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# AN ECONOMIC ANALYSIS OF THE EFFECTS OF RECYCLING FOCUSED ON BOTTLE COLLECTION PROGRAMS IN THE PACKAGING SECTOR

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## ABSTRACT

AN ECONOMIC ANALYSIS OF THE EFFECTS OF RECYCLING FOCUSED ON BOTTLE COLLECTION PROGRAMS IN THE PACKAGING SECTOR

By

Yongseong Ha

With a variety of efforts, the infrastructure for recovering beverage containers has been well developed. This study investigated the major factors that affected recycling activities during the span of 1989 to 2002.

Bottle collection methods and bottle deposit rates are the main areas of interest. Mandatory bottle deposit laws and curbside collection programs are two major ways to collect for recycling. Currently nine states have bottle deposit laws and California has a redemption system. Deposit amounts vary by state: 2.5 cents, 5 cents and 10 cents. Alternatively, curbside recycling programs are found in most U.S. states.

This study focused on the two main aspects: recycling and bottle deposit systems. First, the relationship between the recycling rate and various socioeconomic variables was examined. Second, the effect of different deposit rates was investigated.

Using multiple regression analysis, this study found that: Waste generation per person shows the highest correlation with recycling activity. The 5 cent system is more associated with high recycling rates among the three deposit rates. And bottle deposit systems contribute to recycling efforts more than curbside programs.

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# CHAPTER 1: INTRODUCTION

## INTRODUCTION

The human activities of production and consumption give rise to solid waste because the level of economic activity relates to the level of waste emitted. According to the laws of thermodynamics, it is not possible to convert waste residuals completely into beneficial or even harmless products. Although some amount of solid waste is an inevitable consequence of human activity, it may be possible to minimize the amount of solid waste generated in our environmental system. This introductory chapter reviews the current waste management options and discusses the research problems including the research objectives.

## TRENDS IN MUNICIPAL SOLID WASTE DISPOSAL

The handling and disposal of solid waste is one of the major concerns for communities throughout the United States. The current solid waste problem is related to both a waste disposal problem and a waste generation problem. The United States is generating more waste now than ever before. From 1960 to 2000, total U.S. municipal solid waste (MSW) generation increased over 260 percent from 88.1 million tons to 231.9 million tons per year, while per capita generation increased over 170 percent from 2.68 to 4.51 pounds per person per day (EPA, 2002).

To reduce or manage MSW, various methods have been applied. The main components of the waste management policy are source reduction, reuse of products, recycling of materials, and waste combustion and landfilling. Although source reduction and recycling are EPA's preferred practices, landfilling is the current dominant method of MSW management. According to EPA, 55 percent of MSW generation was landfilled and the rest was handled by recycling (30%) and combustion (15%) in 2000.

In using the landfilling and combustion techniques, however, some restrictions have been made. EPA (2002) reported that there are fewer years of landfill capacity available and most states have less than a decade of capacity left. Besides, landfill tipping fees vary by states. For example, Table 1 shows the landfill tipping fees of eight states. Vermont has the highest fee at $75 per ton while Colorado has the lowest fee at $11 per ton. Besides these eight states, Goldstein and Madtes (2001) also reported that fourteen states are in the $20 to $30 per ton range and eight states are in the $30 to $40 per ton range.

Table1. Landfill Tipping Fees by State in 2000

| State | Fee ($/ton) |
|---|---|
| Vermont | 75.0 |
| Massachusetts | 67.0 |
| New Hampshire | 66.0 |
| Maine | 65.0 |
| Delaware | 58.5 |
| New Jersey | 55.0 |
| Nevada | 20.0 |
| Colorado | 11.0 |

Source: Goldstein and Madtes, 2001

Many states also depend on combustion systems for managing MSW. According to Goldstein and Madtes (2001), the District of Columbia had the highest combustion rate at 79 percent. In Connecticut, 65 percent of MSW was incinerated, followed by Maine (39 percent), Massachusetts (36 percent), and Hawaii (32 percent). In using combustion systems, however, air pollution is caused because some residue reaches the air. To deal with this problem, various emission control systems are used such as settling chambers, cyclones, filtration, electronic precipitators and wet scrubbers. There are also solid residues that generally must be landfilled. EPA (2001) estimated that MSW combustor ash amounts to about 25 percent (dry weight) of unprocessed MSW input.

Under these circumstances, recycling is becoming the more preferred practice to deal with MSW. Recyclable materials must be collected before they are processed and recycled into valuable products. In general, collection of recyclables from residential sources is separate from commercial recyclables collection programs. Most residential recycling is recovered from curbside collection, drop-off centers, buy-back programs, and container deposit systems. On the other hand, the largest quantity of recovered materials in the commercial sector is provided by old corrugated containers (OCC) and office paper. The recovered materials are picked up by a paper dealer or self-delivered to the recycler. In 2002, EPA estimated that residential waste constituted between 55 and 65 percent of total MSW generation and commercial waste was between 35 and 45 percent of MSW.

In 2001, Goldstein and Madtes reported that recycling is considered as a preferred method for managing MSW in the United States. Ten states have mandatory recycling goals for waste reduction, and four states have already attained their recycling goals.

Massachusetts and Rhode Island have the largest recycling goals at 70 percent. In addition, sixteen states aim to reach at least half of their wastes recycled.

## WASTE MANAGEMENT STRATEGIES

### Economic Instruments

Economic analysis has been used in decision-making in MSW management due mainly to the advantage of economic instruments, which help modify human behavior through the price mechanism. In managing packaging waste generation, it should be defined where in the solid waste generation and disposal system is the optimal point to apply incentive-based policies. In general, incentives applied at the point of disposal (downstream) are considered as more efficient than those applied at the point of purchase or manufacture (upstream).

A variety of economic instruments have been used or considered in waste-related policy. All are attempts to achieve an efficient solution by influencing the wide discretion of producers and consumers. Although it is difficult to decide which option should be used, an incentive must start from the baseline goal that the generation of packaging waste is optimally prevented or that waste generated is treated as efficiently as possible. The following economic instruments can be applied in waste management policy for packaging materials:

1) Virgin materials tax; this tax is put on raw materials used for the production of packaging products. As source reduction, it is applied to reduce the use of raw materials.

2) Product charges; they are added to the price of packaging products as taxes. When products are fully made from recycled materials, they can be exempted, while a lower charge can be imposed if products are partly made from recycled materials. These charges can facilitate reuse and recycling.
3) Waste charge; payments can be charged when waste is collected or disposed. As a user charge, this system increases the final costs of waste disposal. The charge can be directly related to disposal of packaging, when packaging is a major component of the waste.
4) Recycling credits; Credits can be paid to those who reuse containers or recycle materials. This method can be used to encourage the division of waste from landfill to recycle.
5) Deposit-refund systems; basically this instrument is a type of product charge since the surcharge is applied to the packaging products. However, it is a refundable surcharge because the surcharge will be returned if the charged products are prevented from final disposal as waste. This system can be applied as either voluntary or mandatory.

Using a legal framework, various economic instruments provide a choice to the consumers or producers to take an action, either "abate and save" or "pollute and pay for it." The instruments described can be applied in a mixed system, depending on waste management policies. However, charges should be carefully reviewed because they can be double-counted, possibly causing damage to the production and consumption of products. In addition, whatever economic instruments are used for recycling, they should be connected to the whole MSW stream.

**Characteristics of Packaging Waste**

Table 2 shows that containers and packaging waste is the largest proportion of total MSW generation. In 2000, containers and packaging waste consisted of over 32 percent (74.7 million tons) followed by nondurable goods at 27.5 percent (about 63.7 million tons). As a percentage of MSW, the long term trend of packaging waste generation was higher in 1980 and decreased somewhat in 2000 (EPA 2002). However, the amount of waste generated has increased dramatically for several decades. Despite various efforts to reduce waste generation, the amount of packaging waste is still increasing. To understand the increase in waste, two main motivating factors should be considered. First, manufacturers and sellers of products and packaging usually have no responsibility for handling materials after they are discarded. Second, recycling competes with raw materials in uncertain economic conditions, in which the market price of recycled materials is very changeable.

Table 2. MSW Generation Rate from 1960 to 2000

| Products | 1960 | | 1980 | | 2000 | |
|---|---|---|---|---|---|---|
| | 1000 tons | (%) | 1000 tons | (%) | 1000 tons | (%) |
| Durable Goods | 9920 | 11.3 | 21800 | 14.4 | 36330 | 15.7 |
| Nondurable Goods | 17330 | 19.7 | 34420 | 22.7 | 63660 | 27.5 |
| Containers and PKG | 27370 | 31.1 | 52670 | 34.7 | 74730 | 32.2 |
| Food Waste | 12200 | 13.8 | 13000 | 8.6 | 25900 | 11.2 |
| Yard Trimming | 20000 | 22.7 | 27500 | 18.1 | 27730 | 12.0 |
| Others | 1300 | 1.5 | 2250 | 1.5 | 3500 | 1.5 |

Source: EPA, 2002

Table 3 shows generation and recovery of packaging wastes in each product category in 2000. Paper and paperboard comprised the largest fraction of packaging waste generation at over 39 million tons, followed by plastics and glass packaging which were equal at 11.2 million tons. On the recovery side, over 58 percent of steel packaging waste was recovered from the MSW stream and over 56 percent of paper and paperboard packaging waste was also recovered. The recovery rate of plastic packaging wastes was relatively lower than other packaging products, at 9 percent. On the other hand, bottle recovery in each packaging type contributed to increasing the recovery rate of packaging waste. More than half of steel and aluminum cans are recovered from the waste stream and over 30 percent of plastic soft drink bottles are also collected for recycling (EPA 2002).

This trend results from the fact that recyclable beverage containers have relatively higher market value. In particular, aluminum cans have a high recycling value. However, EPA (2002) reports that the recycling amount for plastic beverage bottles stayed constant and recently decreased for glass bottles and aluminum cans.

