what they disposed and, in many cases, was not even reflected in a separate line item on the tax bill. Cities either operated their own waste pickup trucks or franchised out this work. There was typically no limit on the amount of trash that households could put out each week. Furthermore, recycling typically required time and effort to find suitable recycling facilities.

To economists, the solution to the various problems comprising the "solid waste crisis" lay in imposing the cost of waste disposal on consumers and households. How and where to impose this cost posed the challenges. It is not possible to determine the cost of disposal at the point of purchase because we cannot know what the consumer will ultimately do with the packaging and spent product. The cost will vary depending upon whether the consumer litters the waste material, disposes of it in mixed refuse, separates the material for recycling, or reuses it. Setting up a disposal checkout stand at each of these points might work in theory, but is hardly feasible. A deposit-refund system accomplishes both of these pricing functions, but applies to only a modest portion of the MSW stream and imposes significant transaction cost burdens on households and retail businesses required to process refunds.

A more promising approach is to charge households based on the volume or weight of their mixed refuse while providing free curbside collection of recyclable and compostable materials. Such fees can be implemented rather simply and inexpensively by charging households an annual fee based on the size of their trash receptacle. In order to economize on this cost, they would likely select a smaller sized can than they have traditionally used and devote greater energy to diverting waste into the free pick-up containers for recyclable materials and yard waste. They might also seek to reduce their

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[5] See U.S. Congress, Office of Technology Assessment, Facing America's Trash

[6] See Peter S. Menell, Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste, 17 Ecol. L.Q. 655 (1990); Lisa A. Skumatz, Variable Rates for Municipal Solid Waste: Implementation Experience, Economics, and Legislation, Reason Foundation Policy Study 160 (Jun. 1993); Jenkins (1992); Stavins, Project 88, Part II; Fullerton & Kinnaman, 1995.

total waste production by purchasing products with less waste, reusing containers, and home composting.

The past decade has witnessed a significant rise in the number of households facing such economic incentives to reduce their waste disposal and separate recyclable materials. The number of communities using variable pricing has grown ten-fold from approximately 100 in 1990 to more than 5000 today.[7] Approximately 20 percent of Americans live within a variable rate pricing community and the approach continues to spread both here and abroad. Meanwhile, the number of communities collecting recyclable materials at the curbside has grown from approximately 1,500 in 1989 to nearly 10,000 today, serving approximately half of all Americans.[8] Over this period, the average amount of solid waste generated per person in the United States has remained constant at 4.5 pounds per person per day despite a substantial rise in average incomes. The percentage of this amount going to landfills and incinerators has fallen from 84% to 70%, as the recycling rate (including yard waste composting) has doubled from 16.2% to over 30% nationally.[9] Reports of a landfill crisis have faded from the headlines. Tipping fees have stabilized and vibrant recycling markets have developed. Most cities that have adopted these approaches have seen their total cost of disposal decline. Initial concerns about pricing garbage triggering illegal disposal have proven to be exaggerated. After some initial opposition or at least hesitancy toward what might appear like a new tax in some communities considering variable rate pricing, most citizens in these communities have embraced this approach. Although the rollout has been most significant in suburban communities, where the prevalence of single family homes makes curbside charges relatively easy to implement, there have been notable successes in larger cities such as Seattle, San Francisco, San Jose, and Austin. Variable rate policies have proven to be quite successful in reducing solid waste generated, diverting a much greater percentage of waste to recycling and yard waste composting, and substantially reducing solid waste. Although the overall benefit-cost ratio of variable rate pricing is only moderately favorable and this approach may not be workable in some urban settings, there is little question that this approach to MSW management is here to stay and can be expected to expand and become more sophisticated over time. Due in part to variable rate pricing, MSW is now seen as a manageable environmental problem.

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[7] See Lisa A. Skumatz, Ph.D., Maximizing Variable Rate/Pay as You Throw Impacts – Policies, Rate Designs, and Progress, Resource Recycling (June 2001, August 2001).

[8] See California Integrated Waste Management Board, Curbside Recycling, the Next Generation: A Model for Local Recycling and Waste Reduction (July 2002) <http://www.ciwmb.ca.gov/LGLibrary/Innovations/Curbside/>

[9] See U.S. Environmental Protection Agency, Municipal Solid Waste in the United States: 2000 Facts and Figures 1-3 (June 2002). With a relatively stable proportion of discarded material being incinerated (approximately 15% of total solid waste), the percentage of MSW going to landfills declined from nearly 70% to 55% during the 1990s. Id. at 125.

This article begins by characterizing the MSW stream and the ways in which consumer and household behavior affect the size and composition of the waste stream and recycling activity. Part II presents an economic perspective on the MSW stream and examines ways in which pricing mechanisms can be instituted to internalize the costs and benefits associated with waste decisions. Part III surveys the landscape of MSW policy during the 1990s, reports on the diffusion of variable rate pricing approaches in the United States, discusses the implementation challenges that EPA and communities faced supplanting conventional MSW systems with incentive-based alternatives, and explores the challenges of diffusing variable pricing approaches to large cities. Part IV assesses the economic and environmental effects of variable rate pricing. The article concludes by reflecting upon what this experience says about MSW policy and the larger question of the role of economic incentive approaches in protecting the environment.

I. <u>Characterzing the MSW Stream and the Role of Consumer Behavior</u>

In order to understand the policy matrix governing the MSW stream, it is necessary to understand the wide range of economic actors who contribute to its size and composition. The MSW stream reflects various levels of decisions made by product and packaging manufacturers, consumers, households, waste processors, and municipalities. As depicted in Figure 1, the waste stream begins with product design and raw material choices made by manufacturers. These choices, however, respond to consumer demand for products and packaging, as well as the availability and cost of materials.

Figure 1
Multi-Tier Structure of the MSW Stream

Consumers influence the MSW stream through their purchasing decisions and, later, through their reuse and disposal choices. To the extent that they seek to reduce solid waste, consumers will demand products or packaging that reduces the amount of residual material after the product is consumed or spent. Alternatively, they may opt for packaging that can be reused, such as sauces sold in reusable Mason jars. In any event, competition among product manufacturers (and retailers) for households' consumption dollar will affect the types of products and packaging that are sold.[10]

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[10] Data from Procter and Gamble Corporation, a large consumer product manufacturer, indicates that grocery packaging as a percentage of MSW decreased from 15.3% to 12.1% between 1980 and 1993 notwithstanding substantial economic growth. See Lisa A. Skumatz, Ph.D., Measuring Source Reduction: Pay as you Throw/Variable Rates as an Example 4 (Slumatz Economic Research Associates) (May 2000) (hereinafter cited as "Measuring Source Reduction"). Landfill archeology data compiled by Dr. William Rathje similarly reveals a decline in the percentage of packaging in landfills over this time period. See The Archaeology of Plastic Packaging and Source Reduction, prepared for the ULS report, by The Garbage Project, Tucson, Arizona (Jul. 1997) (cited in id.).

After a product has been consumed, households play a critical role in diverting waste from landfills (or incineration) by separating waste materials into economically valuable waste streams. The economics of recycling turn critically on the availability of a steady, homogenous supply of waste – whether glass, metal, newsprint, paperboard, plastics, or yard waste. It is rarely economically viable to separate materials from mixed refuse streams. Hence, if wastes become intermingled at the household level, it is likely that they will remain so and ultimately be disposed in a landfill or incinerator.[11] If a household separates wastes into discrete waste streams that can reach recycling enterprises, such materials can often be reprocessed for less cost than manufacturing from raw materials. In some cases, it is more economical to produce new products, such as "plastic lumber" made from recycled plastics used to produce decking, park benches, waste receptacles, signs, and play structures.

Waste separation occasionally occurs at a mixed waste processing facility prior to disposal, although this is relatively rare due to the high labor cost of centralized separation and the contamination of waste streams.[12] Magnets have been used for quite some time to separate ferrous metals, which have a significant salvage value and can be removed at relatively low labor cost. Modern technology, such as customized fans for extracting light materials such as plastics and conveyor belts, have increased the use of centralized separation, but it remains a rather small piece of the overall recycling equation.[13]

Most recyclable materials pass through a materials recovery facility (MRF) prior to reentry into a manufacturing process. Even streams of recyclable materials must typically be further separated. Many curbside collection programs allow households to place all beverage containers -- glass, metal, and plastic -- into the same bin. The materials must be further segregated at an MRF. In addition, some materials are processed (e.g., shredded) and packaged prior to shipping. At low technology MRFs, these activities are done by hand. The growing number of high technology facilities use eddy currents, magnetic pulleys, optical scanners, and air classifiers to segregate wastes.[14]

Table 1 shows the composition of the MSW stream as of 1990 as well as the percentage of

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[11] Cans and bottles can be sorted and diverted from a mixed refuse stream, but the labor cost often exceeds the salvage benefit, especially where there has been curbside collection of glass and metal containers. Newsprint and paperboard become contaminated with food and liquid wastes in mixed streams and cannot be effectively separated thereafter.

[12] The number of mixed waste processing facilities has grown from approximately 100 in 1990 to nearly 500 by 1999. See Eileen Brettler Berenyi, Whither MRF-Based Recycling? Resource Recycling 12 (Apr. 1999).

[13] See Katz, supra n. __ at 27.

[14] See EPA 2000 Report, supra n. __, at 116.

waste being recycled (or, in the case of yard and food wastes, being composted) at that time. With regard to glass and metal beverage containers, it should be noted that 9 states enacted deposit-refund or container redemption laws during the 1970s and 1980s, predominantly for litter control purposes.[15] These laws significantly increased the number of beverage containers being recycled in these states.

Table 1
Composition of the MSW Stream: 1990

II. An Economic Approach to Consumer-Level MSW Regulation

The MSW policy literature highlights a range of goals:

- reducing the amount of solid waste generated ("reduce, reuse, recycle")
- diverting waste from landfill (50% is an oft-cited goal)
- sharing the costs of solid waste management equitably (polluter pays principle)
- promoting eco-friendly product design ("green design")

Economic analysis generally seeks to promote efficient resource use. In some cases, that might entail source reduction or recycling, but economists tend to be agnostic about the particular results. They focus upon whether the decision making processes and institutions internalize the full social benefits and costs of decisions.

The complex nature of the MSW stream creates opportunities and challenges for confronting decision makers with the full benefits and costs of their choices. Take, for example, the decision to purchase a beverage packaged in a glass verus plastic container.[16] The total economic cost of the container over its life cycle depends not just on its manufacturing cost, but also how the container is ultimately disposed. At the time of purchase, there is no way to know how that container will be disposed. Therefore, an advance disposal charge based on the average disposal cost will under-price social disposal cost if the consumer litters the container or throws it into a mixed refuse receptacle and over-price the social disposal cost if the consumer brings it to a recycling center or separates it for

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[15] See Facing America's Trash, supra n. __, at 35. 11 states container deposit or redemption laws today. See http://www.bottlebill.org/USA/States-ALL.htm; John K. Stutz and Susan M. Williams, Economics of Expanding Bottle Bills, Resource Recycling 20 (Apr. 1999).

[16] See generally Menell, Beyond the Throwaway Society: An Incentive Approach to Regulating Municipal Solid Waste, 17 Ecology Law Quarterly 655 (1990).

curbside collection.[17] A two-tier tax, such as a deposit-refund system, can possibly control for both aspects of consumer decisionmaking – which container to purchase and how it is ultimately disposed – but entails substantial transaction costs. Retail stores or redemption centers must be staffed so as to provide the refunds and consumers must incur substantial storage, transportation, and time costs in redeeming containers. A curbside charge for pick-up of mixed refuse with free collection of valuable recyclable materials (such beverage containers, newsprint, and paperboard) creates a relative price differential between disposal options that can roughly approximate social cost at a more modest transaction cost.

This section presents an economic approach to regulation of consumer decisions bearing upon the size and composition of the MSW stream. It begins by assuming zero transaction costs in order to identify a first-best policy in a frictionless world – i.e., how society could completely internalize the social costs and benefits associated with MSW stream. It then introduces transaction costs in order to focus upon those policies best attuned to the reality of regulating the MSW stream. The next section examines a number of additional considerations – the problem of illegal disposal, achieving critical mass and coordination within recycling markets, and additional environmental externalities associated with materials use – bearing on the formulation of an economic approach to governing municipal solid waste. The final section provides an overall qualitative comparison of the principal consumer-oriented MSW policies.

A. Pricing the MSW Stream in the Absence of Transaction Costs

In a world without transaction costs, the optimal policy would confront consumers with the full economic costs and benefits of their purchasing and disposal decisions. This hypothetical world can be represented by two "checkout" stands. The first actually exists at most retail stores. Consumers place the items that they wish to purchase upon a conveyor belt. The items are scanned and consumers are charged the individualized retail cost for each item before it is placed in a bag at the end of the conveyor system.