Table 3. Packaging Waste by Products in 2000

| | Generation (1000 tons) | Recovery (1000 tons) | Recovery Rate (%) |
|---|---|---|---|
| **Glass** | | | |
| Beer and Soft Drink Bottles | 5860 | 1560 | 26.6 |
| Wine and Liquor Bottles | 1970 | 440 | 22.3 |
| Food and Other Bottles & Jars | 3360 | 940 | 28 |
| **Total Glass Packaging** | 11190 | 2940 | 26.3 |
| **Steel Packaging** | | | |
| Food and Other Cans | 2640 | 1510 | 57.2 |
| Other Steel Packaging | 240 | 160 | 66.7 |
| **Total Steel Packaging** | 2880 | 1670 | 58 |
| **Aluminum** | | | |
| Beer and Soft Drink Cans | 1520 | 830 | 54.6 |
| Other Cans | 50 | Neg. | Neg. |
| Foil and Closures | 380 | 40 | 10.5 |
| **Total Aluminum Packaging** | 1950 | 870 | 44.6 |
| **Paper and Paperboard** | | | |
| Corrugated Boxes | 30210 | 21360 | 70.7 |
| Milk Cartons | 490 | Neg. | Neg. |
| Folding Cartons | 5580 | 430 | 7.7 |
| Other Paperboard Packaging | 200 | Neg. | Neg. |
| Bags and Sacks | 1550 | 300 | 19.4 |
| Other Paper Packaging | 1370 | Neg. | Neg. |
| **Total Paper & Paperboard Packaging** | 39400 | 22090 | 56.1 |
| **Plastics** | | | |
| Soft Drink Bottles | 830 | 290 | 34.9 |
| Milk Bottles | 690 | 210 | 30.4 |
| Other Containers | 2630 | 260 | 9.9 |
| Bags and Sacks | 1650 | 10 | 0.6 |
| Wraps | 2550 | 170 | 6.7 |
| Other Plastic Packaging | 2840 | 90 | 3.2 |
| **Total Plastic Packaging** | 11190 | 1030 | 9.2 |
| **Others Misc. Packaging** | 8120 | 480 | 6.1 |

Neg. is less than 5000 tons or 0.05 percent
Source: EPA, 2002

## MAJOR BOTTLE COLLECTION METHODS

To control the generation of packaging waste, various collection methods are operating in the market. Especially, beverage containers such as cans and bottles are the aim at the state level. Typical methods for container collection include deposit systems, curbside programs, drop-off centers and buy-back centers. However, only two collection methods, mandatory deposit systems and curbside recycling programs, are the focus of this discussion because these two programs are widely used.

### Mandatory Deposit Systems

Mandatory deposit-refund systems called "bottle bills" have been implemented for a reduction of packaging waste from beverage containers in the United States. In dealing with packaging waste, it may be considered that this system increases return of packaging and diverts recyclable materials from the MSW stream. Current deposits apply to glass, metal, and plastic containers for carbonated soft drinks, beer, wine, and some bottled water and other beverages. Nine states have enacted container deposit systems: Connecticut, Delaware, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont. Except for Michigan, which has a 10 cent deposit, the deposit in the remaining 8 states is the same at 5 cents. In these nine states, consumers have to pay a deposit on beverage containers when they buy the products. The deposit will be redeemed if the empty containers are returned to retailers. This law in most states requires retailers to accept for refunds containers of the same brand and type that they offer for sale. In addition, retailers in most cases are paid a fee to cover the costs of handling returned containers (OECD, 1993). California applies a rather different system in which the consumer pays no separate deposit, but containers can be redeemed when they are returned to designated redemption centers. In California and Maine, more containers are covered than in other deposit states (Appendix A).

Although bottle deposit laws only aim at beverage containers, the actual amount of these containers accounts for less than 4 percent of total MSW generation. Of this portion, about 35 percent of all recovery of beverage containers comes from the nine deposit states, and another 20 percent comes from California (EPA, 2002).

The rationale for why beverage container wastes have been targeted includes:

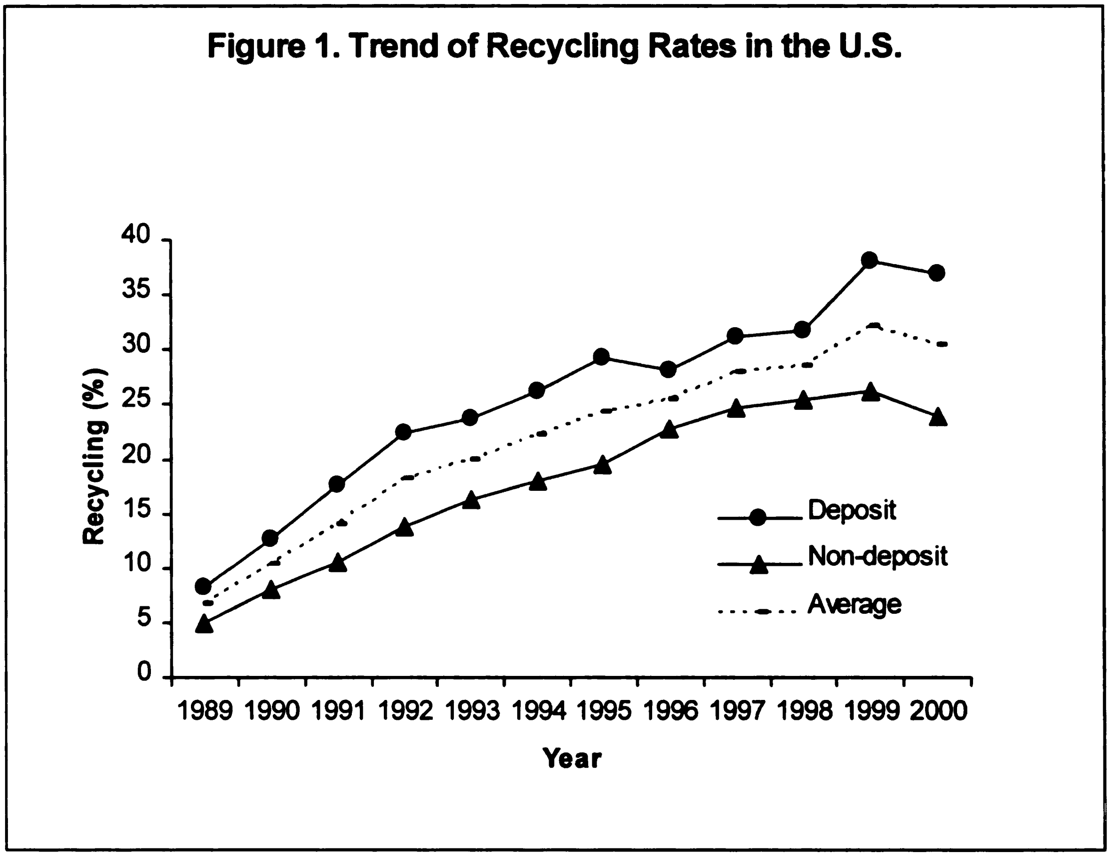
1) The typical lifetimes of beverage containers are less than one month (Stilwell et al., 1991). This fact indicates that a large volume of packaging waste is disposed of by consumers who just want the product, not the packaging. With little understanding of the benefits of packaging, packaging is treated as a by-product of the purchase, and discarded right after the contents are removed.
2) Manufacturers and sellers usually have no responsibility for the environmental impact of their products such as collecting, recycling, or landfilling discarded materials (GRRN, 2000). Therefore, taxpayers are forced to pay for disposal costs in general. This situation may create a free rider problem in handling the packaging wastes because someone can produce more wastes without paying more control costs.

These characteristics imply that in most cases the generation of waste beverage containers is caused by individual people. Consumers have a direct influence on the generation of waste beverage containers. To deal with this characteristic, container deposit systems are introduced because they are focused on modifying consumer behavior using the polluter pays principle. OECD (1974) explained the principle as the following:

> "The polluter should bear the expenses of preventing and controlling pollution 'to ensure that the environment is in an acceptable state.' The notion of an 'acceptable state' decided by public authorities, implies that through a collective choice and with respect to the limited information available, the advantage of a further reduction in the residual social damage involved is considered as being smaller than the social cost of further prevention and control. In fact the Polluter-Pays Principle is no more than an efficiency principle for allocating costs and does not involve bringing pollution down to an optimum level of any type, although it does not exclude the possibility of doing so."

The effectiveness of container deposit systems is positively proved in the market. For instance, OECD (1993) assessed the impacts of the container deposit systems and found that return rates of containers were between 72 to 98 percent in the nine deposit states. In addition, reductions of litter and solid waste volumes have been found as a result of the deposit return systems. Additionally, EPA (2002) estimated that about 55 percent of recovered beverage containers come from the nine deposit states and California. Figure 1 shows the effect of recycling efforts between the deposit states and the non-deposit states in the nation. The trend reveals that the deposit states have a higher recycling rate than the non-deposit states in recent decades.

Successful recycling basically depends on collecting high-quality post-consumer materials. BEAR (2002) noted that deposit systems provide the highest quality materials with the highest market values, as mandatory deposit systems avoid cross-contamination of materials at the point of collection and sorting. Therefore, it is considered that mandatory deposit programs have efficiently influenced the recovery of materials of higher quality from the waste stream.




Source: Glenn (1990, 1992, 1998, 1999), Glenn and Riggle (1991), Goldstein (1997, 2000), Goldstein and Madtes (2001), Steuteville (1994, 1995, 1996), Steuteville and Goldstein (1993)

**Curbside Programs**

Curbside recycling programs are offered to residents and may be operated by local governments or private businesses. These collection programs typically cover most single-family homes and some multi-family residences. In general, curbside participants are asked to place their recyclables in curbside collection bins. When the citizen separates recyclable materials into discrete containers at curbside, collection crews load materials on a specially designed vehicle. If all materials are commingled into one bin, the collection crew sorts the recyclables, or the commingled recyclables are transported to a special facility for separation.

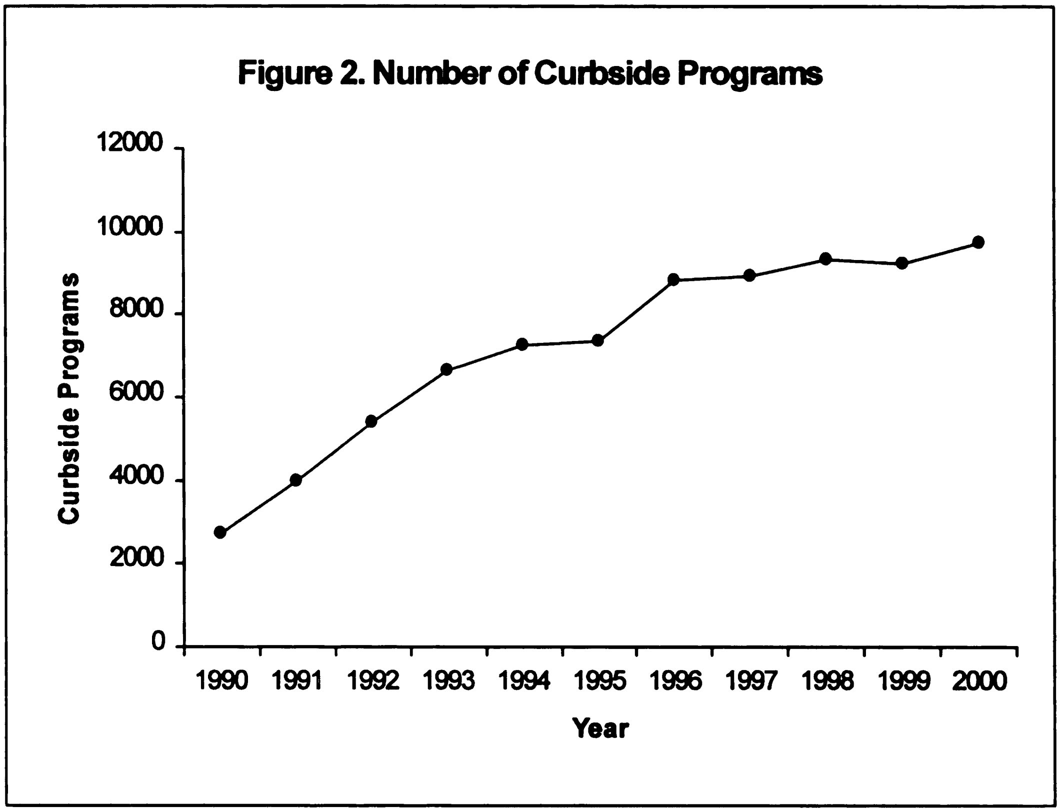
In most cases, recyclables are easily commingled in the process of curbside collection because typically the programs allow households to put recyclables in bins or carts without any sorting. Due to the commingled nature of the collected materials, such programs require materials recovery facilities (MRFs), where commingled materials are sorted into single-stream materials. This recovery system is designed to limit cross-contamination of materials, which results in lower-valued materials or even unmarketable ones. Along with the MRFs, truck-side sorting is an option that is sometimes used.

From the economic point of view, constructing MRFs requires a significant financial expense and also results in substantial costs for maintaining and operating the facility. For this reason, MRFs are typically located in large population areas that can manage the significant costs. For instance, Mullins et al. (1997) reported that cities with populations of 250,000 and over typically have two MRFs and the average cost to maintain a MRF is $643,271. Despite the high cost requirements for MRFs, curbside programs have been rapidly growing for the last decade in the United States. In 2000, more than 9700 curbside programs were operated (Figure 1) and about 140 million people received curbside recycling services (Figure 2).

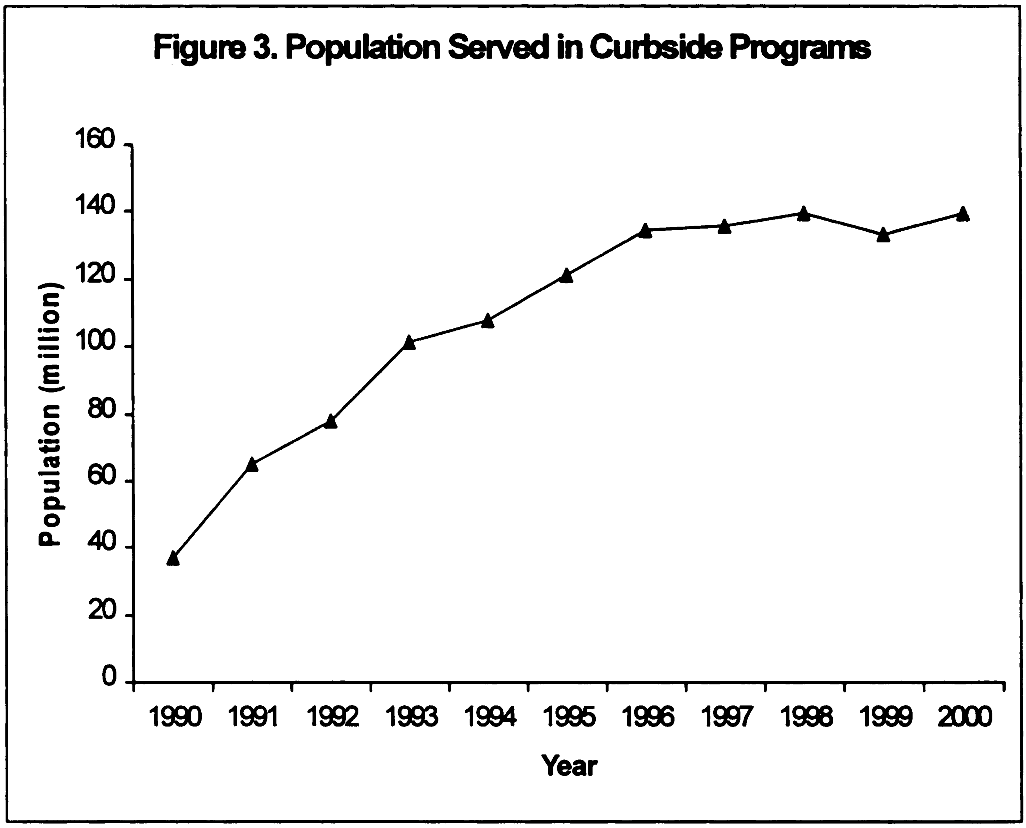
Goldstein and Madtes (2001) reported that New York had 1500 curbside recycling programs in 2000, leading the nation. Pennsylvania was the second with 892 curbside programs, followed by Minnesota (765) and Wisconsin (631). California led the nation with 31.1million people served by this service and New York was the next with 17.2 million people. This report also found that 100 percent of the population had access to a curbside program in Connecticut. New York and New Jersey were at 90 percent or higher, and California, Nevada, Rhode Island and Washington were at over 80 percent. Nationally, about 50 percent of the U. S. population was served by curbside programs in 2000.

Curbside programs are relatively convenient, compared to mandatory deposit systems, because they provide easy access to the collection point for households. In addition, only low capital and operating costs for processing will be necessary if materials are highly sorted (NREL, 1992).

Collection schedules vary from once a week to once a month. The collection frequency can influence the participation rate and the total quantity recycled. The special type of curbside program will be selected as a function of the community's demographics, the availability and reliability of processing facilities, community value, and the type of collection vehicles used (McGrath, 1990). Therefore, all curbside programs are not identical. One program may be poorly run, covering few materials, while another may be well publicized, very convenient, covering many more materials.




Source: Glenn (1992, 1998, 1999), Glenn and Riggle (1991), Goldstein (1997, 2000), Goldstein and Madtes (2001), Steuteville (1994, 1995, 1996), Steuteville and Goldstein (1993)




Source: Glenn (1992, 1998, 1999), Glenn and Riggle (1991), Goldstein (1997, 2000), Goldstein and Madtes (2001), Steuteville (1994, 1995, 1996), Steuteville and Goldstein (1993)

## RESEARCH PURPOSES

As discussed, beverage containers are recovered through various collection systems. Beverage container materials maintain a higher market value than other packaging materials. With a variety of efforts, therefore, the infrastructure for recovering beverage containers has been well developed. However, the efforts to reduce beverage container materials in the waste stream vary state by state. As discussed, some states have enacted mandatory deposit systems to recover beverage containers for recycling and others have several collection programs in which residents participate voluntarily. This gives rise to interest in how the different collection systems and different deposit levels are related to the recycling activity in the nation.

This research will investigate and test some major factors that affected consumer attitudes toward recycling practices during the span of 1989 to 2000. Using an economic analysis, this study will present empirical evidence. The findings can be applied in the development of effective and efficient options for waste management policy. The research will focus on two main aspects: recycling and deposit-return systems. First, the research examines the relationship between the recycling rate and various socioeconomic variables. Emphasis will be placed on the examination of the premise that the level of waste generation has a positive impact on recycling efforts. With a set of explanatory variables, this test will show how the recycling activity is affected by the amount of individual's behavior.

Second, this study examines the effect of container deposit legislation. Although this legislation is solely focused on the packaging waste to divert recyclable containers from the MSW stream, bottle deposit laws will be applied to identify how recycling efforts in the packaging sector affect the overall recycling activity. Currently the nine deposit states and California have enacted bottle bills, but they have different levels of deposit such as 2½ cents, 5 cents, and 10 cents. The effects of this difference will be examined to investigate what level of deposit is most effective. The differences between the bottle-bill states and non bottle-bill states will also be identified. In addition, the effects of curbside collection programs will be evaluated.

## ORGANIZATION OF THE RESEARCH

The following chapters of this research are organized as follows: Chapter 2 presents a review of the relevant literature, mainly focusing on recycling programs, mandatory deposit systems and curbside programs, and recycling behaviors. Chapter 3 describes the methods of analysis, data collection methods, research hypotheses and parameter selection. In Chapter 4, the statistical analyses and findings are discussed. Finally, Chapter 5 presents the conclusions of the research. It presents the summary of the empirical findings, policy implications and directions for future research.

# CHAPTER 2: LITERATURE REVIEW

## INTRODUCTION

This chapter reviews the research related to the proposed study. Current issues in the solid waste management area will be identified, along with analyzing a variety of relevant studies and previous contributions. It consists of two broad parts: 1) waste management strategies for recycling activities and 2) effects of bottle collection programs. Because collection of commercial solid waste is usually implemented by contract with private firms, the commercial sector will not be emphasized.

## WASTE MANAGEMENT STRATEGIES FOR RECYCLING

Most waste management strategies start with designing some type of incentive for recycling, and then it is presented to citizens as either a set package or a choice from a number of incentives. In developing solid waste policy, a critical factor is to understand citizen's opinions and whether there are options that make the disposal alternative more attractive to them. As proper and well developed methods are implemented, a better physical and social infrastructure will be provided. Therefore, a variety of recycling programs have been provided to create an incentive for residents to recycle as much as possible and dispose as little as possible.

### Determinants of Residential Recycling Decisions

In the past, researchers have examined the factors that influence participation in recycling efforts. Along with these efforts, local officials also desire to initiate or to refine recycling programs. The main reason for this phenomenon is that if they can manage the factors that are important for achieving a high rate of recycling, the recycling activity can be more easily applied in our society (De Young, 1986; Sundeen, 1988).

To identify significant determinants, the socioeconomic attributes of the residents have been explicitly related to recycling activities. These attributes typically include personal factors such as income, age and education. Many investigations have provided empirical evidence showing that these variables strongly affect environmental behavior, especially recycling.

Using OLS (ordinary least squares) estimation techniques, Richardson and Havlicek (1978) analyzed economic and social factors affecting the generation of household solid wastes. In the empirical model, the household is treated as a production unit generating solid wastes. This study found that the household income is positively related to the waste generation of glass containers, aluminum and other metal products, but not plastics in general. In addition, household size and age (18 to 61 years of age) have a positive correlation in the waste generation. In terms of the effects of income and age variables, this result is consistent with Mohai and Twight (1987), who especially pointed out that the young indicate the greatest level of environmental concerns, while middle-aged people are the most likely to voluntarily engage in recycling programs. As a similar point of view, De Young (1986) found that recyclers are older (mean 42 years of age) than non-recyclers (mean 35 years of age), and recyclers have higher income levels ($40,000-$50,000 range) than non-recyclers. In contrast, Sundeen (1988) found that income, homeownership, and age are not related positively to recycling activities.

According to Vining and Ebreo (1990), residents with higher incomes and education are more likely to recycle. They explained this result as due to either better access to information or because they have relatively more materials to recycle than those with lower incomes.

Focusing on a pricing system for waste collection services, Hong et al. (1993) showed that the disposal fee significantly affects households' curbside recycling participation. For example, the participation rate in curbside recycling increases as the disposal fee increases. Due to the same effect, the quantity of non-recyclables decreases as the fee increases. On the other hand, changes in income are not likely to convert household's generation of total solid wastes into curbside recycling. Therefore, they insisted that income is considered as an insignificant factor for the participation decision on curbside recycling through the empirical analysis.