The second "checkout" stand is hypothetical and can be characterized a complex conveyor system at the curbside. Consumers would face a choice of how they wished to dispose of items. The easiest method would be to place items in the mixed refuse bin. This material would be weighed and the consumer would be charged the cost per pound of landfilling or incinerating the waste, whichever was most competitive at that point in time.[18] Alternatively, the consumer could separate some of its

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[17] Uniform taxes cannot reflect material-specific differences in packaging. Advance disposal fees cannot reflect the actual social cost of disposal because it is not know at the point of purchase how the consumer will dispose of any waste materials. See Menell, supra n.__, at ___-___.

[18] See e.g., Lisa A. Skumatz, Ph.D., Garbage by the Pound, Resource Recycling (November 1989) (proposing such a system); see also Menell, supra n.__.

waste material into different bins – glass (by color), plastic (by type), metal (by type), newsprint, paperboard, food waste, yard waste, etc. A checkout clerk would weigh each of the bins and determine a total bill. Some items might have a negative price where the salvage value of the item exceeded the hauling cost. Waste haulers and recyclers would compete for the consumers' trash, thereby producing a competitive market in waste removal and reprocessing. Over time, consumers would factor these costs and net salvage values not only into their waste separation decisions but also into their demand for products and packaging. Product and packaging manufacturers would receive these signals through the derived demand for their goods and would have appropriate incentives to design better products. As virgin resource availability and cost, recycled material salvage values, landfill and incineration tipping fees, and hauling costs changed over time, consumer would respond accordingly and an efficient allocation of resources would obtain.

B. <u>Regulating the MSW Stream in the Presence of Transaction Costs</u>

Despite technological advances in weighing and billing systems, the first best world of perfect curbside charges is unlikely to be attainable any time soon in the residential context. The labor costs, time commitment, capital equipment, and physical space required to effectuate the "perfect" curbside charge "outweigh" the benefits under current circumstances.[19] Overall, the economic benefits of such an elaborate system would fall well below the costs. The difference in net economic value between disposing of mixed refuse in a landfill and separating newsprint or even glass or aluminum beverage containers for recycling is not nearly great enough to justify such a complex and expensive system for diverting waste materials into distinct streams. Nonetheless, this simple exercise highlights the basic goal of trying to provide consumers with at least rough price signals relating to their purchasing and disposal decisions. The key for policy design is to balance these considerations with the very real costs of administering a system of charging for waste disposal that provides incentives for consumers to reuse waste components, separate the most valuable waste streams, and consider the waste end of the product life cycle in their product and packaging choices.

The design of the optimal waste disposal governance system must account for a variety of transaction costs. These costs in turn depend upon a variety of factors, including the nature of trash hauling markets, technology, demographic, socioeconomic, geographic, and climactic variables, and the state of recycling markets.

Waste Hauling Markets – In addition to households, waste hauling enterprises play a critical role in waste separation and disposal. In most markets, only a single company handles this activity because of economies of scale in a single provider. Due to the labor and transportation costs and the relatively small amount of waste per household, it makes little sense for multiple haulers of the same

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[19] It should be noted that larger-scale commercial hauling companies have increasingly incorporated weight-based systems that distinguish among waste stream components.

type of refuse to travel the same route.[20] There are significant savings in regularized pickups and practices throughout residential community. Therefore, most municipalities contract out this work to a single vendor through a competitive bidding process. With the rise in curbside collection of recyclable materials, it is now feasible to have one vendor handling mixed refuse, another responsible for separated recyclable materials, and possibly a third in charge of picking up yard waste. The role of municipalities in contracting and coordinating these services influences the cost structure of MSW policies.

Technology – Technology affects the options for solid waste policy on various levels. The viability of source separation depends on the means for separating wastes at curbsides (design of trash bins, garbage bags), multi-family dwellings (e.g., trash chutes, locked garbage bins), and material recycling facilities. Charging households for their waste disposal and recycling depends on the effectiveness of weighing systems. The degree to which curbside pick-up can cover multiple waste categories turns on the design of recycling truck bins and compactors. Charging for waste also depends on accounting and billing systems.

Demographic, Socioeconomic, Geographic, and Climactic Variables – The viability of waste disposal charges and household-based separation varies significantly across communities based upon a range of factors. Relatively affluent suburban communities have thus far proven to be the most promising setting for variable rate pricing because of the fact that most households have a distinct curbside at which trash is removed, generate substantial waste that can usefully be diverted from the mixed refuse stream (most notably, yard waste), and the risk of illegal disposal is particularly low. Many factors, however, affect the feasibility of curbside recycling and different market-oriented approaches. For example, high average annual precipitation undermines curbside pickup of paper and paperboard, although covered bins can address this problem. Large apartment building having only a single chute for waste make separation and individualized billing particularly difficult.

Recycling Markets – The benefits of materials separation depends upon the salvage value of separated materials. Such markets depend on the larger infrastructure of industrial activity and the state of recycling technology. Many industries established their production processes and facilities based upon the use of virgin materials. Therefore, when significant levels of separated waste material became available as a result of state and local policies favoring recycling, prices plummeted.[21] Over time, the further development of processes for using separated materials, the development of transportation infrastructure and marketing organizations for making these materials more widely available, the

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[20] In many communities, commercial waste hauling is handled on a contract basis. The quantities of refuse from commercial enterprises is sufficiently large per pick-up for this scale of activity to make economic sense.

[21] See Luoma, Trash Can Realities, Audubon, Mar. 1990, at 86, 90 (noting virtual collapse of recycled materials prices as a result of sudden increase in supply)

relocation of some industry to take advantage of these new sources of input material, and government and consumer preferences for products made from recycled content have stabilized salvage values.

Drawing upon these considerations, the principal options[22] for influencing consumer decisions bearing on the size and composition of the MSW stream are:

(1) Advance Disposal Charges – charging consumers a surcharge at the retail level for products and packaging.

(2) Curbside Pick-Up of Recyclable Materials – providing free curbside pick-up of designated categories of recyclable materials, such as newsprint, paperboard, bottles and cans, and yard waste. Communities can also offer annual or semi-annual pick-up of odd-sized wastes (such as spent appliances) and household hazardous wastes.

(3) Disposal Bans – typically done in conjunction with curbside pick-up, banning disposal of certain categories of recyclable materials in mixed refuse.

(4) Variable Rate Disposal Charges or Unit-Pricing – charging households for mixed refuse based on amount (volume or weight). This policy is typically done in conjunction with free curbside pick-up of recyclable materials. It can be implemented in a variety of ways:

    (a) Variable Can – Households select a particular sized mixed refuse receptacle (such as 16, 32, or 64 gallons per week) and are charged an annual fee for regular (typically weekly pickup).

    (b) Bag, Tag, or Sticker Charges – Households purchase designated trash bags, tags, or stickers that they can place on generic trash bags or receptacles. Bags or other marking designations can be purchased at city hall, community center, fire stations, or local grocery and convenience stores.

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[22] As noted in the introduction, see supra n. __, some communities have at times considered bans of specific products and packaging for purposes of managing MSW. For example, Maine banned the sale of asceptic packaging (multi-material drink boxes) in 1990, but later lifted the ban after environmental studies showed that this packaging was relatively benign and had distinct environmental advantages. See Frank Ackerman, Why Do We Recycle (1997). Vermont considered but ultimately dropped a proposal to ban disposal diapers. See Menell, Eco-Information Policy, <cite> Product bans of otherwise non-hazardous products no longer appears to be a serious consideration in MSW policy circles.

(c) Hybrid Systems – This system combines the variable can with a bag, tag, or sticker approach. Households register for a regular weekly pick-up of a particular sized receptacle and can augment that disposal with designated bags or tags.

(d) Weight-Based Systems – This approach uses specially-equipped waste hauling trucks that can weigh each household's mixed refuse, record the relevant information in a data base, and bill households by the pound on a regular basis. In more sophisticated versions, radio frequency tags are affixed to waste receptacles to identify the household and automate data collection.

(5) Recycling Centers – providing or subsidizing facilities for free or paid drop-off or recyclable materials.

(6) Deposit-Refund Programs – combining a retail charge with a redemption refund for some classes of recyclable materials, typically beverage containers.

The transaction costs associated with these policies fall into the following principal categories: waste hauling; billing, administrative, and retail systems; consumer costs; and enforcement costs. Providing for the pick-up of separate categories of waste significantly increases the cost of waste removal. It typically requires specialized bins, specialized trucks, greater direct fuel cost, and additional labor. It does, however, result in mixed refuse disposal fees because of the reduced tonnage delivered to landfills and incinerators and may produce significant salvage revenue. Many of these policies also involve the creation and maintenance of billing and administrative systems. Some of the policies also require the operation of retail enterprises for selling bags, tags, or stickers to households. A third class of transaction costs fall upon consumers. In addition to the physical labor and time associated with separating wastes, there are storage costs and other forms of inconvenience. Some systems also impose transportation costs upon consumers. These costs can affect some households much more significantly than others. For example, the elderly may find some of the requirements particularly onerous and inconvenient. Enforcement comprises a fourth category of transaction costs. Under some of these policies, local law enforcement, waste haulers, or regulatory officials must monitor consumer behavior and impose fines or other penalties upon households. In addition, the availability of valuable separated wastes at the curbside can lead to a problem of waste theft – people who "cherry pick" wastes that can be redeemed at material recycling facilities. These activities can undermine the overall solvency of waste collection activities.

The principal transaction costs associated with particular consumer-oriented MSW policies can be characterized as follows:

(1) Advance Disposal Charges – This system entails substantial administrative costs in establishing fees, imposing these fees at the retail level, and collecting revenues. These

costs are borne by the regulatory authority and most significantly by retail establishments. Bar coding and optical scanning technology reduce these costs to some extent, but there would be a significant additional layer of paperwork involved in administering this system.

(2) Curbside Pick-Up of Recyclable Materials – As noted above, curbside pick-up of recyclable materials entails substantial hauling and consumer costs which increase proportionately with the number of separate categories designated. Climate, geography, and population density can influence these costs.

(3) Disposal Bans – These policies add enforcement expenses to the costs of curbside pick-up of recyclable materials.

(4) Variable Rate Disposal Charges or Unit-Pricing – These policies are also typically pursued in conjunction with curbside pick-up of recyclables and therefore entail those additional transaction costs. In addition, the following versions have other transaction cost ramifications:

(a) Variable Can – This approach has relatively low administrative costs as fees can be included in an annual property tax statement.

(b) Bag, Tag, or Sticker Charges – This approach requires systems to be established and administered for enabling households to obtain designated bags, tags, or stickers. Since households pay for disposal through the purchase of bags, tags, or stickers, there is no need for billing through annual or more frequent statements.

(c) Hybrid Systems – This approach requires both aspects of billing noted in (a) and (b), although the bag, tag, or sticker transactions will be less than under a pure system of that nature since most households will be able to make due with their variable can.

(d) Weight-Based Systems – This approach entails substantial additional labor, equipment, and administrative expense in order track household mixed refuse disposal.

(5) Recycling Centers – These facilities involve labor, storage, and processing costs. In addition, to the extent that they pay for materials, there is an administrative cost for weighing or otherwise measuring delivered material. Households choosing to use these centers incur substantial transportation and time costs.

(6) Deposit-Refund Programs – These programs entail substantial administrative costs in providing those returning containers with per container refunds. Consumers also bear substantial storage, transportation, and time costs in returning containers.

C. Additional Considerations

1. Illegal Disposal

The imposition of variable rate disposal charges aroused concern that some households might seek to save money on waste disposal by illegally disposing of their refuse.[23] Even modest increases in improper disposal of refuse could undermine the efficacy of variable rate policies because the social costs of such activity vastly exceed the costs of proper disposal. Improper disposal is much more likely to contaminate streams, cause infestations, promote the spread of disease, and contribute to litter problems and associated aesthetic blight. There are various ways of addressing the illegal disposal problem, including education campaigns, careful design of variable rate policies, making available positive rewards for legal diversions (such as recycling centers providing refunds for separated wastes), enforcement efforts, and periodic free pick-up of particularly problematic wastes (such as tires and large appliances). In addition, commercial enterprises can use locks on dumpsters to prevent others from using their disposal facilities. In many respects, the problem of illegal disposal represents an additional form of transaction costs borne by enforcement officials, regulatory officials, and commercial facilities that might receive additional waste.

2. Facilitating Recycling Markets

A well-functioning recycling market requires the availability of a steady and reasonably pure stream of input material – newsprint, paperboard, glass, metal, plastic, or organic material (yard and food waste). As these streams form, recycling entrepreneurs, waste arbitragers, and entire industrial sectors have an incentive to take advantage of these sources of input material and redeploy their manufacturing operations accordingly. Well-functioning high volume curbside recycling programs create such streams and provide the impetus for investment in new business models and industrial processes utilizing recycled materials. They also provide incentives to the development of entirely new product lines, such a "plastic lumber." By hastening the formation of recycling markets and standardizing the type and quality of materials available, state and regional initiatives address a coordination problem in the formation and development of recycling markets.