From a somewhat different point of view, Lansana (1992) compared several differences between recyclers and non-recyclers using socioeconomic factors. This study found that age and education are significant factors for recycling. For instance, in a group with the highest recycling average, the age group of recyclers was 40 to 64 while non-recyclers were less than 40 years old. Recyclers also had at least 7 to 12 years of education, which indicates more education than non-recyclers. However, there were no significant differences between the groups on the basis of their income. The age factor was also observed by Lake et al. (1996) who found that households with a middle aged (45 to 64 years of age) head of the household have higher recycling rates. They explained that in this age group, people spend more time engaging in recycling activities.

Lake et al. (1996) also calculated the diversion rate, defined as the quantity of household waste which is diverted from disposal to recycling. According to the analysis, the average diversion rate per individual household (25.1%) exceeds the overall diversion rate (22.9%). This result is explained as houses producing a large amount of waste are recycling a lower percentage of their waste than houses with small total weights. When all those households who recycle less than 10 percent by weight are excluded from the analysis, the overall diversion rate rises to 29 percent and the average individual rate increases to 32 percent as well. This result suggests that the participation of those households who do not now take part in recycling is an important factor in developing waste management policies.

Steuteville (1996) pointed out that recycling has apparently become part of American life and a responsibility of local government. To verify this trend, Mullins et al. (1997) examined changes in local government practices. They surveyed 1071 cities with populations of 5000 or above in the U.S. and found that population size is highly related to waste services. For instance, larger cities (with more than 250,000 people) more frequently offer solid waste pickups for residential waste collection. This study noted that about 67 percent of the 975 local governments that provided information require recycling by state law or local ordinance. In detail, 83 percent of all cities recycle aluminum, 81 percent glass, and 76 percent plastic beverage bottles. For collecting recyclables, 80 percent of surveyed cities offer curbside programs and 69 percent of communities provide drop-off centers. This study also found that localities are not likely to use a single method, otherwise they want to use not only multiple providers for collecting materials but also multiple methods for disposing of solid waste. However, they only used curbside pickup and drop-off centers as recycling methods.

To induce optimal recycling activity, Dinan (1993) examined several alternative policies for the recovery of old newspapers (ONP). The policies discussed included a virgin material tax, a combination of disposal tax and reuse subsidy, and a combination of disposal tax and reuse subsidy with unit-based pricing, which is a direct method to charge households by the amount of waste that they generate. This article shows that a combined disposal tax and reuse subsidy policy could be an efficient method of reducing waste and is suited to deal with recyclable waste items, while a virgin material tax is not. A particular concern results from the unit-based pricing. Because households pay the same amount for each unit of trash, illegal disposal increased. This study concluded that implementing a combined policy provides more efficient recycling results than using just one policy.

**Environmental Attributes and Behaviors for Recycling**

A number of recycling studies have focused on two behavioral approaches to understand and explain people's motives for recycling. Most groups emphasized intrinsic motives for recycling behavior, while a few groups investigated the extrinsic motives of recycling incentives. In an extrinsic study, Luyben and Cummings (1981-1982) explained individual recycling behavior and audited the behavior of subjects. They found that the combination of information fliers, lotteries and contest prizes is likely to increase recycling in a dormitory system. In addition, Goldsby (1998) explained the extrinsic motive as the most consistent, strongest influence on behavioral reaction. He considered convenience as one of the important extrinsic motives and found that 43.5 percent of respondents would like to recycle more if a more convenient system was provided. This study shows the direct effect of extrinsic motives on recycling behavior and also demonstrated that such external factors help to improve recycling.

On the other hand, intrinsic motives are defined as the characteristics inherent within the individual that lead his behavior (Guagnano et al., 1995). Research on intrinsic motivation has suggested that a good deal of human behavior is best explained in terms of goals and rewards that lead participants to maintain recycling activity (Deci, 1975; Eckblad, 1981).

De Young (1985-1986) found that intrinsic motivation and personal satisfaction are the most dominant factors in people's decision to recycle, while monetary reward is not an important reason. Likewise, Resource Recycling (1982) reported that economic rewards have only the slightest effect on people's willingness to recycle. In addition, studies of behavior-change strategies have suggested the importance of attitude change to achieve people's substantial behavior change (Burn and Oskamp, 1986; Katzev and Pardini, 1987-1988). Hopper and Nielsen (1991) insisted that recycling is a form of altruistic behavior and any type of social motivation will substantially increase recycling efforts.

In a comparison study of recyclers and non-recyclers, Vining and Ebreo (1990) presented knowledge, motives, and demographic factors. They found that non-recyclers are more concerned with financial incentives, rewards, and the convenience of recycling, while concerns for the environment are equal between the two groups. De Young (1986) indicated that changes in recycling behavior motivated by monetary incentives do not last when the reward is removed, suggesting that on-going forms of economic incentives are necessary to make long-term changes in recycling behavior. This study suggested that a waste management policy should be selected to encourage non-recyclers to begin recycling. This study provides the relative importance of different motivational factors; mandatory deposit laws such as beverage container deposit legislation are not considered in the analysis.

To determine characteristics affecting the successful management of different recycling programs, Folz and Hazlett (1991) conducted a national survey. This survey indicated that mandatory recycling programs attain participation and diversion rates twice as high as voluntary programs. Higher participation also occurred in cities that have more expensive waste collection fees, which are used for financing the operating costs of the recycling program. This result suggests that more residents are motivated to recycle due to the higher fees. Unlike previous studies, this study observes that recycling success is not related to socioeconomic parameters but depends more on the policies chosen. Therefore, they insist that policy selection and its implementation are the most important factors for the success of local recycling programs, regardless of the per capita income, education, or any other characteristics. This finding supports the study by Thomas (1990) and the position that citizens are more likely to participate effectively in collection efforts when they have been party to the policy decision.

Lansana (1992) indicated that the attitudes of residents toward the recycling program are significant predictors of their behavior. In particular, the recyclers are willing to recycle additional materials. For instance, overall, 92 percent of recyclers are willing to add new items to be recycled, while 97 percent of the non-recyclers are not willing to participate in the recycling program. This finding suggests the need for careful planning and implementation of recycling programs when a new strategy is developed. In behavior patterns, recyclers prefer mandatory programs because they assume that the policy will ensure that people in the community recycle. In addition, many households also prefer the use of curbside programs rather than the use of drop-off centers because of easy access to the collection point.

## THE EFFECTS OF BOTTLE COLLECTION PROGRAMS

With concern from states about recovering beverage bottles from the waste stream, a number of studies have estimated the effects of bottle deposit laws. As an early study of the impact of mandatory deposits, Porter (1978) estimated the social benefits and costs of mandatory deposits on beer and soft drink containers in Michigan. The social benefits of a change to mandatory deposits were increased control of litter and solid waste and the cost savings. In a similar point of view, Porter (1983) also evaluated the economic efficiency of mandatory deposits in Michigan. This study confirmed the previous study in that solid waste pickup and disposal costs were saved and amenity benefits from litter reduction were positive because of the mandatory deposit legislation. However, these results cannot be generalized to other states since these costs depend mainly on the return rate of deposit containers in each state.

Due to this limited application, Naughton et al. (1990) applied a methodology for analyzing the impacts of bottle bills in California. They found that return value is more important than convenience, while Porter (1983) found that the convenience of return is as important as redemption values. With the same five cent deposit level, they also indicated that the level of urbanization is one of the key factors. For instance, rural states such as Vermont, Maine, and Oregon have higher return rates than more urban states such as Massachusetts and New York. To estimate the net cost impacts of bottle bills on consumers, three types of redemption values, such as 1 cent, 3 cents and 5 cents, were used. Among the three values, the 5 cent redemption value was recommended to achieve 80 percent recycling. In addition, overall beverage container returns increased from 40 to 57 percent in California. This increase was mainly caused by the refund system, and a decrease in both beverage container litter (by 29 percent) and beverage container solid waste (by 17 percent) also resulted.

In previous studies, general equilibrium models were built to explain household waste generation and disposal (Dinan, 1993; Jenkins, 1991; Morris and Holthausen, 1994). Fullerton and Kinnaman (1995) included illicit burning and dumping in their model, with an assumption of no tax on the garbage. When applying the various parameters, they found that a negative impact caused by garbage can be corrected by a tax on garbage, while a tax on virgin materials is not useful for encouraging recycling. If illicit burning is added as a third option, the tax on garbage turns out to be insignificant. Furthermore, the model shows that the downstream tax system (at the point of disposal) turns out to be the most efficient policy, while the upstream tax (at the point of production) is easier to implement. Finally, this study found that the optimal regulatory structure is a deposit-return system because it is a tax on all output plus a rebate on proper disposal. In this study, a variety of consumption goods are included in the analysis rather than considering beverage bottles as the only item.

As one cost-effective way to encourage household recycling, Reschovsky and Stone (1994) applied market incentives which replaced the common flat-fee pricing for waste disposal with quantity-based pricing. They found that the most effective waste management policy, among eight policy combinations, is the combination of mandatory recycling and curbside pickup. The study suggests that households are more sensitive to the private costs of waste reduction and less sensitive to the costs of waste disposal. This finding is consistent with other studies (Vining and Ebreo, 1990; Markowitz, 1991). In addition, they demonstrated that efforts to encourage recycling by imposing high quantity-based fees or by enforcing mandatory recycling without providing a convenient way to recycle cause households to regard recycling as a meaningless activity. It was also found that curbside programs show the greatest effect on reported recycling behavior when they are coupled with the other programs, such as the combination of mandatory recycling and curbside pickup.

In a recent study, BEAR (Business and Environmentalists Allied for Recycling, 2002) presented a report on beverage container recovery programs, using data from 1999. When various recovery programs are rated, deposit systems show the highest level of recovery. For example, the average redemption rate of deposit states is 78 percent, varying from a high of 95 percent in Michigan to a low of 72 percent in Massachusetts. In a regional comparison of all types of recovery programs, the ten deposit states achieved an overall recovery rate of 71.6 percent, while the recovery rate in non-deposit states was 27.9 percent. This result shows that there is a big difference between those two systems. The second highest level of recovery is curbside programs, and the last is drop-off centers. In deposit states, curbside programs collect 9.5 percent of containers generated in residences and drop-off centers collect 1.6 percent. These rates increase to 18.5 percent and 4.5 percent, respectively, in non-deposit states because more containers are available than in deposit states.

In terms of the cost issue, Okamoto (1991) pointed out that deposit laws are costly especially in that consumers bear economic costs related to the time required to return containers and collect deposits. In addition to the comparison of recovery programs, BEAR (2002) estimated the costs and revenues associated with recovery programs using the value chain assessment, which includes all entities involved in the production, sale and consumption of beverages and in recovering, processing and recycling beverage containers. As the same trend with the recovery activities, deposit systems have the highest gross cost. Curbside programs are the second highest and the lowest cost is drop-off programs. Gross costs for deposit systems are 3.16 cents per container, and net costs including revenue from material sales are 2.21 cents. Despite the high cost, it is pointed out that deposit systems yield the highest quality containers, providing the highest market values. The redemption system in California has the lowest net operating costs because distributors and retailers do not handle containers and redeemed containers are not sorted by brand.

## CONCLUSION OF LITERATURE REVIEW

The review of previous studies shows that there are some options for various economic incentives for recycling activities. Given the range and diversity of people's opinions toward recycling and other waste disposal methods, policy makers should seek proper strategies that will enhance the management of MSW issues in their state or community. The switch in policies and the creation of programs to develop alternative waste management strategies will fundamentally change the way waste is discarded (EPA, 2001). From this point of view, recycling programs should be efficiently designed to collect the majority of available materials generated in the waste stream. Otherwise, recycling goals will not be achieved and large amounts of recyclables will be introduced to landfills or combustion again.

Optimal recycling programs are likely to vary considerably from community to community; thus results from previous studies cannot be generalized to other communities. Therefore, in most cases, the results are regarded as suggestive and compared to the experience of other communities. Despite various limitations, it is necessary that the level of information is improved to assess the effectiveness of recycling programs. This is mainly because recycling is a feasible part of the waste disposal structure for some materials, especially for beverage containers. Furthermore, this effort can provide substantial influence on recycling activity since as the markets for recyclables mature, other materials will be economically feasible to recycle as well. This research will seek to improve the level of information available by an economic analysis method.

## CHAPTER 3: METHOD

### INTRODUCTION

This chapter reviews the framework of the data set used in the study and then examines the estimation method, hypotheses and regression models developed and used in the study. First, the estimation method of the study is explained. Second, the hypotheses and associated variables are defined. Finally, the regression models are discussed. Several regression models were constructed to determine the significance and importance of variances of interest. In the first part of the regression models, the factors that influence recycling activities are identified. In the second part, the effects of different deposit incentives imposed on packaging are estimated.

### RESEARCH DATA

This study focuses on the macro aspects of recent recycling efforts, from 1989 to 2000. According to EPA (2002), recycling activity was not significant before the 1980s and a rapid increase in the infrastructure for recycling started in the late 1980s. In addition, BioCycle started the annual national survey to deal with solid waste management practices at the state level in 1989. Therefore, the given period of time was used for the study. The analysis was carried out at the state level which includes 50 states and the District of Columbia. Each state has a 12 yearly time periods for the independent variables. Therefore, total observations for a variable are 612 since the matrix of data for one variable is 12 by 51. For the analysis of the study, a statistical program called "Stata version 7" was used. There are some missing values in the variables. For the treatment of the missing values, cells are left empty in the data. Then Stata will automatically deal with the missing values (Hamilton, 2003).

The main data source for waste-related variables such as recycling rate, MSW generation and curbside programs was BioCycle reports titled "The State of Garbage in America." The annual report compiles waste stream estimates in the United States. The data for MSW per person is calculated using both MSW generation and population data since no direct data on personal waste generation by state is provided. For the curbside programs, the reported number of programs within the state was selected as the variable.

The BioCycle data are useful to this analysis in two ways: First, as the EPA (1995) pointed out, BioCycle's data covers more waste streams than EPA's annual update. Second, data are reported by state, including all states in the United States. In the report, the recycling rate includes all materials generated from the municipal solid waste stream. Finally, there are two reasons for using BioCycle's recycling rate for this study: First, little other recycling data at the state level is available. Second, the effect of various bottle deposit systems can be easily calculated in terms of how they affect the overall recycling activity.

To measure the population and metropolitan area population, data are used from the annual report of the U.S. Department of Commerce (2001) titled "Statistical Abstract of the United States." As a dummy variable, metropolitan area population is used as a measure of the extent of urbanization. According to the U.S. Department of Commerce, the average value of metropolitan and consolidated metropolitan area population is about 80 percent for the last decade in the United States. Because precise measures of urbanization of each state are not available, the average value of the metropolitan population is used as a proxy for urbanization. Therefore, if the percentage of the metropolitan area population in a state surpasses the national average, it is noted as 1, otherwise it is zero. Among the 50 states and the District of Columbia, 19 states are higher than the national average. In addition, data for personal income are from the U.S. Department of Commerce (2001) report titled "Survey of Current Business."

Several categorical variables are used to measure the differences between the deposit states and non-deposit states and between the five cent system and other deposit systems. The dummy variables describe a shift in the y-intercept or constant. In the regression for overall recycling trend, the dummy is named DEP. DEP equals 1 for deposit states and zero in non-deposit states.

In the comparison among three deposit systems, two systems are treated as dummy variables since one of these will be redundant. If all three dummies are included, Stata will automatically drop one because multicollinearity otherwise makes the calculation impossible (Hamilton, 2003). The dummies are named FIVE and REDEEM. FIVE equals 1 in the 5 cent system and zero in all other deposit systems and REDEEM equals 1 for the redemption system and zero otherwise.

All 5 cent deposit systems are not the same in terms of included containers and deposit amounts for liquor. Despite the difference, all 8 states are classified as 5 cent deposit states in most studies. One of the main reasons for this classification might be that separate data for each container type are not available. In the study, it is assumed that all 5 cent deposit states have the same bottle deposit system.

In California, a variety of deposit items were added after 1998 (Appendix A). Although the alteration may cause a structural change in the recycling activity, it cannot be included in the analysis because of the lack of data. Therefore, it is assumed that the alteration does not influence the regression analysis of the study.

Except for the categorical variables, the data summary for all variables used in the analysis is presented in Table 4.

Table 4. The Summary Statistics of Variables

| Variables | Mean[a] | Std. Dev. | Min | Max |
|---|---|---|---|---|
| RECYCLE[1] | 19.18 | 12.07 | 0 | 59 |
| MSWp[2] | 1.126 | 0.349 | 0.42 | 2.66 |
| POP[3] | 5131.78 | 5680.69 | 454 | 33872 |
| CURB[4] | 136.15 | 224.99 | 0 | 1500 |
| INCOME[5] | 22183.85 | 4938.26 | 11915 | 40870 |

Note: 1: percentage
2: tons per person
3: thousands
4: numbers
5: dollars
a: sample mean

## THE MODELING METHOD OF ESTIMATION

To estimate the set of equations proposed in the study, panel data are used. Data are formed by the pooling of observations for the 51 states, including the District of Columbia, over 12 time periods. Since panel data consist of both cross-section and time-series data, there are a variety of benefits for evaluation of the effects of economic programs. For instance, panel data allow us to control for each state's heterogeneity and to construct and test more complicated behavioral models than pure cross-section or pure time-series data (Hsiao, 1985; Solon, 1989). In addition, variables can be more accurately measured because data are usually collected on micro levels (Klevmarken, 1989).

To estimate the values of unknown parameters on the basis of observation, the statistical technique of regression analysis will be applied. In the analysis, it is expected that the data follow the statistical properties of ordinary least squares (OLS) estimates under the normality assumption. Before the regression results are accepted as decision criteria, a diagnostic approach will be conducted to validate the regression analysis. When any potential problems, which cause any reason to distrust the regression results, are found in the initial regression analysis, a specialized regression method will be provided to make the regression results valid.

## ESTIMATION FOR FACTORS AFFECTING RECYCLING

### Hypotheses

Using various socio-economic variables, previous studies have tried to identify the most important factors for recycling activity. Most of them have attempted to find relationships between waste generation and other variables which are assumed to influence MSW generation. These studies result in determination of a positive or a negative correlation between factors. In most studies, data were from a random survey of either households or officials who are working in the related area. Only a few studies have focused on the relationship between recycling rates and socio-economic variables.

In the study, an economic analysis is conducted to evaluate the correlation between recycling rate and a set of independent variables which were most often used in other studies. For this analysis, data were collected through a variety of economic and statistical reports. Data used in this study present people's reactions to the country's recycling efforts.

The expected causal relationship between recycling rate and a set of explanatory variables is hypothesized as follows. First, the generation of MSW per person has been considered as one of the most important factors for recycling activity in the country because recycling activity is related to personal behavior, especially in packaging bottle recycling. In this study, it is assumed that the recycling rate increases as personal waste generation goes up. Thus, it can be hypothesized that:

H1: The amount of MSW generation per person will have a positive correlation with the recycling rate.

There are generally four kinds of possible relationships between population and waste generation. First, waste generation increases as population goes up. This effect is common and can be seen in most areas. A related relationship is that waste generation decreases as population goes down. Third, as population increases, waste generation decreases. This indicates that some consumer behavior has changed that affects waste generation. This is a favorable situation since one of the main goals of waste-related policies is to modify consumer behavior. The last case is that as population decreases, waste generation increases. However, these relationships described above can differ when recycling is considered instead of waste generation. In this study, it is assumed that increased consumption by population growth has not increased recycling rates. Therefore, it is assumed that the recycling rate is not related to the population change although waste generation is positively related to population in general. Thus, the second hypothesis states that:

H2: There is no correlation between population and recycling rate.

Income is related to people's purchasing power. In a review of the interaction between income and demand for products, Varian (1993) explained that:

> "In general, when income goes up, the demand for a good could increase more or less rapidly than income increases."

In addition, according to economic theory, population growth will result in consumption of more products since the entire demand curve shifts, causing the equilibrium price and quantity to rise.

This explanation confirms that income can be positively associated with waste generation. Besides, higher-income people are on average more educated than lower-income people and so they can be expected to be more concerned about environmental issues. With these factors considered, it is expected that higher-income people are more likely to recycle than lower-income ones. Thus the third hypothesis states that:

H3: There will be a positive correlation between income and recycling rate.

The design and management of recycling programs is affected by the total number of residents. Although it cannot be said simply that more populous areas produce more waste than do less populated areas, an increase in density of the resident population will produce rather different recycling outcomes. To indicate the degree of urbanization of each state, population density is used as an independent variable. In this study, the focus is only on highly populated areas.

Urban areas generally rely on standard methods of MSW pickup and disposal. Even though people who live in populated areas know about the recycling programs in their community, they may be less sensitive about recycling because it is easy to neglect in such crowded areas. In addition, Jenkins (1991) explained that greater urbanization leads to a lot of packaging waste because small quantities were purchased frequently due to easy access to retail stores and little storage space. Thus, the fourth hypothesis states that:

> H4: Recycling activity will have a negative association with metropolitan areas where population density is generally higher.

As a waste policy, bottle bills target only packaging products, especially beverage bottles. As explained, this mandatory legislation has a very strong effect on the composition of the MSW stream. Including California, currently 10 states have bottle bills and others have different recycling programs. All bottle deposit systems, including the redemption system, are expected to have a positive impact although they have some different characteristics. Because bottle bills are mandatory legislation, they are expected to directly affect the recycling rate. Thus, the fifth hypothesis states that:

> H5: There will be a positive association between bottle deposit laws and the recycling rate.

In general, curbside programs are assumed to be less effective than bottle deposit laws since they are not based on a pecuniary motive and most of them are voluntarily operated in many communities. However, as a substitute for bottle deposit laws, curbside programs are found in most states throughout the country, even in bottle bill states. In addition, it is found that this recycling system has also influenced consumer behavior. Thus, the sixth hypothesis states that:

H6: There will be a positive correlation between the recycling rate and availability of curbside programs.