3. Environmental Externalities and Non-Market Values

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[23] See Don Fullerton and Thomas C. Kinnaman, Garbage, Recycling, and Illicit Burning or Dumping, 29 J. Envt; Econ. & Mgmt. 78 (1995); Don Fullerton and Thomas C. Kinnaman, Household Responses to Pricing Garbage by the Bag, 86 Amer. Econ. Rev. 88 (1996).

Recycling has the potential to augment media-specific environmental protection efforts by reducing energy use, air pollution, water pollution, mining wastes, water use, and related ecological effects associated with manufacturing from virgin materials.[24] The extent to which these effects are external to existing regulatory activities is difficult to gauge. Furthermore, recycling can have adverse environmental effects as well. For example, by shifting the locus of manufacturing activities from more remote areas (closer to virgin sources) toward urban areas (where recycling stream can be found), recycling could in some circumstances increase stresses on critical waterways, air resources, and already stressed habitats. Nonetheless, there appear to be some benefits that can be derived from partially closing some loops in product life cycles.

A somewhat more amorphous benefit associated with MSW policy can be characterized as the non-market value of recycling activities. Many consumers and households appear to derive positive utility from engaging in separating of recycling material. The fact that a significant number of consumers brought separated materials to recycling centers without any economic reward reflects some of this value. The significant participation in curbside recycling efforts even without variable rate pricing of mixed refuse reinforces this point. It seems reasonable to attribute some non-market value to making recycling opportunities widely available. Consumers derive personal satisfaction (or assuage guilt) from taking responsibility for addressing a social cost to which they contribute. Moreover, as one of the most direct ways in which consumers and households affect the larger environmental system, waste disposal has some value in teaching and inculcating moral responsibility. It may also spillover into a better appreciation of environmental values. It is important to bear in mind, however, that consumer perception of environmental effects are often quite distorted and can be manipulated.[25] Nonetheless, there can be some benefit from harnessing this goodwill and channeling it in productive directions.

D. <u>The MSW Policy Matrix</u>

MSW policy should integrate the incentive effects of internalizing the costs and benefits of product choices and disposal decisions on consumer and household behavior, transaction costs, and various other effects. Table 2 provides a summary of the main effects of the range of consumer and household-oriented policies.

Table 2
MSW Policy Matrix

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[24] See Lester Brown, Eco-Economy: Building an Economy for the Earth (2001); C. Pollack, Mining Urban Wastes: The Potential for Recycling 22 (Worldwatch Paper No. 76 1987).

[25] See Menell, Structuring a Federal Market-Oriented Eco-Information Policy, 54 Maryland Law Review 1435 (1995); Menell The Uneasy Case for Ecolabelling, 4 <u>Review of European Community and International Environmental Law (RECIEL)</u> 304 (1995).

Based upon this qualitative assessment, the most promising options are the relatively simple variable rate policies for areas where curbside pick-up is feasible. Many residential communities already arrange for pick-up of waste on a regular basis. Economies of scale in collecting recyclables at the curbside presents a plausible optimal solution to balancing the costs and benefits of alternative MSW policies. By contrast, advance disposal charges do nothing to promote separation activities by households. Deposit-refund systems entail high transaction costs for addressing a relatively small portion of the waste stream. Since curbside collection of mixed refuse already takes place, having consumers make special trips and requiring redemption centers and retail stores administer a labor-intensive refund system ignores the larger cost-benefit analysis. The main advantage of the deposit-refund system relates to litter control, but increased fines and publicly funded sanitation are likely to be more cost-effective ways of addressing this problem and go beyond littering of beverage containers.

III. MSW Policy During the 1990s

As noted at the outset of this article, a series of events and media reports raised the salience of MSW policy. All levels of government became involved in what had traditionally been a local environmental issue. This section first discusses the larger federalism landscape surrounding MSW policy. It then examines the most significant policy development affecting consumer MSW behavior during the past decade – the development and diffusion of variable rate policies throughout the nation. Section IV will then examine the efficacy of this set of instruments.

A. MSW Federalism and Legislation

As its profile has broadened, municipal solid waste policy has grown beyond city and local politics to involve federal and state legislation, regulation, and hortatory efforts. Municipalities and counties continue to play the principal role in determining how solid waste generated within their jurisdictions is disposed and setting policy directed at household behavior. This section summarizes the new emerging landscape of MSW regulation.

1. Federal Role

The federal government has come to play two principal roles in the MSW field. Pursuant to its authority under the Solid Waste Disposal Act of 1965 as amended by the Resource Conservation and Recovery Act of 1976 (RCRA) and the Hazardous and Solid Waste Amendments of 1984,[26] the U.S. Environmental Protection Agency (EPA) has responsibility for regulating the transportation, storage,

[26] See U.S. Environmental Protection Agency, Office of Solid Waste, 25 Years of RCRA: Building Our on Our Past to Protect Our Future (2001).

and disposal of wastes.[27] Of most significance with regard to MSW policy, RCRA prohibited open dumping of waste and mandated strict requirements for treatment, storage, and disposal of hazardous wastes. In October 1991, EPA promulgated new standards for MSW landfills requiring installation of costly technological safeguards, such as liners, leachate collection systems, ground water monitoring equipment, and gas vents.

These requirements have significantly altered the environmental practices and business models for solid waste disposal. Prior to the 1990, most municipal solid waste was disposed in open dumps owned and operated by municipalities and counties. As federal regulations imposed and tightened environmental controls on solid waste facilities, many municipalities were forced to close their dumps. Much of the uproar over an imminent shortage of landfill capacity grew out of this new regulatory environment. By the mid 1990s, private enterprises had taken over much of the disposal business, building vast new facilities that have greatly expanded landfill capacity.[28]

The EPA has played a comparable role in the regulation of incineration. Most of these facilities are designed to both reduce the amount of waste materials as well as generate energy – either directly through combustion in mass burn facilities or by shredding and screening wastes to produce highly combustible fuel pellets (refuse-derived fuel). These processes produce two types of pollutants – air emissions and ash residues. Under the Clean Air Act, EPA sets standards for conventional and hazardous air pollutants that affect the design and siting of waste to energy incinerators. The disposal of incinerator ash falls within the scope of federal waste disposal regulation. Depending upon the composition of the wastes burned and the design of the incineration facility, this ash can contain significant concentrations of toxic metals. In an important 1994 decision,[29] the U.S. Supreme Court ruled that the Resource Conservation and Recovery Act (RCRA) does not exempt ash produced by municipal waste incinerators from stringent hazardous waste regulations. The U.S. Environmental Protection Agency and one federal appeals court had previously interpreted RCRA as exempting the ash produced from incinerating municipal solid waste. Under the Supreme Court's decision, incinerator ash that contains hazardous constituents exceeding specified levels now must be managed, stored, treated, and disposed of as a hazardous waste. This substantially raises the cost of incineration as a waste disposal method.

At the consumer level, EPA has played largely an advisory role in advising states and municipalities to adopt particular MSW policies. In 1989, EPA issued its Agenda for Action in which it

[27] See 42 U.S.C. §§6901-6992.

[28] See Demand is Finally Catching Up With Excess Capacity; Critical in the Northeast, Solid Waste Digest: National Edition, October, 2002, at p.1

[29] City of Chicago v. Environmental Defense Fund, 511 U.S. 328 (1994).

established a national goal for source reduction and recycling of 25% by 1992.[30] Throughout the 1990s, the agency has convened a series of roundtable policy fora in order to assess and develop guidance materials regarding MSW policies at the community and consumer level.[31] In 1993, EPA decided to take an active role in encouraging variable rate pricing of MSW. EPA officials came to see variable rate pricing as a way of addressing three important principles: environmental sustainability, economic sustainability, and equity. Under its "Pay-as-You-Throw (PAYT)" program, the agency developed an information clearinghouse and education materials to guide local decisionmakers. It also funded a series of studies and pilot projects designed to assess variable rate pricing.[32] As these studies confirmed both the efficacy of PAYT and the design challenges, EPA entered a tool building phase in which it produced pamphlets, a video, presentation materials, implementation guides, and summaries of success stories. Workshops on implementation of variable rate pricing were convened by the EPA, states, and solid waste organizations throughout the nation. Publications such as Waste Age, Resource Recycling, and Biocycle published numerous articles on variable rate pricing in the mid to late 1990s.

As it completes its last phase of this project, EPA is focusing upon the more complex targets. Its American Big City Campaign (ABC) aims to assist larger communities in adapting PAYT to reach higher density living patterns which make it more difficult to determine household-specific waste quantities and the potential for and health effects of illegal disposal pose special problems.

The federal government has sought to spur the demand for recycled products through procurement regulations providing affirmative preference for products containing recycled content. As the largest consumer in the world, the federal government plays a substantial role in many important product markets. Pursuant to Section 6002 of the Resource Conservation and Recovery Act, federal government agencies must give preference in their procurement programs to products and practices that conserve and protect both natural resources and the environment. Under this provision, EPA has developed guidelines to assist Federal agencies with procuring products containing recovered or recycled materials.[33] Federal agencies that purchase more than $10,000 of an item listed by EPA in its Comprehensive Procurement Guideline are required to establish an affirmative procurement program for that item "that assures that items composed of recovered/recycled materials are purchased to the

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[30] In 2000, EPA raised this goal to 35% by 2005.

[31] See Janice Canterbury, EPA and PAYT Celebrate 10 Years of Growth and Success (forthcoming 2003).

[32] See Duke studies

[33] See U.S. EPA, Comprehensive Procurement Guidelines <http://www.epa.gov/cpg/products.htm>

maximum extent practicable."[34]

2. State Policies and Mandates

State governments play a variety of roles in the regulation of MSW. Under RCRA, they typically assume responsibility for implementing and enforcing federal requirements for the design and operation of disposal facilities. Many state environmental agencies also assume comparable responsibilities for overseeing air pollution regulations.

Of more direct significance for consumer-level MSW policies, most states have become involved in promoting recycling and encouraging localities to adopt specific solid waste regulatory approaches. Several states have funded studies of MSW policies, including variable rate pricing. Nearly all states have established recycling goals, typically ranging from 25% to 50% of MSW generated.[35] As of 1999, 39 states had adopted policies promoting the adoption of variable rate approaches by municipalities.[36] Minnesota and Washington require that all municipalities adopt such programs, whereas Wisconsin and Iowa require adoption only if a community has not met a 25% recycling goal. 34 states provide education and grants to municipalities to help finance recycling programs, with some states allocating funds specifically for or with preference for variable rate approaches. 23 states ban disposal of yard waste in mixed refuse. Seven states require all municipalities to implement curbside recycling programs and to pass local ordinances prohibiting disposal of designated categories of recyclable materials in mixed refuse.[37] 11 states have enacted some form of deposit-refund or redemption system for beverage containers. In addition, many states have sought to stimulate the demand side of recycling markets. 29 states require state government offices to purchase recycled materials.

3. Local Regulation

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[34] See U.S. EPA, Fact Sheet: Affirmative Procurement (August 1994) <http://es.epa.gov/techinfo/facts/pro-act9.html> See also Executive Order 13101, Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition (Sept. 14, 1998) (expanding upon prior such order establishing guidelines and oversight bodies to promote recycling through federal procurement activities).

[35] See Jim Glenn, The State of Garbage in America, Biocycle 32-43 (April 1998).

[36] See Lisa A. Skumatz, "Variable-Rate or 'Pay-as-You-Throw' Waste Management: Answers to Frequently Asked Question," 10-11 (Reason Foundation Policy Study 295, Los Angeles, California 2000) (hereinafter cited as "Skumatz 2000").

[37] See Glenn, supra n.__.

Local governments remain the principal decision makers in the setting of household-level MSW policies. Prior to 1990, most municipalities approached solid waste policy as a local government service funded out of property taxes. They perceived their jobs as simply hauling trash to town and county dumps. They typically had available land for such purposes. The principal administrative function was in operating or contracting out for trash hauling services.

With the rising level of MSW generated, imposition of costly federal environmental regulations on the operation of landfills, tightening budgets, concern about rising taxes, and growing public concern about waste issues, municipalities increasingly found themselves in a bind. State mandates to establish curbside recycling programs tended to increase their costs of service, adding to budgetary pressures. EPA and state encouragement of variable rate pricing, as well as a growing number of success stories showing that these policies can reduce waste generated while providing a direct and acceptable means of funding such programs, brought many communities to adopt this approach.

B. The Rise of Variable Rate Pricing

The adoption of variable rate disposal approaches greatly expanded from approximately 100 programs nationally in 1990 to more than 5000 today.[38] More than 20 percent of Americans reside in communities using some form of variable rate pricing. Among these communities, variable can policies are most common (approximately one-third), following by bag (one-quarter), and hybrid and sticker programs (one-sixth each).[39]

Over the past decade, numerous approaches to variable rate pricing have been tested across thousands of laboratories of local government. Despite early enthusiasm based upon some promising pilot studies,[40] no weight-based programs have reached full-scale operation in the United States.[41] Relatively simple systems tend to be the norm, with variable can policies more common in larger

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[38] See Skumatz 2000, supra n. __, at 5; see also EPA data.

[39] See Skumatz 2000, supra n. __ at 6.

[40] See, e.g., Lisa A. Skumatz, Garbage by the Pound: the Potention of Weight-Based Rates, Resource Recycling (Jul. 1991); Lisa A. Skumatz, Hans Van Dusen, and Jennie Carton, Garbage by the Pound: Ready to Roll with Weight-Based Fees, Biocycle (Nov. 1994).

[41] See Skumatz 2000, supra n.__, at 6. A weight-based program that was slated to be implemented in Iowa was scuttled prior to full-scale operation as a result of the sale of the hauling company. Several hauling firms have used weight-based technology in commercial applications. There are numerous full-scale residential weight-based programs currently operating in Europe. See Lisa A Skumatz, "Factoids" on Variable and Weight-Based Rates in Solid Waste (Skumatz Economic Research Associates) (June 2001).

communities and bag, tag, and sticker models more common in smaller communities.[42] The more recent trend has been toward hybrid approaches, which keep implementation costs relatively low while allowing for greater precision in pricing.

Based upon the range of experiences, EPA and consultants have developed reliable tools for determining program design based upon a wide range of community characteristics and goals.[43] Community acceptance has proven to be a critical factor in getting programs established. Whereas variable can programs involve relatively little change in the nature of household waste mechanics, bag, tag, and sticker programs entail significant changes in household practices. Education plays a central role in getting variable rate programs off the ground.

Communities tend to view variable rate pricing as part of a comprehensive set of policies addressing waste reduction, promoting recycling and diversion from landfills, control of improper disposal, and equity concerns. Essentially all communities using variable rate pricing have instituted some form of pick-up of recyclables and yard waste at no additional charge. Many also offer periodic pick-up of bulky items (such as appliances and odd-sized wastes). Some offer free pick-up or drop-off of household hazardous waste (such as unused paints, pesticides, and cleaning solvents). Most variable rate communities have also deployed educational campaigns and enhanced enforcement to deal with illegal dumping of mixed refuse and theft of recyclable materials. Many communities have also instituted rebates and discount for low-income residents.[44]

Multi-family residences pose particular challenges for variable rate programs due to the commingling of wastes in common trash receptacles. The lack of a one-to-one relationship between the "curbside" and each household makes it difficult to monitor individual household behavior. In addition, high-rise apartments buildings typically have a single trash chute, which makes separation of wastes complicated. Storing separated wastes on each floor of the building increases the incidence of pests and raises labor costs. Multi-unit dwellings tend to have much lower recycling diversion rates and higher contamination of recycling streams than single family communities.[45] Not surprisingly, the

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[42] Id. at 7-9.

[43] See e.g., U.S. EPA, Rate Structure Design: Setting Rates for a Pay-as-You-Throw Program (Jan. 1999); U.S. EPA, Pay-as-You-Throw Success Stories (Apr. 1997); U.S. EPA, Pay-as-You-Throw: Lessons Learned About Unit Pricing (Apr. 1994); Skumatz 2000, supra n.__.

[44] See Lisa A. Skumatz, Ph.D., Hans Van Dusen, and Jennie Carton, Illegal Dumping: Incidence, Drivers, and Strategies, Research Report 9431-1 (Skumatz Economic Research Associates) (Nov. 1994, updated 2000).

[45] See, e.g., Scott D. Bauer and Marie Lynn Miranda, The Urban Performance of Unit Pricing: An Analysis of Variable Rates for Residential Garbage Collection in Urban Areas 23 (Apr. 1996)

adoption of variable rate pricing has tended to be most rapid in suburban communities, although these approaches have achieved success in several large communities throughout the nation, including Los Angeles, California (nearly 4 million residents), San Jose, California (850,000), San Francisco, California (775,000), Austin, Texas (650,000), Oklahoma City, Oklahoma (500,000), Minneapolis, Minnesota (380,000), and Norfolk, Virginia (260,000).

Variable rate programs have proven quite workable in smaller-scale multi-family dwellings, such as garden apartments and townhouses. New technology is now available for high-rise apartments that allows tenants to direct a disposal chute electronically into six different bins. Pilot studies find that households find this technology convenient. It has increased recycling significantly and promises a payback period of three years.[46] Newer multi-story buildings can be designed to facilitate variable rate programs and recycling.

Variable rate programs can be tailored to the particular waste profile of particular communities. Studies of San Francisco's waste stream revealed that food waste comprised a particularly large percentage of the city's mixed refuse after the implementation of variable rates in conjunction with curbside collection of recyclables and yard waste.[47] After experimenting with a variety of separation options for food scraps, the city developed the "Fantastic Three" program. Households received three carts (wheeled receptacles): a free blue 32 gallon cart for recyclables (paper, bottle, and cans), a free 32 gallon green cart for compostables (yard waste, food waste, and soiled paper), and a variable rate black cart (20, 32, or 64 gallons) for all other refuse. In addition, the city provided households with a convenient 2 gallon kitchen pail for collecting food scraps. After an extensive outreach and educational program through direct mail, the targeted neighborhoods achieved 46 percent diversion rate (14 percent for organics and32 percent for recyclables), a 90 percent increase over prior experience of recycling and trash collection in that neighborhood. Almost two-thirds of the increase was attributable to the new compostables collection effort. Nearly three-fourths of those surveyed preferred the new approach to recycling.

The success and rapid adoption of variable rate pricing in the United States has spurred interest

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(finding recycling rates for single-family dwellings of 35% and multi-unit buildings of 10% in San Jose, California).

[46] See Lisa A. Skumatz and John Green, Reaching for Recycling in Multi-Family Housing, Resource Recycling (Skumatz Economic Research Associates) (Oct. 1999).

[47] See California Integrated Waste Management Board, Curbside Recycling, the Next Generation: A Model for Local Government Recycling and Waste Reduction 7-10 (Jul. 2002) (hereinafter cited as "Next Generation"); Jack Macy, San Francisco Takes Residential Collection Full-Scale, Biocycle 51 (Feb. 2000).

in such approaches internationally.[48] The European Commission has in the past several years begun to play a role comparable to that served by the U.S. EPA in encouraging communities throughout Europe to adopt variable rate policies. With nearly 80 percent of its population residing in cities, Europe faces significant implementation challenges. PAYT builds upon the "Polluter Pays" principle, which is widely accepted in Europe.[49] Germany, Austria, Sweden, and the Netherlands have begun to adopt this approach.

IV. Economic and Environmental Analysis of Variable Rate Pricing

The rapid and widespread adoption of variable rate pricing of MSW by local communities suggests that it addressed many of the goals sought: source reduction, promotion of recycling and diversion of wastes from landfill and incineration, and equitable sharing of the costs of solid waste management. This section presents the available empirical research on the efficacy of these programs. There are two principal sources of such evidence – wide-scale census data and case studies collected

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[48] See Tonia Horton, Environomic$: Can the Marriage of Economics and the Environment End Happily Ever After?" MSW Management Elements 50 (1999) (noting that PAYT programs have taken root in Japan, China, Germnay, Canada, Italy, and the Netherlands).

[49] Dr. Christian Patermann, Director of the Environment and Sustainable Development Research Programme, notes that:

> The polluter pays principle is one of the main pillars of the PAYT project which addresses the critical issue of waste management in cities. The principal objective is to design a variable rate pricing system as a policy option for reducing household discards. Flat rate taxes are not effective in reducing the generation of wastes at the source, hence the idea to develop and test a "pay-as-you-throw" (PAYT) scheme in several European cities. The project will assess if such a scheme can effectively incite households to divert an increased portion of their domestic waste away from traditional disposal, for example through a higher recourse to recycling or the purchasing of goods with less bulky packages. This project could contribute to a substantial modification of household behaviour towards increased responsibility.

Christian Patermann, Sustainable Development in European Cities: How Research Can Contribute <http://www.ekt.gr/ncpfp5/eesd/info/material/developement.doc>. See also Variable Rate Pricing based on Pay-As-You-Throw as a Tool of Urban Waste Management: A Joint Research Project funded by the European Commission under the environmental component "Energy, Environment and Sustainable Development"(describing a 30 month project exploring PAYT approaches for European communities). <http://web.tu-dresden.de/intecuspayt/>

by EPA and private consultants working in the solid waste field[50] and a few academic econometric studies focused on relatively small-scale experiments.[51] This section begins by examining changes in the size and composition of the MSW stream over the past decade and empirical estimates of the role of variable rate pricing in these patterns. It then looks at direct economic benefits and costs of variable rate pricing. Section C considers additional factors bearing on the efficacy of variable rate pricing.

A. Effects on the Size and Composition of the MSW Stream

After rising steadily from 1960 through 1990 from 2.68 pounds per person per day to 4.50 pounds per person per day, the generation of MSW per person remained constant throughout the 1990s, notwithstanding the fact that per capita income rose 17% in real terms during the decade.[52] The

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[50] Lisa Skumatz, Ph.D. is the most prominent of these researchers. In addition, researchers at Duke University conducted a series of studies pursuant to an EPA grant. Evaluating Unit-Based Pricing of Residential Municipal Solid Waste as a Pollution Prevention Mechanism (U.S. EPA Cooperative Agreement #CR822-927-010). See Marie Lynn Miranda, Scott D. Bauer, and Joseph E. Aldy, Unit Pricing Programs for Residential Municipal Solid Waste: An Assessment of the Literature (Mar. 1996); Marie Lynn Miranda & Joseph E. Aldy, Unit Pricing of Residential Municipal Solid Waste: Lessons from Nine Case Study Communities (Mar. 1996); Scott D. Bauer and Marie Lynn Miranda, The Urban Performance of Unit Pricing: An Analysis of Variable Rates for Residential Garbage Collection in Urban Areas (Apr. 1996); Marie Lynn Miranda and Sharon LaPalme, Unit Pricing of Residential Solid Waste: A Preliminary Analysis of 212 Communities (1997) (hereinafter cited as "Study of 212 PAYT Communities"); Marie Lynn Miranda, Unit-Based Pricing in the United States: A Tally of Communities <http://www.epa.gov/epaoswer/non-hw/payt/comminfo.htm>. The Institute for Local Self-Reliance has also conducted a series of important case studies for the EPA. See U.S. Environmental Protection Agency, Cutting the Waste Stream in Half: Community Record Setters Show How (Jun 1999) (hereinafter cites as "Cutting the Waster Stream in Half").

[51] Professors Don Fullerton of the University of Texas at Austin and Thomas C. Kinnamon at Bucknell University have been the most active scholars in the academic empirical solid waste field. They have recently collected their principal papers in the volume "The Economics of Household Garbage and Recycling Behavior (2002). Robin Jenkins, Ph.D., now with the EPA's National Center for Environmental Economics, carried out one of the first major empirical assessments of variable rate programs. The Economics of Solid Waste Reduction: The Impact of User Fees (1993); see also Robin Jenkins, Salvador A. Martinez, Karen Palmer and Michael J. Podolsky, "The Determinants of Household Recycling: A Material Specific Analysis of Recycling Program Features and Unit Pricing," 45 J. Envtl Econ. & Mgmt. 294 (2003).

[52] See U.S. Department of Commerce, Bureau of Economic Affairs, Table 2.1 Personal Income and Its Disposition
<http://www.bea.doc.gov/bea/dn/nipaweb/TableViewFixed.asp?SelectedTable=27&FirstYear=2002

amount of discards to landfill and incineration declined during the 1990s from an average of 3.07 pounds per person per day to 2.50 pounds per person per day. This was due to a substantial rise in the amount of waste recycled (up from .64 pounds per person per day to 1.04 pounds per person per day) and composted (up from .09 pounds per person per day to .32 pounds per person per day). Table 3 shows the change in the composition of the MSW stream over this period.

Table 3
Composition of the MSW Stream: 1990-2000

The increase in resource recovery over the course of the 1990s is striking, nearly doubling from 16.2% to 30.1%. The most dramatic changes can be seen in composting of yard wastes, which grew from 12% to nearly 57%. There were also notable increases in the recycling of paper and paperboard, metals, plastics, and rubber.