**Regression Model**

A simple regression model was constructed to determine the significance and importance of variables of interest for recycling activity. The testable regression model can be presented as follows:

$$RECYCLE = \alpha + \beta_1 MSW_p + \beta_2 POP + \beta_3 INCOME + \beta_4 METRO + \beta_5 DEP + \beta_6 CURB + e \quad (1)$$

where: $MSW_p$ = MSW generation per person (tons per year)

POP = population of each state (thousands)

INCOME = per capita income (dollar per year)

METRO = dummy variable for the metropolitan population areas

DEP = dummy variable for deposit states

CURB = the number of curbside programs

e = residual

The first independent variable tests the impact of each person's MSW generations. The second variable examines the effect of population differences. The third variable tests the impact of personal income. The fourth variable evaluates the effect of urbanization; it is 1 if a state has more than 80 percent urbanization on average and zero otherwise. The fifth variable examines the effect of implementing bottle deposit laws; it equals 1 if a state has bottle bill laws and zero otherwise. The last variable tests the impact of curbside programs.

## ESTIMATION FOR FACTORS AFFECTING RECYCLING RATE IN THE BOTTLE REFUND STATES

### Hypothesis

A variety of economic instruments, including variable fees and taxes, have been applied in waste-related policies. To achieve an efficient solution by allowing consumer discretion, various incentives have been introduced. The typical instruments are bottle deposit laws and curbside programs in the packaging sector. In terms of economic measures, the relationships between these two variables are defined in the previous part of the study. In this analysis, in contrast, bottle refund states will be the focus to measure the effect of different refund rates for recycling. Therefore, only data for the 10 bottle refund states will be used for the study.

As described before, currently three deposit rates are used in 10 states: 5 cents, 10 cents and redemption (2.5 cents). Due to the different refund rates, the effect of the refund systems for recycling can be different even though all bottle refund systems are mandatory. From an economic point of view, it is expected that a high deposit rate is more effective than a low rate because it can induce more consumers to follow the bottle legislation. Therefore, it is assumed that among the three refund systems, the 10 cent refund system is more effective than other refund systems.

To verify the impact, a regression analysis will be applied. In the model, the 5 cent system will be set as a target variable. Since currently many states adopt the 5 cent refund rate, it will be tested as a common method for recycling. Other refund systems are used for the control variable to explain the regression model. Thus, it can be hypothesized that:

H7: The correlation rate with the recycling rate in the 5 cent deposit system will be less than the recycling rate in the 10 cent refund system.

**Regression Model**

A multiple regression model will be introduced to test hypotheses concerning recycling variation in the 5 cent refund states. Most of the independent variables have been examined and established as important determinants of recycling activity in previous studies. Even though the 5 cent deposit rate is widely accepted as one of the primary deposit systems, the recycling effect of this level has not been extensively examined. By introducing dummy variables, the regression model is expressed as follows:

$$\text{RECYCLE} = \alpha + \beta_1 \text{MSW}_p + \beta_2 \text{CURB} + \beta_3 \text{FIVE} + \beta_4 \text{POP} + \beta_5 \text{INCOME} + \beta_6 \text{METRO} + \beta_7 \text{REDEEM} + e \qquad (2)$$

where $\text{MSW}_p$ = MSW generation per person (tons)

CURB = the number of curbside programs

FIVE = dummy variable for 5 cent refund states

POP = population (thousands)

INCOME = per capita income (dollar per year)

METRO = dummy variable for the metropolitan population areas

REDEEM = dummy variable for the redemption state

e = residual

The third variable is 1 if the states have the given deposit rate and zero otherwise. The null hypothesis ($\beta_3 = 0$) implies that the 5 cent deposit system is not significantly different from the 10 cent refund system. Other independent variables are used as control variables and they have the same conditions applied in the first regression (Equation 1). If some of the independent variables become invalid determinants, another regression method will be employed to provide a statistically significant regression analysis.

# CHAPTER 4: RESULTS

## INTRODUCTION

This chapter presents the results of the research. Each section discusses the empirical analyses that assess the variable characteristics. In each regression analysis, diagnostics will be conducted for model validation. This discussion is followed by a summary of the research findings.

## RESULTS OF ANALYSIS

### Estimation for Factors Affecting Recycling

A multiple regression model was used in order to test factors that are related to the recycling rate. Empirical results of the regression analysis are reported in Table 5. The proposed regression model explains about 50 percent of the variation in the recycling rate of 51 states. The variables POP and METRO have a negative relationship to the recycling rate while others are positive. In addition, the variables POP and INCOME have an extremely low effect on the dependent variable. Diagnostics will be conducted to verify the result in terms of statistical properties before this result is considered as the final regression model.

Table 6 is the matrix of correlations between variables. This matrix is used to check for the evidence of collinearity between the independent variables. In general, high correlations between pairs of variables indicate possible collinearity problems. The variables CURB and POP are the only pair in which correlation is over 50 percent.

Table 5. Test of the Factors of Recycling Rate

| Independent Variables | β Coef. | t | P> \| t \| |
|---|---|---|---|
| MSWp | 8.8152<br>(1.1518) | 7.65 | 0.000 |
| POP | -0.0002<br>(0.0001) | -2.49 | 0.013 |
| INCOME | 0.0010<br>(0.0001) | 11.45 | 0.000 |
| METRO | -2.9390<br>(0.9431) | -3.12 | 0.002 |
| DEP | 3.6400<br>(0.9298) | 3.91 | 0.000 |
| CURB | 0.0183<br>(0.0020) | 8.91 | 0.000 |
| CONSTANT | -14.6054<br>(1.9467) | -7.50 | 0.000 |
| $R^2$ | 0.50 | | |
| F | 93.87 | | |

Note: parentheses are standard errors
significant at $\alpha = 0.05$
Prob > F = 0.0000
obs. = 579

Table 6. Estimated Correlation Matrix of Variables

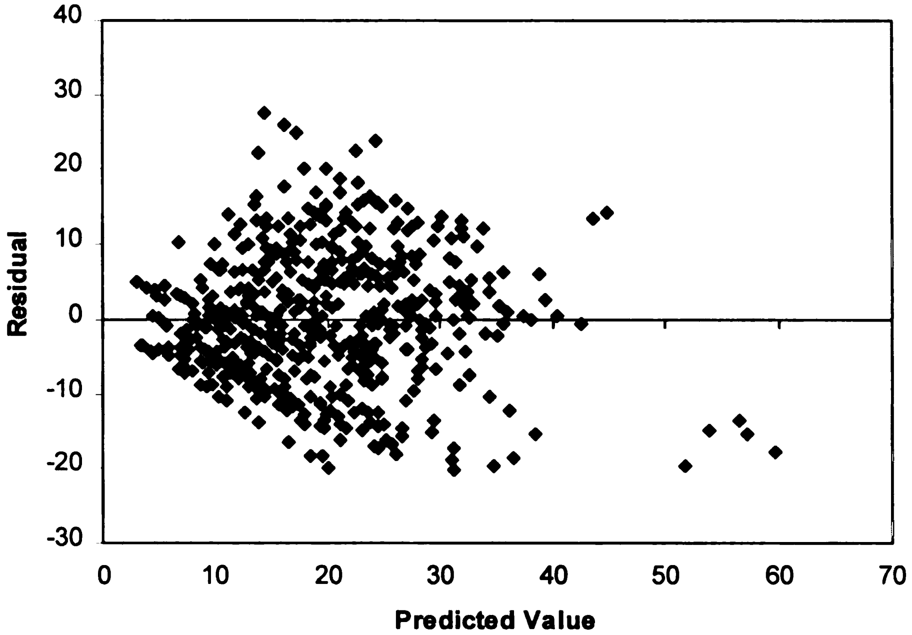
| | MSWp | POP | INCOME | METRO | DEP | CURB |
|---|---|---|---|---|---|---|
| MSWp | 1.0000 | | | | | |
| POP | 0.3367 | 1.0000 | | | | |
| INCOME | 0.2789 | 0.1950 | 1.0000 | | | |
| METRO | 0.2166 | 0.4934 | 0.4555 | 1.0000 | | |
| DEP | 0.1326 | 0.2191 | 0.2234 | 0.2239 | 1.0000 | |
| CURB | 0.1292 | 0.5382 | 0.3957 | 0.2913 | 0.2052 | 1.0000 |

High correlation of over 40 percent is presented in the pair of variables METRO and POP and the pair of variables METRO and INCOME.

The correlations imply that the variable POP or METRO might not be a suitable parameter for the regression model. Because in most cases the independent variables are correlated with each other, removing a particular variable from the model will alter the estimated regression coefficients of the remaining variables. Therefore, a stepwise regression, which has been widely used for providing ways to automate the process of model selection, is applied to choose any variable to eliminate. The result of the stepwise regression indicates that no variable should be dropped from the model (Appendix B), thus it is decided that all proposed independent variables will be used for the analysis.

In using cross-sectional data, homoscedasticity or equal variance is one of the most important assumptions since it implies that all independent variables are equally important. To detect heteroscedasticity or unequal variance, the estimated residuals are plotted against the estimated recycling rate from the regression line (Figure 4). The scattergram shows that the variance of the error term has a systematic pattern. In particular, the estimated recycling rate has a linear association on the lower part of the graph, suggesting a symptom of unequal variance in the data.

**Figure 4. Residual vs. Predicted Value for Overall States**



Due to the systematic pattern between the variables, the Breusch-Pagan test was also used to confirm whether the presence of the unequal variance was significant (Table 7). The observed chi-square value of 20.85 is significant at the 5% level of significance because it exceeds the critical chi-square value of 3.84 from the chi-square table. Because this result confirms that there is unequal variance in the regression, the data should be transformed in such a manner that in the regression the variance of the residual is equally spread.

Table 7. Breusch-Pagan Test for Overall Recycling Rate

| | | | |
|---|---|---|---|
| $H_0$: Constant variance | | | |
| | Chi2(1) | = | 20.85 |
| | Prob > chi2 | = | 0.0000 |

The method of generalized least squares (GLS) is applied in the transforming method. GLS is a special case of OLS on the transformed variables that satisfy the general assumptions of the classical model. The difference between GLS and OLS is that equal weight or importance to each observation is assigned in GLS by making the error term a constant (Gujarati, 1995). To use GLS, the method of theoretical change will be introduced from OLS to GLS.

In general, the two-variable model is described as follows:

$$Y_i = \alpha X_{0i} + \beta X_{1i} + e_i \qquad (3)$$

where $Y_i$ is the dependent variable, $X_{0i}$ is the explanatory variable for each i, $\alpha$ is the intercept, $\beta$ is the slope coefficient and $e_i$ is the error term. When the original variables are divided by the variance, Equation 3 can be written as

$$Y_i^* = \alpha^* X_{0i}^* + \beta^* X_{1i}^* + e_i^* \qquad (4)$$

where transformed variables are marked by asterisks. Equation 4 indicates that the variance of the error term is homoscedastic or equal variance. Therefore, the estimated $\beta^*$ is now the unbiased estimator, providing true values.