This data alone, however, does not establish the role of variable rate pricing in raising diversion rates. As noted earlier, even at the end of the period, only 20% of the national population resided in communities using variable rate pricing. Furthermore, it is necessary to separate out the effects of contemporaneously adopted policies, most significantly the adoption of curbside collection of various categories of recyclable materials (including yard wastes). In addition 11 states have had some form of deposit-refund system in place for this period. Recycling rates of bottles and cans are quite high in these jurisdictions.[53]

Three types of empirical evidence are available to assist in establishing the effects of variable rate pricing upon source reduction, recycling rates, and economic performance. A team of Duke University researchers gathered extensive data from a range of variable rate programs throughout the nation. Table 4 contains data from those cities in which waste disposal tonnage is available from the year preceding adoption of a variable rate policy through the first full year or two of the plan. These data strongly suggest that variable rate pricing significantly encourages waste diversion. They also provide some basis for distinguishing between improvements in diversion rates attributable to variable rate pricing and those resulting from curbside pick-up of recyclable and compostable wastes. San Jose, California began its curbside collection programs more than four years before the implementation of its hybrid pay-as-you-throw system. Waste diversion rates increased dramatically following the introduction of the variable rate charge for mixed refuse. The data on total waste generated suggest that variable rate programs not only increase waste diversion but also promote source reduction. The magnitudes, however, are modest and the sample size is small. It is notable that all of the programs experienced some reduction in total volume without accounting for population or economic growth. In

&LastYear=2003&Freq=Qtr>

[53] See Container Recycling Institute, Beverage Container Deposit Systems in the U.S. (Update Nov. 22, 2002). <http://www.bottlebill.org/USA/states-all_deposit_systems.htm>

a subsequent study of 212 communities across 30 states, the Duke researchers found the annual amount of waste disposed per household decreased by 14 percent and that recyclable collections increased by 32 to 59 percent in the first year of the variable rate program.[54]

Tables 4 and 5
Variable Rate Case Studies

Table 5 contains data from a more recent series of case studies of programs adopting variable rate programs. These communities were selected for study because of their large diversion rates.[55] Nonetheless, they reflect diverse community characteristics. The results reinforce the strong results found in the Duke study. The increased diversion rates are quite striking -- from 11% to 49% over the rates that had been achieved with curbside collection of recyclable materials. The last column – possible source reduction – represents the percentage change in total solid waste per household that was picked up at the curbside. It does not account for the effects of rising income or home composting.[56]

A second approach looks at actual per household waste disposal quantities immediately preceding and immediately following the introduction of unit pricing. Professors Don Fullerton and Thomas Kinnaman collected data from 75 households in Charlottesville, Virginia following the implementation of an 80 cents per 32 gallon bag curbside charge on July 1, 1992.[57] Using regression analysis, they found that the implementation of unit pricing reduced the volume of waste disposed in mixed refuse by 37%, but that much of this gain was attributable to greater trash compaction by residents. The data revealed that the weight of mixed refuse fell by only 14 percent. Fullerton and

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[54] See Study of 212 PAYT Communities, supra n. __.

[55] See Cutting the Waste Stream in Half, supra n. __.

[56] Eleven of the eighteen communities profiled in this study used variable rates as a central part of their overall MSW policy. Table 5 omits three of the cities studied because they implemented curbside recycling at the same time as variable rate pricing or have incomplete data. (These communities all experienced greatly increased diversion following implementation of their new MSW policies.) The same study identified seven other cities that achieved high diversion rates through curbside collection and education programs (without introducing variable rates). See Cutting the Waste Stream in Half, supra n. __. Each of the cities that used variable rates considered this element of their program to be key to its success. The authors of the study conclude that variable rate policies can be a particularly effective strategy for diverting waste toward recycling and composting and source reduction. See id., at 20-21.

[57] See Don Fullerton and Thomas C. Kinnaman, Household Responses to Pricing Garbage by the Bag, 86 Amer. Econ. Rev. 88 (1996).

Kinnaman also found that the program increased the weight of recycled material by 16 percent.

A third set of empirical evidence comes from cross-sectional and time series modeling conducted by Dr. Lisa Skumatz on the basis of a vast database her firm (Skumatz Economics Research Associates) has collected since the late 1980s.[58] In a nationwide study based on data from more than 500 communities, cross-section regression analysis controlling for the influence of demographic, community, and program features found that variable rates provided a larger increment to recycling than any other single factor, adding 5.5% to a community's recycling rate and 4.5% to the yard waste diversion rate.[59]

In a further study using waste disposal data from more than 1,000 communities featuring a variety of MSW approaches, Skumatz computed "generation" per capita rates and found that communities using variable rate program discarded (to landfills and incinerators) on average 16% less waste than communities without such programs.[60] Of this 16%, Skumatz was able to attribute 5-6% to increased recycling and 4-5% to increased yard waste diversion, leaving a residual of 5-7% attributable to source reduction. Skumatz corroborated these cross-section regression results with a time series model. She first estimated waste generation as a function of population, households, gross domestic product, recycling prices, a packaging index (to control for changes in packaging efficiency over time), among other variables. This model showed that total discards would be 17.3% higher in a given community without variable rate pricing. Skumatz then estimated the extent to which this effect is attributable to recycling and yard waste collection. She found that these effects are responsible for 11.5% of the reduction in discards, leaving a residual of 5.8% attributable to source reduction.[61]

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[58] See Measuring Source Reduction, supra n.__.

[59] See Lisa A. Skumatz, Ph.D., Nationwide Diversion Rate Study – Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies (Skumatz Economic Research Associates, Inc., Superior Colorado) (July 1996); Lisa A. Skumatz, Ph.D., Beyond Case Studies: Quantitative Effects of Recycling and Variable Rates Programs, Resource Recycling (Sept. 1996).

[60] See Lisa A. Skumatz, Ph.D., Measuring Source Reduction: Pay as You Throw (PAYT)/Variable Rates as an Example (Skumatz Economic Research Associates, Superior Colorado) (May 2000); Lisa A. Skumatz, Ph.D., Source Reduction Can Be Measured, Resource Recycling (August 2000).

[61] Dr. Skumatz has also examined the relative effects of different variable rate policies. This research finds that bag and hybrid programs produced higher diversion rates that variable can programs, controlling for community and other program factors. See Lisa A. Skumatz, Ph.D., Maximizing VR/PAYT Impacts: Policies, Rate Designs, and Progress, Resource Recycling (Jun. 2001).

B. Direct Economic Benefits and Costs of Variable Rate Policies

The principal economic benefits of variable rate policies lie in the reductions in landfill and incineration tipping fees attributable to diversion to recycling and composting and source reduction. The national average tipping fee in 2002 stood at $33.70, up from $19.12 in 1988, although it has remained relatively constant since 1995.[62] Nonetheless, rates vary widely across regions, with the low range throughout much of the South, West, and Midwest ($20 - $40 per ton), moderate to high range in the mid-Atlantic states ($45 per ton), and highest range in the Northeast ($60 - $90 per ton) .[63]

Tipping fees represent just a portion of the overall MSW costs. Based upon a series of case studies in the early 1990s, the Solid Waste Management Association of North America found that approximately half of total MSW management system costs are attributable to collection activities, 19% for facilities, 15% for general and administration, 12% for tipping fees, and 4% for transfer activities.[64] These percentages, however, merely provide a rough guide. Actual costs and their allocation depend upon a wide variety of local factors, including tipping fees, program design, community structure and geography, demographics, and climate.

In addition to these cost factors, municipalities can derive revenue from the sale of recycled waste streams, compost, and possibly from energy derived from incineration or sale of refuse-derived fuel. In July 2003, the following prices could be obtained in the Midwest for suitably prepared recycled streams:

Table 6
Recycled Materials Market Prices (Midwest - July 2003)

Variable rate policies may impose additional administrative costs upon municipalities. During the early to mid 1990s, Wisconsin and Iowa conducted surveys of operating and administrative costs in communities adopting variable rate policies. In Wisconsin, 40% of communities adopting variable rates experienced a decline in program costs, 27% had level costs, and the remaining third had higher

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[62] See Ed Repa, Tipping Through Time, Waste Age (Nov. 1, 2002); Nora Goldstein, The State of Garbage in America, Biocycle 42 (Dec. 2001).

[63] See id.

[64] See Solid Waste Management Association of North America, Integrated Municipal Solid Waste Management: Six Case Studies of System Costs and Energy Use: Summary Report (GR-G 2700 1995); see also Peter Kemper and John M. Quigley, The Economics of Refuse Collection (1976).

costs.[65] The Iowa survey produced similar results, with 60% of the communities adopting variable rates experiencing lower or stable program costs.[66] A more recent study of communities across California conducted by Dr. Lisa Skumatz corroborated these findings.[67] Her research found that the incremental administrative costs of variable rate policies tended to be small and in some case actually produced savings. The higher diversion rates, however, produced significantly costs for collection and processing of diverted material. These costs, however, offset tipping fees for mixed refuse and produced some income from the sale of recycled materials.

Table 7 presents two scenarios for assessing hypothetical net savings available from adoption of variable rate pricing: one with a national average tipping fee ($33.70 per ton) and the other with a tipping fee from the range encountered in the Northeast ($70 per ton). Apart from these differences in tipping fees, both communities are identical. They have 50,000 households with average daily per household discards prior to the implementation of variable cost pricing ("PAYT") of 11 pounds of refuse per day. In order to simulate the effect of variable cost pricing, the table incorporates Dr. Skumatz's estimates of variable rate diversion and source reduction: 6% increased recycling, 4% increased yard waste diversion, and 6% source reduction. The table assumes a relatively conservative additional per household transaction cost of $6 per household for the year,[68] average materials revenue of $15 per ton for recyclables, and average materials revenue of $5 per ton for yard waste. These assumptions produce a $221,000 annual cost saving in a community facing the national average tipping fee and nearly a $688,000 cost saving in a Northeastern community paying $70 per ton.

Table 7
Variable Rate Benefit Scenarios

Due to the wide range of variables affecting MSW costs and revenue opportunities for particular communities, determining the overall direct economic costs of variable cost pricing and whether it improves upon traditional mixed refuse pick-up and disposal and simple curbside collection

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[65] See Gruder, Wisconsin Volume Based Rate Collection Guide (University of Wisconsin Extension, Madison, Wisconsin 1993).

[66] See Frable and Berkshire, Pay as you Waste: State of Iowa Implementation Guide for Unit-Based Pricing (Iowa DNR, Des Moines, Iowa 1997).

[67] See Lisa A. Skumatz, Ph.D., Achieving 50% in California: Analaysis of Recycling, Diversion, and Cost-Effectiveness (conducted for the California chapters of the Solid Waste Association of North America (SWANA), Sacramento, California) (April 1999); Lisa A. Skumatz, Ph.D., Resource Recycling (Sept. 1999).

[68] Skumatz considers the high end of the range for additional transaction costs to be 56¢ per capita (less than $1.50 per household) per year. See Source Reduction, supra n. __.

systems are not as simple as Table 7 suggests. For example, if additional transaction costs for implementing a variable rate system were doubled to $12 per household annually, then adopting PAYT would result in a net loss of nearly $80,000 in a community paying the national average tipping fee. PAYT would still yield a net savings of approximately $390,000 in a community paying $70 per ton for landfill disposal.

Waste collection involves various non-linear (or lumpy) cost factors. For example, reducing the frequency of collection from once per week to every other week, altering the number and types of vehicles used, and changing the number of workers per vehicle significantly affect overall cost. The waste reductions possible as a result of variable pricing can possibly open up significant opportunities for reorganizing collection services.[69] In addition, transaction costs of variable rate policies may require an additional staff member to be hired. Furthermore, transaction costs, diversion rates, and source reduction may change over time. It seems likely that these effects would favor the cost-effectiveness of variable rate pricing. As communities become better acquainted with PAYT and as households adapt their consumption choices and recycling behavior, it can be expected that transaction costs would fall and diversion rates rise. Therefore, it is important to consider evidence from actual programs.

The most direct data bearing on program cost effects of variable rate policies comes from the detailed case studies assembled by the Institute for Local Self-Reliance in the late 1990s. Table 8 presents a comparison of program costs for five cities prior to and following implementation of variable rates.[70] Due to changes in landfill tipping fees and possibly materials revenue for recycling before and after implementation, these numbers do not provide direct comparison of overall program costs. Nevertheless, they are supportive of the cost-effectiveness of variable rate policies in these communities. Fitchburg, Wisconsin experienced a significant drop in overall program costs notwithstanding a rise in landfill tipping fees. The numbers for Chatham, New Jersey reflect a substantial drop in tipping fees, although this explains only a portion of the 50% drop in program costs.

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[69] Households generally put out fewer receptacles after implementation of variable rate charges. Following adoption of variable rates in Seattle, the number of 32 gallon equivalent cans put out declined from 3.5 per week to 1. They have strong incentives to reduce volume by reducing, diverting, and compacting waste. The latter phenomenon came to be known in PAYT circles as the "Seattle Stomp." Although such compaction does not reduce landfill costs, which are based on weight, it can reduce collection costs by reducing the time per household loading trucks and the number of truck runs.. See Lisa A. Skumatz, Variable Rates for Municipal Solid Waste: Implementation, Experience, Economics, and Legislation, Reason Foundation Policy Study 160 (Jun. 1993).

[70] These were the only cities of the 11 variable rate communities profiled for which adequate comparative cost data was available. As noted earlier, see supra n.__, two of the cities implemented PAYT at the same time that they commenced curbside collection of recyclables and yard waste and therefore they do not provide a clear basis for distinguishing the effects of these elements of the change in MSW regime. See Cutting the Waste Stream in Half, supra n. __.

The high cost of recycling per ton in Portland and San Jose suggest that curbside recycling in these cities is not cost-effective. Nonetheless, implementation of variable rate pricing reduced total cost per household in these cities due to efficiencies in mixed refuse collection, source reduction, and yard waste diversion.

Table 8
Variable Rate Case Studies: Net Costs

C. Other Effects

Various additional factors bear on the environmental and economic performance of variable rate policies. On the negative side, placing a positive price on mixed refuse may encourage avoidance behavior in the form of illegal or improper disposal. On the positive side, variable rate policies may promote the smooth functioning of recycling markets, address environmental externalities, and alleviate landfill capacity concerns. More ambiguously, such policies may produce non-market benefits and costs for households and consumers.

1. Illegal Disposal

In addition to creating incentives for source reduction and diversion of waste to recycling and composting, variable rate pricing also creates an incentive to dispose of waste illegally – such as by dumping it the back woods and depositing it in someone else's dumpster. Such activities contribute to harm pollution and aesthetic blight. They also raise the costs of MSW regulation by requiring additional expenditures on public education about and enforcement of prohibitions on illegal disposal. They also impose additional costs on the private sector, such as added monitoring of property, installation of security fences, and placing locks on dumpsters.

Notwithstanding some early expressions of concern about illegal disposal rising as a result of variable rate policies,[71] the problem has proven to be modest in size and manageable in the communities in which variable rate pricing has been implemented. A 1996 survey by Duke researchers of 212 communities adopting variable rate policies found that 48% experienced no change in illegal diversion following implementation of a unit pricing program, 19% reported an increase, 6% reported a decrease,

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[71] An early 1990s series of interviews with local solid waste officials from 14 variable rate communities found no problems in 6 communities, minor problems in 4, and significant problems in 4. See Daniel R. Blume, Under What Conditions Should Cities Adopt Volume-Based Pricing for Residential Solid Waste Collection?, Office of Management and Budget, Ofice of Information and Regulatory Affairs, Natural Resources Branch (May 1991); see also Don Fullerton and Thomas C. Kinnaman, Garbage, Recycling, and Illicit Burning or Dumping, 29 J. Envt; Econ. & Mgmt. 78 (1995).

and 27% reported that they did not know whether there had been any change.[72] In surveys of over 1,000 variable rate communities, Lisa Skumatz found that the much of the illegally dumped material is not residential in origin. The largest categories are construction and demolition waste (more than 25%), yard wastes (approximately 40%), and bulky appliances (white goods).[73] Her research finds that illegal dumping was initially a problem in approximately less than a third communities adopting variable rates, but that it largely abated and that no program managers considered it a barrier to adoption of variable rates.[74] Other studies also find relatively little increase in illegal disposal following implementation of variable rate pricing.[75]

Experience in implementing variable rate policies has revealed relatively inexpensive and effective ways to address the problem.[76] Convenient or annual free curbside pick-up of white goods and hazardous household wastes, which pose the largest pollution problem, substantially reduce disincentives for improper disposal.[77] Education and outreach programs have also proven to be

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[72] See Study of 212 PAYT Communities, supra n.__, at __.

[73] See See Lisa A. Skumatz, The State of Variable Rates: Economic Signals Move into the Mainstream, Resource Recycling (Aug. 1997); Lisa A. Skumatz, Ph.D., Hans Van Dusen, and Jennie Carton, "Illegal Dumping: Incidence, Drivers, and Strategies," Skumatz Economic Research Associates (SERA) Research Report 9431-1, Seattle, Washington, (Nov. 1994, supdated 2000); see also U.S. Environmental Protection Agency, Region 5, Illegal Dumping Prevention Guide (Mar. 1998) (targeting construction, demolition, remodeling, roofing and landscaping contractors, waste management and general hauling companies, automobile repair and tire shops, and scrap collectors as among the major contributors to the problem of illegal disposal).

[74] See Lisa A. Skumatz, The State of Variable Rates: Economic Signals Move into the Mainstream, Resource Recycling (Aug. 1997); Lisa A. Skumatz, Hans Van Dusen, and Jennie Carton, "Illegal Dumping: Incidence, Drivers, and Strategies," Skumatz Economic Research Associates (SERA) Research Report 9431-1, Seattle, Washington, (Nov. 1994); Lisa A. Skumatz, Variable Rates for Municipal Solid Waste: Implementation Experience, Economics, and Legislation, Reason Foundation Policy Study 160 (Jun. 1993).

[75] See Podolsky and Speigel (1998); Strathman, Rufolo, and Mildner (1995), Miranda (1994), Miranda and Bauer (1996), Nestor and Podolsky (1998), Skumatz

[76] See Jill Slovin, "Communities Form Strategies Against Illegal Dumping," World Wastes, (Jan. 1995); Lisa A. Skumatz, Hans Van Dusen, and Jennie Carton, "Illegal Dumping: Incidence, Drivers, and Strategies," Skumatz Economic Research Associates (SERA) Research Report 9431-1, Seattle, Washington, (Nov. 1994, updated 2000).

[77] See Lisa A. Skumatz, Ph.D., Hans Van Dusen, and Jennie Carton, "Illegal Dumping: Incidence, Drivers, and Strategies," Skumatz Economic Research Associates (SERA) Research Report

effective at relatively modest cost. The problem can also be addressed in the design of the rate structure (keeping the marginal cost of legal mixed refuse disposal reasonable), by offering discounts and rebates for lower income households in order to ease their income constraints, and providing convenient means for disposing of recyclable and compostable wastes. The problem of illegal disposal can also be stemmed by securing public disposal areas, increased site maintenance, and targeted monitoring and enforcement. These policies will in many cases be worth pursuing for environmental protection, crime, and public health reasons regardless of implementation of variable rate pricing.[78]

Risk of illegal disposal is a factor in considering further diffusion of variable rate pricing, particularly in urban areas with poverty-stricken neighborhoods. Communities with high crime, gang and drug activity, and abandoned properties are particularly prone to illegal disposals and may be less appropriate for a full scale variable rate program. Illegal disposal might also be more of a concern with a weight-based program because households would face a positive marginal cost for each ounce of mixed refuse. Under variable can systems, households have zero marginal cost up to the volume of their trash receptacle. That provides some leeway for avoiding additional charges through compaction and storage of waste until there is more room available.

2. Recycling Markets

As curbside recycling programs blossomed in the early 1990s, recycling markets struggled to absorb the rise of input material. The prices available for many forms of recycled materials – most notably paper – plummeted as supply greatly outstripped industrial capacity and demand for recycled products.[79] Reports of separated paper, which already increased the costs of MSW collection, being stored in warehouses and tossed into landfill[80] led some observers to conclude that recycling was nothing more than a palliative which in reality wasted resources.[81] New York City's troubled recycling

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9431-1, Seattle, Washington, (Nov. 1994, updated 2000).

78 See U.S. Environmental Protection Agency, Region 5, Illegal Dumping Prevention Guide (Mar. 1998).

79 See Philip Burgert, Slow Recovery Reported For Recycling Markets, Waste Age (Dec. 1, 1993).

80 See Luoma, supra n.__; Success Hits Paper Recycling, Chicago Tribune, Sep. 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 separates newspapers).

81 See Jeff Bailey, Waste of a Sort: Curbside Recycling Comforts the Soul, But Benefits Are Scant, Wall. St. J. A1 (Jan 19, 1995); John Tierney, "Recycling Is Garbage," New York Times Magazine, June 30, 1996, at 24 (hereinafter cited as "Recycling Is Garbage").

program[82] became a posterchild for a dark side of recycling.[83] An inability for recycling markets to make productive use of separated materials would certainly dampen the economic and environmental benefits from diverting solid waste from landfills and incinerators. Economic markets rely upon not just the availability of materials but also coordination of time and place. As the OTA's 1989 report noted, "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."[84]

Perhaps the greatest characteristic of markets is their ability to adapt over time to economic opportunity. A glut of potentially valuable material encourages entrepreneurs to enter the market to take advantage of the inexpensive supply.[85] The transition from economic markets built predominately upon virgin input materials toward one than can take advantage of both virgin and recycled input streams has gradually taken place during the past decade in many regional and product markets. The growth of recycling streams have spurred tremendous growth in recycling enterprises. Traditional industries – such as paper, paperboard, and metals – have shifted manufacturing operations toward the utilization of recycled content. Industry and a growing proportion of the public have come to realize that the pure "closed loop" vision of recycling is not a practical reality because of the costs of collecting and reprocessing materials. It is not currently economically efficient to recycle a used polystyrene cup into a new polystyrene cup,[86] but it may make sense to burn it for energy[87] or use it as input to some other production process. Thus, new products incorporating recycled materials – such as "plastic

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[82] See Recycling is Garbage, supra n.__ (reporting that in 1996 New York City was spending an extra $200 per ton to collect recyclables and an additional $40 per ton to persuade salvage companies to accept it.) The problem in part related to volatility of recycling prices and the high cost of collecting recyclable materials in New York City. Tierney notes that a brief surge in the price of old newspapers to $150 per ton brought New York's recycling program to solvency, but the program suffered as prices ebbed. See id.

[83] See Kivi Leroux, Recycling's War of Words, Waste Age (Apr. 1, 2000).

[84] See Facing America's Trash, supra n.__, at 145.

[85] See Sharla Paul, Reaching Equilibrium In Recyclables Markets, Waste Age (Aug. 1, 1995) (noting large investments by various industries to develop the capacity to utilize recycled input streams).

[86] See Martin B. Hocking, Paper Versus Polystyrene, A Complex Choice, 251 Science 504 (1991); see also Letters, 252 Science 1361 (1991).

[87] Plastics have the highest energy content of the major components of the MSW stream, producing 15,000-20,00 Btu per pound, twice the heating content of Wyoming coal and nealy as much as residual fuel oil. See Office of Solid Waste, U.S. Environmental Protection Agency, The Solid Waste Dilemma: An Agenda for Action, Background Document, 1-36 (1988).

lumber," regrinding of construction and demolition waste to use a road base materials, and the use of organic wastes to produce renewable fuels – have opened up new business and manufacturing opportunities.[88] On the demand side of the market, government programs favoring procurement of products made from recycled content as well as higher quality standards for recycled products and growing consumer purchasing of recycled products have accelerated this transition to some extent.

These developments have stabilized recycling markets. Whereas early recycled material programs were subject to erratic salvage prices for paper and other separated materials, salvage prices have become much more predictable and robust. As of 2001, recovered paper represents more than 36% of the total fiber supply in the paper industry and is expect to grow by an average of 2.2% for the next three years.[89] The infrastructure for plastics recycling is now well-established, with one industry expert noting that "[d]emand strong and prices are sustainable."[90] Compost industry experts now believe that the market for compost is beginning to mature on a national level. According to one consultant, "[c]oncerns about oversupply of compost are unfounded, except in limited locations and instances of poor quality."[91] The growth in recycling industries has spurred exchange infrastructure to develop, which has reduced market volatility.[92] The Internet as well has begun to play a role in stabilizing and expanding recycling marketing channels.[93] The volatile post-consumer commodity markets of the early to mid-1990s settled down significantly by the end of the decade.[94] The principal industries in the United States now rely on both virgin and recovered materials in their manufacturing processes and conditions exist for continued evolution toward use of the growing recycled material

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[88] See Cheryl L. Dunson, Constructing the Future, Waste Age (Jan 1, 2000).

[89] See Kivi Leroux, An Eye on the Economy, Waste Age (Apr. 1, 2001).

[90] See id.

[91] See id.

[92] See Sharla Paul, Reaching Equilibrium In Recyclables Markets, Waste Age (Aug. 1, 1995).

[93] See William Moore, The Recovered Paper Industry Dots the Internet, Waste Age (Sep. 1, 2000).

[94] See Kivi Leroux, Boring is Good, Waste Age (May 1, 2000). Commenting on the relationship between recycling market prices and curbside collection programs, Steve Edelson, director of materials marketing for Recycle America, the recycling subsidiary of Waste Management Inc., observed that "[t]he most advantageous scenario is a good market basket, not where you have lots of high and lots of lows . . . . I don't want high prices. That just leads to scalping from the curbside and fly-by-night traders who capitalize on the scene."

stream.[95] This promises to improve the outlook for variable rate programs.

3. Environmental Externalities

A well-functioning recycling marketplace also offers benefits in reducing adverse environmental impacts from virgin resource extraction, transportation, and energy-intensive manufacturing processes associated with raw material inputs.[96] The extent to which these benefits are not forthcoming in the marketplace depends upon the whether existing regulatory institutions adequately internalize adverse environmental effects. The principal virgin material industries – mining, timber, and oil extraction – each have long legacies of ecosystem damage and pollution.[97] Although they have each come under greater regulatory and legal constraints over the past few decades, there remain significant ecological and pollution concerns with their activities. Fully analyzing these regulatory regimes extends beyond the scope of this article, but it is worth noting some of the most significant effects and the comparison between virgin sources and recovered materials. Tables 9 and 10 present in summary fashion the most significant energy and climate change benefits flowing from the substitution of recovered materials for their virgin counterparts in manufacturing processes.