Because the data used in the study combine all cross-section and time-series units, finally the two-variable model would be:

$$Y_{it} = \alpha + \beta X_{it} + e_{it} \qquad \text{for } i = 1, 2, 3, \cdots\cdots, N \quad t = 1, 2, 3, \cdots\cdots, T \qquad (5)$$

where N is the number of cross-section units and T is the number of time periods. With one large pooled data set, the regression is run with NT observations.

The GLS result is presented in Table 8. All values are somewhat changed, compared to the OLS result in Table 5. The p value of the variable METRO is significant at the 0.021 percent level while others are significant at the 0.0001 percent level. The result indicates that the values of the t-statistic lie in the critical region, thus the test statistic is statistically significant.

The first independent variable MSWp tests the effect of the MSW generation per person on recycling rate. The hypothesis, that a positive association exists between the two variables, can be accepted. The estimated parameter of 8.77 indicates that this variable significantly affects the recycling rate among the other independent variables.

Table 8. The Result of GLS Regression for Overall Recycling Rate

| Independent Variables | β Coef. | z | P> \| z \| |
|---|---|---|---|
| MSWp | 8.7745 (1.1725) | 7.48 | 0.000 |
| POP | -0.0003 (0.0001) | -3.53 | 0.000 |
| INCOME | 0.0010 (0.0001) | 10.91 | 0.000 |
| METRO | -2.0891 (0.9025) | -2.31 | 0.021 |
| DEP | 3.8304 (0.8884) | 4.31 | 0.000 |
| CURB | 0.0207 (0.0021) | 9.78 | 0.000 |
| CONSTANT | -14.4344 (1.8764) | -7.69 | 0.000 |

Note: parentheses are standard errors
significant at $\alpha = 0.05$
z is a transformed t value
P> | z | is a p value for z
obs. = 579

The coefficient value 8.77 implies that by holding other variables constant the recycling rate on average increased by 8.77 percent for every one percent point increase in the MSW generation of each person over the period 1989-2000.

The second independent variable POP tests the effect of the population change. The hypothesis presuming no relationship between population and recycling rate can be accepted. The association of the two variables suggests that population growth will have no effect for recycling over the country but its impact will not be practical significance.

The third independent variable INCOME tests the effects of per capital income on recycling rate. The hypothesis stating a positive association between the two variables can be accepted. However, a 1 percent increase in income causes the recycling rate to increase on average by only 0.001 percent. This result indicates that income is not a significant variable for recycling.

As a dummy variable, the fourth independent variable METRO tests the effect of population density on overall recycling rate. The hypothesis proposing a negative effect can be accepted. This result shows that recycling is less effective in highly urbanized areas.

The fifth and sixth variables DEP and CURB test the effect of different recycling systems. The hypotheses of positive recycling rate can be accepted for both variables. The coefficient of bottle deposit laws is 3.34 and the curbside collection is 0.02. This result suggests that the bottle deposit system is more significant than curbside programs for recycling.

**Estimation for Factors Affecting Recycling Rate in the Bottle Refund States**

To compare the difference among the three deposit systems, a multiple regression was conducted (Table 9). The regression result shows that the proposed model explains about 61 percent of the variation in the recycling rate. Most variables have a positive association with the recycling rate except for the variables POP and METRO. The variables CURB, POP and REDEEM have relatively higher p values. In addition, the correlation between the independent variables shows that the variables POP and REDEEM are associated over 50 percent with some other variables (Appendix).

The results indicate that it should be decided whether any variable is not necessary for the regression model. The stepwise regression, therefore, is applied to detect unnecessary variables in the model (Table 10). The result reveals that the independent variable POP should be removed from the model. The stepwise regression shows that the p value of the target variable FIVE is reduced to become statistically more significant. However, the variables CURB and REDEEM still have somewhat higher p values. These values are control variables, thus they will be kept in the model unless regression diagnostics show they are not necessary.

Except for the variable METRO, the signs of the independent variables are positive. The variable MSWp is the major factor with the parameter coefficient of 18.3 while the variables CURB and INCOME have extremely small effects on the dependent variable. This trend is the same as shown in the first regression for overall recycling rate.

Table 9. The Result of Regression for the Deposit States

| Independent Variables | β Coef. | t | P> \| t \| |
|---|---|---|---|
| MSWp | 18.3131<br>(2.3158) | 7.91 | 0.000 |
| CURB | 0.0033<br>(0.0033) | 0.99 | 0.324 |
| FIVE | 6.4261<br>(2.6139) | 2.46 | 0.016 |
| POP | -0.0000<br>(0.0002) | -0.13 | 0.894 |
| INCOME | 0.0011<br>(0.0002) | 6.36 | 0.000 |
| METRO | -13.8337<br>(2.1680) | -6.38 | 0.000 |
| REDEEM | 2.5002<br>(5.2269) | 0.48 | 0.633 |
| CONSTANT | -21.3088<br>(4.5363) | -4.70 | 0.000 |
| $R^2$ | | 0.61 | |
| F | | 24.94 | |

Note: parentheses are standard errors
significant at $\alpha = 0.05$
Prob > F = 0.0000
obs. = 119

Table 10. The Result of Stepwise Regression for the Deposit States

| Independent Variables | β Coef. | t | P> \| t \| |
|---|---|---|---|
| MSWp | 18.2993 (2.3033) | 7.94 | 0.000 |
| CURB | 0.0030 (0.0023) | 1.27 | 0.207 |
| FIVE | 6.5071 (2.5318) | 2.57 | 0.011 |
| INCOME | 0.0011 (0.0002) | 6.59 | 0.000 |
| METRO | -13.9782 (1.8724) | -7.47 | 0.000 |
| REDEEM | 1.9236 (2.9517) | 0.65 | 0.516 |
| CONSTANT | -21.4957 (4.2975) | -5.00 | 0.000 |
| $R^2$ | | 0.61 | |
| F | | 29.35 | |

Note: parentheses are standard errors
significant at $\alpha = 0.05$
Prob > F = 0.0000
obs. = 119

Before the stepwise regression is accepted as a final model, diagnostics are done for the stepwise regression to verify the statistical validity. First, the variance inflation factor (VIF) for each of the independent variables is calculated (Table 11). According to the "rule of thumb" given by Chatterjee and Price (1991), there is no strong evidence of multicollinearity since VIF values are smaller than 10 and the mean VIF is not considerably larger than 1.

To detect unequal variance, the estimated residuals are drawn against the estimated dependent variable in Figure 5. The graph shows that the pattern of the residuals is random. No systematic pattern between the two variables suggests that unequal variance is not present in the data. In addition, the Breusch-Pagan Test (Table12) confirms that the observed chi-square value of 2.49 does not exceed the critical value of 3.84 at the 5 percent level. The tests indicate that there is no evidence of significant unequal variance.

Table 11. VIF Test for Bottle Refund Regression

| Variable | VIF | 1/VIF |
|---|---|---|
| FIVE | 2.44 | 0.4094 |
| METRO | 2.00 | 0.5007 |
| REDEEM | 1.87 | 0.5348 |
| INCOME | 1.84 | 0.5436 |
| MSWp | 1.58 | 0.6334 |
| CURB | 1.24 | 0.8034 |
| Mean VIF | 1.83 | |

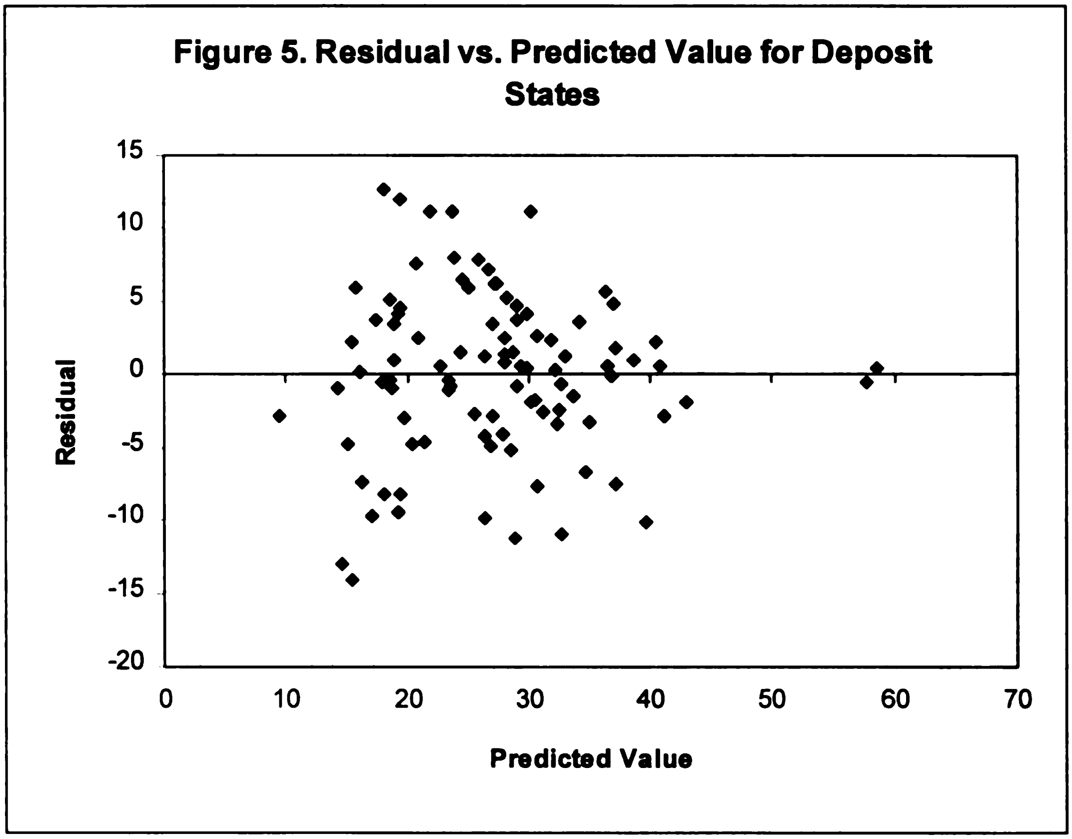


Figure 5. Residual vs. Predicted Value for Deposit States
15
10
5
0
-5
-10
-15
-20
Residual
0
10
20
30
40
50
60
70
Predicted Value

Table 12. Breusch-Pagan Test for Bottle Refund System

| $H_o$: Constant variance | | |
|---|---|---|
| Chi2(1) | = | 2.49 |
| Prob > chi2 | = | 0.1148 |

In the comparison of the three deposit systems, the 10 cent refund rate is treated as zero. The coefficient of the variable FIVE is 6.5 and it is1.9 for the variable REDEEM. Since dummy variables are used to account for qualitative factors, this result says that there is a very high correlation between the 5 cent refund system and recycling activity which is about 6 times more association than with the 10 cent deposit system. The next correlation is found in redemption which shows about 2 times more association than the 10 cent system. Thus, the hypothesis of more effectiveness of the 10 cent refund system cannot be verified. This is presumably because the proposed independent variables may be insufficient to prove the effectiveness of the 10 cent deposit system.