Table 9
Energy and Climate Change Effects of Substituting Recovered Materials for Virgin Raw Materials

Table 10
Environmental Benefits from Substituting Recycled Inputs

It should be noted, however, that recycling is not an environmentally benign activity.[98] By shifting more manufacturing activity closer to urban populations, there can be greater human exposure,

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[95] See Cheryl L. Dunson, Constructing the Future, Waste Age (Jan. 1, 2000) (quoting Will Ferretti, executive director of the National Recycling Coalition, a Alexandria, Va.-based non-profit organization dedicated to the advancement of recycling, source reduction, composting and reuse, as noting that "The fact that basic industries in the United States now utilize, to a significant degree, recovered materials as part of their feed stock indicates that recycling development and innovations have transformed an industrial economy from a virgin base to a recovered industrial economy.")

[96] See U.S. Environmental Protection Agency, Puzzled About Recycling's Value? Look Beyond the Bin 8 (Jan. 1998).

[97] See generally Natural Resources Defense Council, Too Good to Throw Away: Recycling's Proven Record (Feb. 1997). <http://www.nrdc.org/cities/recycling/recyc/recyinx.asp>

[98] See generally Facing America's Trash, supra n.__, at 190-94.

increased congestion, and more effluents and emissions into surrounding ecosystems with less absorptive capacity. Nonetheless, as a general proposition, the shift toward recycling offers far-reaching environmental and ecological benefits by reducing raw material extraction and energy-intensive manufacturing processes.

4. **<u>Landfill Disposal Capacity</u>**

As noted at the outset of this article, widespread public perception of a looming shortage of landfill capacity of crisis proportions mobilized interest in MSW policy at the federal, state, and local levels during the late 1980s. The experience of the 1990s has revealed the perceived "crisis" to have been driven more by mass media hype than by economic or environmental reality. While restrictive federal solid waste disposal regulations and constraints on siting did bring about a dramatic decline in the number of operating landfills from 7,924 in 1988 to just 1,967 in 2000,[99] total landfill capacity grew significantly during this time period. RCRA regulations shifted the nation away from relatively small "town dumps" toward massive regional landfills. These technology-based requirements

> created enormous operating economies-of-scale for landfills that for example make it half as expensive (on a per ton basis) to operate a 300 thousand ton per year landfill than a 60 thousand ton per year operation. The required pollution control equipment is more a function of footprint than of volume. Private firms had an edge in that they are generally not restricted by political boundaries, can command larger service areas from which to draw volume, and have greater access to capital markets. Enormous financial wherewithal is necessary to permit and construct new capacity.[100]

As a result, the numerous landfill closures of the late 1980s and 1990s represented only 8% of national capacity, whereas new landfills established during the 1990s were on average 25 times larger than those they were replacing.[101] The average size of landfills increased from 1 million tons of capacity to 3.5 million tons.[102] The significant rise in diversion of waste to recycling and composting has helped to extend the life of landfills, although it is important to note that the total quantity of waste destined for disposal has declined by only 8.5% during the 1990s due to population and income growth.[103]

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[99] See EPA 2000 Report, supra n. __, at 15.

[100] See Demand is Finally Catching Up With Excess Capacity; Critical in the Northeast, Solid Waste Digest: National Edition, October, 2002, p.1.

[101] See id.

[102] See id.

[103] See EPA 2000 Report, supra n.__, at 125.

The net effect of these developments has been to expand national excess landfill capacity from under 10 years in 1988 to approximately 20 years today.[104] It has also increased the average distance that discarded waste travels from approximately 15 miles in 1990 to 50 miles today.[105] Due to the cost of transporting waste long distances and public resistance in some states to serving as a waste repository, there remain some regional problems. The densely populated Northeastern states face the most severe capacity concerns. Pennsylvania and Virginia have eased this pressure significantly through accepting interstate transfers, but public resistance to importing waste and expanding landfill capacity has increased in recent years.

For these reasons, incineration has continued to play a significant role in MSW management in the Northeastern states. Approximately one-third of solid waste in this region is burned in waste-to-energy incineration facilities.[106] Connecticut incinerates approximately 65% of its municipal solid waste.[107]

The perception that the United States faces or will likely face a national MSW crisis appear to have passed. Few in industry or the environmental community speak in such terms any longer. The discussion has shifted to the means for managing waste and debate centers on new technology. Perhaps the most controversial issue in waste treatment today is the concept of bioreaction. Whereas modern landfill technology is based on the principle of long-term storage and management of waste in order to reduce environmental effects from leachate and air emissions, the waste management industry has begun implementing landfill designs and operating procedures intended to promote bioreaction. Such reactivity hastens the generation of biofuel waste energy and increases the rate of compaction so as to free up more space for additional wastes. This approach transforms landfills from slowly decomposing tombs to active biological vessels, which arguably creates greater environmental exposure. The organics/composting industry fears that this new approach threatens to divert its growing waste stream and exacerbates the severe regulatory disadvantage of allowing the landfill industry to defer costs of inevitable environmental contamination to future generations.[108] EPA is

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[104] See id.; Jim Glenn, The State of Garbage in America, Biocycle 32-43 (Jul. 1998).

[105] See id.

[106] See Nora Goldstein, The State of Garbage in America, Biocycle 42, 43, 45 (Dec. 2001)

[107] See id.

[108] For a spirited debate about bioreaction, see Bill Sheehan and Jim McNelly, Bioreactors and EPA Proposal to Deregulate Landfills, 44 BioCycle 60 (Jan 2003); Nora Goldstein, Composing and Organics Recycling vs. Bioreactors: Another Perspective, Biocycle 44 (May 2003); Ed Skernolis and Gary Hater, Letter to the Editor, Biocycle (May 2003); Ed Skernolis and Gary Hater, Waste Management, Inc. Response, Biocycle 38 (May 2003); Bill Sheehan and Jim McNelly, Authors

currently considering whether to develop additional regulatory controls on this disposal technology.[109]

5. Non-Market Effects

Recycling poses an interesting paradox from the standpoint of households, consumers, and citizens. On the one hand, the public generally exhibits strong support for recycling through its actions and political support as reflected in surveys and the passage of lofty recycling goals in most states in the late 1980s and early 1990s.[110] On the other hand, recycling itself imposes significant costs upon households and many did not actively participate until it came to them along with financial incentives.[111]

From a policy standpoint, this paradox can be approached in a number of ways. It can be taken at face value and recycling could be treated as a goal that should be pursued, regardless of its economic or environmental merits. It can be justified on the grounds that what matters most is what people perceive. It can also be justified as serving to involve consumers and households directly in an activity that directly affects the environment and inculcates affinity for environmental concerns. Just as economists seek to measure and give significance to existence value of natural resources using contingent valuation studies, it is certainly possible to consider policies promoting recycling as creating value not commodified in traditional markets. Thus, the benefits to variable rate policies should include not just reduced tipping fees and recycled materials revenues, but also an estimated dollar amount per household or citizen.[112] In fact, people may derive utility not merely from their own activities but also

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Respond to Waste Management, Inc., Biocycle 39 (May 2003).

[109] Cite

[110] Seven out of ten Americans view recycling as an important solution to environmental problems. See, e.g., National Solid Waste Management Association, Public Attitudes Towards Garbage Disposal (Washington, D.C: 1988); Shades of Green: Eight of 10 Americans are Environmentalists, Wall Street Journal, August 2, 1991 at p. 1. See generally Frank Ackerman, Why Do We Recycle (1997); cf. Anne E. Carlson, Recycling Norms, 89 Cal. L. Rev. 1231 (2001).

[111] Cf. Don Fullerton and Thomas C. Kinnaman, Household Responses to Pricing Garbage by the Bag, 86 Amer. Econ. Rev. 971, 975 (1996) (finding that nearly three-fourths of the Charlottesville, Virginia population participated in recycling without any legal or financial incentive).

[112] Using survey responses to hypothetical questions about how much individuals would pay to retain a curbside recycling program, Kinnaman found that Lewisburg, Pennsylvania residents would be willing to $92.48 per year (net of any household resource costs). See Thomas C. Kinnaman, Explaining the Growth in Municipal Recycling Programs: The Role of Market and Nonmarket Factors, 5 Public Works Management & Policy 37 (2000). Cf. R. DeYoung, Some Psychological Aspects of Reduced Consumer Behavior, the Role of Intrinsic Satisfaction and Competence Motivation, 38

from those of their neighbors or complete strangers. Meeting specific diversion goals or even beating the Europeans or Japanese in Olympic-like national competitions could be seen as socially valuable.

Alternatively, the strong support for recycling can be viewed as a proxy for strong support for a clean environment. From this perspective, the policymaker should look behind the stated preference and determine the best approach to pursue the electorate's implicit goal. This perspective would not place recycling on a pedestal, but rather approach the policy matrix with a cost-benefit scale (with no attention paid to soft preferences).   This approach could be rationalized on the grounds that citizens have fallen victim to distorted media accounts of the underlying issues surrounding municipal solid waste and recycling and that policy matters in this area should be left to the experts.[113]

One poignant vignette from Steven Soderbergh's 1989 film "Sex, Lies, and Videotape" nicely captures the misperception that may underlie the almost religious quality surrounding recycling. The film opens with a woman explaining to her psychiatrist what has been troubling her lately: "All I've been thinking about all week is garbage. I mean, I just can't stop thinking about it. . . . I've just gotten real concerned over what's gonna happen. . . . I started feeling this way . . . when that barge was stranded." As the film develops, it is clear that the character's real problems lie in sexual and marital unhappiness and not MSW policy. While rather extreme, the notion that consumers latch onto symbolic environmental issues arises frequently. Consumer guilt over drink boxes, disposable diapers, polystyrene clamshell packaging (after CFCs were no longer used as blowing agents), and plastic grocery bags all likely reflect misapprehension of the complexities of the MSW stream and the economic and environmental effects of recycling. Yet these distorted views can have real effects. As one waste industry reporter astutely observed:

> The misadventures of the 1987 garbage barge, Mobro, did more to increase recycling in America than all of the combined efforts of legislative delegations and environmental groups. With the nation focused on and fearing an apparent lack of disposal space, an emphasis to recycle and reduce waste soared.[114]

Under this view, it can be argued that policymakers should seek to measure the inconvenience associated with recycling directly and factor it into policy decisions. Thus, the cost of variable rate policies should be adjusted upward to reflect the actual time spent and space needed to separate recyclable containers. John Tierney, the author of the controversial New York Times Magazine piece entitled "Recycling is Garbage," attempted this calculation:

Environment and Behavior 358 (1996) (finding that individuals derive intangible satisfaction from engaging in frugal or conservation activities).

[113] Cf. Stephen Breyer, Breaking the Vicious Circle (1993).

[114] See Cheryl L. Dunson, Constructing the Future, Waste Age (Jan. 1, 2000).

> I tried to estimate the value of New Yorkers' garbage-sorting by financing an experiment by a neutral observer (a Columbia University student with no feelings about recycling). He kept a record of the work he did during one week complying with New York's recycling laws. It took him eight minutes during the week to sort, rinse and deliver four pounds of cans and bottles to the basement of his building. If the city paid for that work at a typical janitorial wage ($12 per hour), it would pay $792 in home labor costs for each ton of cans and bottles collected. And what about the extra space occupied by that recycling receptacle in the kitchen? It must take up at least a square foot, which in New York costs at least $4 a week to rent. If the city had to pay for this space, the cost per ton of recyclables would be about $4,000. That figure plus the home labor costs, added to what the city already spends on its collection program, totals more than $3,000 for a ton of scrap metal, glass and plastic.

This approach, however, overrides a central premise of traditional economic analysis – that consumer preferences should be taken as given.[115] Even if one were open to overriding consumer choice in some cases, this hardly seems like a compelling situation. Respecting households' joy in separating recyclables does not pose any harm to others or oneself.

Variable rate pricing strikes a sensible balance between these two approaches. By imposing at least a partial measure of the social costs of disposal on households and allowing them the opportunity to separate recyclables in some reasonably convenient manner, this policy approach encourages household sovereignty, promotes a relatively high diversion rate, and imposes costs roughly upon those responsible. Even though it may on net not be worth the administrative costs in all circumstances, the non-market benefits would appear to weigh in favor of adopting such a approach. Corroborating this conclusion, Lisa Skumatz finds that more than 90% of customers are pleased with variable rate policies after they are implemented and perceive them to be more fair than alternatives.[116]

Conclusions

Pulling all of these considerations together, variable rate policies would appear to be modestly successful as an efficient means of regulating MSW and remarkably successful as a means of achieving high diversion rates. This approach has also fostered the development of recycling markets which may yield even larger environmental benefits over the long run in terms of reduced adverse impacts from virgin resource extraction and more efficient resource use and reprocessing within the broader economy. Municipal governments and households throughout thousands of communities of varying sizes and demographic characteristics have embraced such variable rate pricing, as have environmental

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[115] Cite Becker & Stigler

[116] See Lisa A. Skumatz, Variable Rates for Municipal Solid Waste: Implementation Experience, Economics, and Legislation, Reason Foundation Policy Study 160 (Jun. 1993).

organizations and conservative think tanks. The economic theory underlying variable rate pricing has proven, after significant tinkering at the implementation stage, to be quite workable in practice. In fact, the practical realities of implementing charges have shown that theoretical perfection in terms of getting the prices right is less important in the grand scheme than keeping the transaction costs manageable. Over time, variable rate pricing can be expected to become even more successful as recycling markets continue to mature, landfill tipping fees rise, and improved technology for curbside collection, monitoring, billing, and measuring waste develops.

Figure 1
Multi-Tier Structure of the MSW Stream

Raw Material Extraction

Product and Packaging Design

Product and Packaging Manufacturing

Consumer purchase

Consumer Waste Generation

Consumer Waste Separation

Waste Recycling, Composting, or Disposal (Landfill, Incineration)

Table 1
Composition of the MSW Stream: 1990

Materials	Tons (000s)	% of MSW	% Recovered
Paper and Paperboard	72,730	35.4%	27.8%
Glass	13,100	6.4%	20.1%
Metals	15,550	8.1%	24.0%
Plastics	17,130	8.3%	2.2%
Rubber and Leather	5,790	2.8%	6.4%
Textiles	5,810	2.8%	11.4%
Wood	12,210	6.0%	1.1%
Food Wastes	20,800	10.1%	<.05%
Yard Wastes	35,000	17.1%	12.0%
Other Wastes	6,090	3.0%	11.2%
Total MSW Generated	205,210	100%	16.2%

* includes recovery of paper for composting

Source: U.S. Environmental Protection Agency, Municipal Solid Waste in the United States: 2000 Facts and Figures 32-33 (June 2002)

Table 2
MSW Policy Matrix

MSW Policy	Incentive Effects		Transaction Costs				Other Effects		
	Purchasing	Separation	Waste Hauling	Billing Systems	Consumer Costs	Enforce-ment Costs	Illegal Disposal	Promoting Recycling Markets	Reducing Envtl Externalities
(1) Advance Disposal Charge	low-medium*	none	none	high	none	none	none	none	low
(2) Curbside Pick-up	low	medium	medium	low	medium	low	low	+	+
(3) Disposal Ban	low	high	medium	low	medium	high	?	+	+
(4) Variable Rate Disposal Charge									
(a) Variable Can	low	high	medium	low	medium	none	?	+	+
(b) Bag, Tag, Sticker	low	high	medium	medium	medium	low-medium	?	+	+
(c) Hybrid	low	high	medium	medium	medium	low-medium	?	+	+
(d) Weight	low	high	high	high	medium	none	medium	+	+
(5) Recycling Centers	low	low	low	low	high	none	none	low	low
(6) Deposit-Refund	low	high*	none	high	high	none	none	+*	+*

* limited to specific products covered (typically beverage containers)

Table 3
Composition of the MSW Stream: 1990-2000

Materials	1990			2000		
	Tons (000s)	% of MSW	% Recovered	Tons (000s)	% of MSW	% Recovered
Paper and Paperboard	72,730	35.4%	27.8%	86,740	37.4%	45.4%
Glass	13,100	6.4%	20.1%	12,770	5.5%	23.0%
Metals	15,550	8.1%	24.0%	18,020	7.8%	35.4%
Plastics	17,130	8.3%	2.2%	24,710	10.7%	5.4%
Rubber and Leather	5,790	2.8%	6.4%	6,370	2.7%	12.2%
Textiles	5,810	2.8%	11.4%	9,380	4.0%	13.5%
Wood	12,210	6.0%	1.1%	12,700	5.5%	3.8%
Food Wastes	20,800	10.1%	<.05%	25,900	11.2%	2.6%*
Yard Wastes	35,000	17.1%	12.0%	27,730	12.0%	56.9%
Other Wastes	6,090	3.0%	11.2%	7,530	3.2%	11.4%
Total MSW Generated	205,210	100%	16.2%	231,850	100%	30.1%

* includes recovery of paper for composting

Source: U.S. Environmental Protection Agency, Municipal Solid Waste in the United States: 2000 Facts and Figures 32-33 (June 2002)

Table 4
Variable Rate Case Studies: Effects on Volume and Diversion

City	Community Characteristics			MSW Regulation			Performance			
	Type	Population Density (pop/sq. mile)	median income	PAYT Year type	Curbside Recycling Year type	Yard Waste Collection Year type	Landfill Volume Time	Recycling Volume Time	Yard Waste Diversion Time	Total Waste Volume
Downers Grove, Illinois	suburban	47,883 3,521	$48,266	1990 sticker	1990 free	1990 $1.50/sticker	-24% 1991-93	+43% 1991-93	+6.5% 1991-93	-3.4% 1991-93
Glendale, California	suburban	177,621 5,806	$34,372	1992 var. can	1988 free	1992 free	-36% 1990-92	+62% 1990-92	0÷27% MSW 1991-92	-5.0% 1990-92
Hoffman Estates, Illinois	suburban	47,266 2,528	$49,475	1992 sticker	1990 free	1990 $.75/bag	-38% 1991-93	+52 1991-93	+23% 1992-93	-5.6% 1991-93
San Jose, California	urban	782,225 4,678	$46,206	1993 hybrid	1987 free	1989 free	-37% 1993-95	+154% 1993-95	+45% 1993-95	-4.1% 1993-95
Santa Monica, California	suburban	87,064 10,490	$35,997	1992 hybrid	1989 free	none	-5.5% 1991-93	+30% 1991-93	not applicable	-2.9% 1991-93

Source: Marie Lynn Miranda & Joseph E.Aldy, Unit Pricing of Residential Municipal Solid Waste: Lessons from Nine Case Study Communities (Mar. 1996)

Table 5
Variable Rate Case Studies: Effects on Volume and Diversion

City	Community Characteristics			Waste/HH/Day before PAYT				Waste/HH/Day after PAYT				
	Type	Population Density (HH/sq. mile)	median HH income (1989)	Total (lbs)	percent discards	percent diverted		Total	percent discards	percent diverted		possible source reduction
						recycle	compost			recycle	compost	
Bellevue, Washington	suburban/ urban	103,700 2,875	$48,900	7.3	89%	6%	5%	9.18	40%	26%	34%	-26%
Chatham, New Jersey	suburban	8,289 1,363	$62,129	16.85	63%	13%	50%	15.81	35%	22%	43%	6%
Fitchburg, Wisconsin	rural	17,266 216	$35,550	6.16	65%	24%	11%	5.89	50%	29%	21%	4%
Portland, Oregon	urban	503,000 1,437	$25,592	6.14	71%	24%	5%	7.10	60%	23%	17%	-16%
San Jose, California	urban	873,300 1,539	$46,206	8.61	67%	10%	23%	8.82	55%	19%	26%	-2%
Seattle, Washington	urban	534,700 2,706	$29,353	5.61	81%	19%	0%	6.34	51%	29%	20%	-13%

Source: U.S. Environmental Protection Agency, Cutting the Waste Stream in Half: Community Record Setters Show How p.22, Table 10 (Jun 1999) (study conducted by the Institute for Local Self-Reliance).

Table 6
Recycled Materials Market Prices (Midwest - July 2003)

Material	Price Range
Cardboard (#11)	$60 - $65 per ton
Newsprint (#6)	$35 - $40 per ton
Newsprint (#8)	$55 - $60 per ton
Aluminum Cans	30¢ per pound
Steel Cans	$40 per ton
Clear Glass	$40 per ton
Amber Glass	$30 per ton
Green Glass	$20 per ton
PET Plastic (soda bottles)	9¢ - 12¢ per pound
HDPE Plastic (milk jugs)	16¢ - 17¢ per pound

Source: Associated Recyclers of the Midwest, Recycled Materials Market Trends (April 2003) <http://www.recyclingcoop.org/martket.htm> (visited Jul. 31, 2003).

Table 7
Variable Rate Benefit Scenarios

Scenario 1: National Ave Tipping Fee 50,000 households 11 lbs/HH/day	Pre-PAYT			Post-PAYT				
	Landfill	18% Recycling	5% Composting	Landfill	Recycling	Composting	Source Reduction	Net Savings
Volume (tons)	80,300	15,056.25	5,018.75	67,452	19,874.25	8,230.75	4,818	
tipping fee/revenue	$33.70	($15)	($5)	$33.70	($15)	($5)		
disposal cost	2,706,110	(225,843.75)	(25,093.75)	2,273,132.4	(298,113.75)	(41,153.75)		
Net Disposal Cost	$2,455,172.50			$1,933,864.90				
PAYT transaction cost				50,000 HH * $6/HH/year = $300,000				
Total Cost	$2,455,172.50			$2,233,864.90				$221,307.6
Scenario 2: Northeastern State 50,000 households 11 lbs/HH/day	Pre-PAYT			Post-PAYT				
	Landfill	18% Recycling	5% Composting	Landfill	Recycling	Composting	Source Reduction	
volume	80,300	15,056.25	5,018.75	67,452	19,874.25	8,230.75	4,818	
tipping fee/revenue	$70	($15)	($5)	$70	($15)	($5)		
disposal cost	5,621,000	(225,843.75)	(25,093.75)	4,721,640	(298,113.75)	(41,153.75)		
Net Disposal Cost	$5,370,062.5			$4,382,372.50				
PAYT transaction cost				50,000 HH * $6/HH/year = $300,000				
Total Cost	$5,370,062.5			$4,682,372.5				$687,690

Table 8
Variable Rate Case Studies: Net Costs

City	Net Program Costs/HH/year						percent change in cost/HH	Cost/Ton Post-PAYT		
	Pre-PAYT			Post-PAYT						
	disposal (tip fee)	diversion	total	disposal (tip fee)	diversion	total		Disposal (tipping fee)	Recycling (materials revenue)	Compost (materials revenue)
Chatham, New Jersey	$393 ($141)	$64	$457	$158 ($101)	$70	$228	-50%	$157 ($101)	$39 ($8*)	$48 ($8*)
Fitchburg, Wisconsin	$72 ($31)	$54	$126	$52 ($36)	$55	$108	-14%	$100 ($36)	$117 (0**)	$78 (0**)
Portland, Oregon	$187 ($72)	$54	$241	$144 ($63)	$67	$211	-12%	$188 ($63)	$196 ($15*)	$132 ($15*)
San Jose, California	$143 ($29)	$64	$207	$82 ($28)	$105	$187	-10%	$95 ($28)	$206 ($0**)	$96 ($0**)
Seattle, Washington	$155 ($60)	$0***	$155	$101 ($45)	$54	$155	0	$173 ($45)	$121 ($0**)	$142 ($0**)

* Averaged over recycled materials and compost.
** No direct materials revenue received by municipality; reflected implicitly in agreement with hauling contractor.
** No recycling costs borne by city.

Source: U.S. Environmental Protection Agency, Cutting the Waste Stream in Half: Community Record Setters Show How p.22, Table 10 (Jun 1999) (study conducted by the Institute for Local Self-Reliance).

Table 9 **Energy and Climate Change Effects of Substituting Recovered Materials for Virgin Raw Materials**					
Materials	Grade	Energy Savings vis a vis Virgin Production	Million BTUs per ton	Oil Barrel Equivalents per ton	CO_2 Tons Avoided
Aluminum		95%	196	37.2	13.8
Paper*	Newsprint	45%	20.9	3.97	(.03)
	Boxboard	26%	12.8	2.43	.04
Glass	Recycle	31%	4.74	.9	.39
	Reuse	328%	50.18	9.54	3.46
Steel		61%	14.3	2.71	1.52
Plastic	Polyethylene Terephthalate (PET)	57%	57.9	11	.985
	Polyethylene (PE)	75%	56.7	10.8	.346
	Polypropylene (PP)	74%	53.6	10.2	1.32

* Energy calculations for paper recycling count unused wood as fuel.

Adapted from Natural Resources Defense Council, Too Good to Throw Away: Recycling's Proven Record Table 1 (Feb. 1997) <http://www.nrdc.org/cities/recycling/recyc/recyinx.asp> (compiled from data derived supplied by Argonne National Labs (1980, 1981), U.S. Department of Energy (1982), Franklin Associates (1990), AL Associates, AISI, Phillips 66, Wellman (1991).

Table 10
Environmental Benefits from Substituting Recycled Inputs

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%	---

Source: C. Pollak, Mining Urban Wastes: The Potential for Recycling 22 (Worldwatch Paper No. 76, 1987).