## SUMMARY OF THE RESEARCH RESULTS

The results of various analysis presented in this chapter generally supported most research hypotheses, in spite of minor exceptions. Among the independent variables, it was confirmed that the variable MSWp was the primary factor for recycling while the variable METRO affected most negatively. Although expected hypotheses were mostly confirmed in the variables POP and INCOME, the values of these parameter estimates were turned out to be insignificant. In particular, the variable POP was deleted in the regression model for deposit states. Only the assumption of difference between the bottle deposit systems was not confirmed by the regression model. Table 13 shows the major research hypotheses and results.

Table 13. Summary of the Research Results

| Subject | Hypothesis | Result |
|---|---|---|
| MSW Generation Per Person | Positive | Confirmed |
| Population | No Effect | Mostly Confirmed |
| Income | Positive | Mostly Confirmed |
| Urbanization | Negative | Confirmed |
| Bottle Deposit Laws | Positive | Confirmed |
| Curbside Programs | Positive | Confirmed |
| 5 Cent System | Less Correlation | Not Confirmed |

# CHAPTER 5: CONCLUSION

## INTRODUCTION

This chapter presents the contribution of the research. First, implications of the study's findings are discussed. The discussions and limitations of the study will be presented and the recommendations for future research will then be discussed.

## CONCLUSIONS

Recycling has been developed as a major technology for taking care of the nation's waste. Every state of the United States has maintained various recycling programs to deal with the MSW generation. For instance, anti-littering and recycling laws, beverage industry recycling programs, Keep America Beautiful systems and other recycling programs are used in the 41 non-deposit states (FDL, 1989). In this study, the recycling rate was explained by several socio-economic factors. As major recycling programs, curbside collections and bottle refund laws were compared.

Multiple regression analysis identified a significant association between the recycling rate and the MSW generation per person. The relationship indicates that the waste generation of an individual is the major factor for recycling. In particular, the coefficient of the variable MSWp is much larger in the regression for bottle refund states than in the regression for the overall states. From the finding, it can be assumed that people living with a bottle refund system participate in recycle activities more than those who live with other recycling systems.

In determining the recycling rate, demographic variables such as population and metropolitan area population were negatively associated with recycling efforts. In particular, the negative correlation between the recycling rate and urbanization was higher in the 10 bottle refund states. As previous studies have shown, the finding suggests that an increase in population or the total number of residents may cause more waste but it cannot guarantee the participation of people in recycling programs. Therefore, it is concluded that recycling effectiveness may not be increased by these demographic variables.

As an economic variable, the effect of income turned out to be extremely small in both regression models. The finding indicates that people of high income tend to recycle somewhat more than those with less income, but there is no practical significance. The result concerning income is consistent with some of the previous studies in the literature.

Recycling in the packaging sector has become a major component of MSW management plans because packaging is directly implicated in two outcomes: litter and solid waste. Due to this nature, packaging materials are frequently criticized as being a main source of solid waste. In addition, many products are designed to be easily thrown way for convenience of customers in these days. To minimize the environmental impact of packaging and reduce waste generation, reducing MSW often means reducing packaging materials. From this perspective, mandatory deposit legislation (or beverage container deposit laws) has been adopted in nine states and California has used a redemption system.

In the comparison of different deposit rates, it was confirmed that the three bottle refunds have different effects on recycling. To distinguish the possible difference between the three refund systems, they were separated by two categories, such as 5 cent and redemption system. The coefficient of the 5 cent system is significantly higher than other refund systems. The finding shows that the 5 cent refund system is a more effective method for recycling because of the higher correlation with recycling rate, compared to other deposit systems.

An interesting result, however, is the finding that redemption is the second most effective method although it is the lowest refund rate at 2.5 cent, staying in between the 10 cent and 5 cent refund systems. Recall that California covers more items for deposit than any other state. Thus, one of the possible reasons for the finding is that redemption covers a wider range of containers. However, more descriptive variables that could offer an explanation are needed to verify this finding.

The examination of recycling methods revealed that bottle deposit laws are one of the significant determinants for recycling. In addition, as mentioned, containers collected through deposit systems have high quality, yielding the highest market value, compared to other recycling systems. Therefore, the relative effectiveness of deposit systems will also increase recycling rates for the covered containers. On the contrary, curbside systems prove to be less significant as correlates of recycling efforts. This finding suggests that current bottle deposit systems contribute significantly to recycling activities more than any other recycling methods.

As a result, several factors should be noted: First, an individual's behavior is the primary variable in determining recycling success. Second, bottle refund systems positively affect the individual's recycling activity which can lead people to recycle in the long run. Three, a wider range of deposit items can lead people to recycle more than an increased monetary valuation on the deposit containers. Four, beverage container deposit laws imposed on the packaging sector turned out to be significantly effective for recycling. Last, as a leading recycling method in the country, the bottle deposit system is more effective than curbside programs.

This study examined the recycling activities in the country focused on the bottle collection methods. The result provides how the recycling rate is affected by various variables and what the difference is between the two bottle deposit methods, mandatory bottle deposit systems and curbside programs. The results can be used for setting a bottle recycling method and they are also used as basic information for waste management approaches.

## DISCUSSIONS AND LIMITATIONS OF THE STUDY

According to BEAR (2002), the redemption rate of recyclable containers in 1998 was 94 percent in Michigan (in 1999), 80 percent on average in 5 cent states and 69 percent in California. This report supports the assumption proposed by the study, which the 10 cent system is highly associated with recycling rate compared to the 5 cent system. However, the difference between the 5 cent and 10 cent system was not confirmed by the proposed regression model. Instead, this study found the opposite result as the 5 cent had a higher correlation with recycling rate.

This result can be explained as follows: First, the different state numbers in bottle deposit systems cause an unexpected influence to the model. As described, only Michigan has the 10 cent rate and California has the redemption system, while the other 8 states have 5 cent systems. If the shortcoming is resolved, the result can be more acceptable with common knowledge. Second, people in Michigan recycle more of the recyclable bottles but they recycle the total materials at a lower rate than is expected for a deposit state. Therefore, the finding is that additional factors have to be considered in the recycling study. Some factors influencing the lower overall recycling rate might be relatively low landfill costs, lack of government support for recycling programs, a higher reliance on voluntary rather than mandatory curbside programs, and less education and publicity about recycling.

In an empirical study, the analysis is directly subject to the limitations of the data. In particular, the accuracy and precision of data are the most important sources to measure parameter estimation. Therefore, a number of sources can enter into the regression model with uncertainty and error. In the study, one source of a possible error is an inaccuracy in the data for curbside programs and recycling rate. There are some inconsistent measures, and some data are under-reported.

The next possible source of error is that the included variables may be inadequate. For instance, the finding that curbside programs were not as significant as deposit does not necessarily mean that the variable is not a contributor to overall recycling activity. This error can be minimized if the proper measure is used the model because it precisely reflects the contribution of a variable.

A better predictive model would require adding other variables that are significant contributors to recycling. As data for recycling becomes available in future years, the model can be re-examined to reflect the recent recycling activities.

## RECOMMENDATIONS FOR FUTURE STUDY

As an empirical study, this research is an initial attempt to examine some of the causal factors that determine recycling efforts. It focused on several relevant parameters that impact waste generation and collection. Future research can continue evaluations of the recycling-based paradigm and develop the recycling model.

To deal with variability in recycling activities, follow-up research is recommended in these areas:

1. Conduct supplemental analysis for the three deposit systems to assess the recycling effect of these systems to verify which system is most effective.
2. Examine the effect of mandatory deposit systems by comparison between deposit states and non-deposit states.
3. Separate recycling rates by container type to include aluminum, glass, PET, HDPE and other.
4. Assess factors which affect costs and revenue in operating recycling programs.
5. Develop models for assessing the effect of energy savings and litter reduction as substantial benefits from implementation of various recycling systems.
6. Expand the recycling models to include drop-off systems, non-residential programs and buy-back centers.

# APPENDICES

## APPENDIX A

Table A-1 Summary of Deposit Containers

| State | Containers | Deposit Rate |
|---|---|---|
| California | soft drinks, beer, carbonated water, non-carbonated water and soda*, wine and distilled spirit coolers*, fruit drinks*, coffee and tea drinks* | 2.5 cents $< 24$ oz<br>5.0 cents $\geq 24$ oz |
| Connecticut | soft drinks, beer, malt, mineral water | 5.0 cents |
| Delaware | soft drinks, beer, ale, malt, mineral and soda water, Aluminum cans exempt from deposit. | 5.0 cents |
| Iowa | soft drinks, beer, soda and mineral water, wine, liquor, wine coolers | 5.0 cents |
| Maine | soft drinks, beer, water, mineral water, wine, liquor, non-alcoholic carbonated and non-carbonated drinks | 5.0 cents<br>15 cents wine and liquor |
| Massachusetts | soft drinks, beer, carbonated water | 5.0 cents |
| Michigan | soft drinks, beer, carbonated water, mineral water, wine coolers, canned cocktails | 10 cents |
| New York | soft drinks, beer, malt, mineral water, soda wine, wine coolers | 5.0 cents |
| Oregon | soft drinks, beer, malt, mineral and soda water | 5.0 cents |
| Vermont | soft drinks, beer, malt, soda water, mixed wine drinks, liquor | 5.0 cents<br>15 cents liquor |

Note: * added after 1998
Source: BEAR, 2002

## APPENDIX B

Table B-1 Result of Stepwise Regression for Overall Recycling

| Independent Variables | β Coef. | t | P> \| t \| |
|---|---|---|---|
| MSWp | 8.8152<br>(1.1517) | 7.65 | 0.000 |
| POP | -0.0002<br>(0.0001) | -2.49 | 0.013 |
| INCOME | 0.0010<br>(0.0001) | 11.45 | 0.000 |
| METRO | -2.9390<br>(0.9431) | -3.12 | 0.002 |
| DEP | 3.6400<br>(0.9298) | 3.91 | 0.000 |
| CURB | 0.0183<br>(0.0020) | 8.91 | 0.000 |
| CONSTANT | -14.6054<br>(1.9467) | -7.50 | 0.000 |
| $R^2$ | 0.50 | | |
| F | 93.87 | | |

Note: parentheses are standard errors
significant at $\alpha = 0.05$
Prob > F = 0.0000
obs = 579

Table B-2 Estimated Correlation Matrix of Variables for Deposit Systems

| | MSWp | CURB | FIVE | POP | INCOME | METRO | REDEEM |
|---|---|---|---|---|---|---|---|
| MSWp | 1.0000 | | | | | | |
| CURB | 0.2944 | 1.0000 | | | | | |
| FIVE | -0.4441 | -0.1245 | 1.0000 | | | | |
| POP | 0.4610 | 0.5203 | -0.6893 | 1.0000 | | | |
| INCOME | 0.3354 | 0.3512 | 0.0525 | 0.1679 | 1.0000 | | |
| METRO | 0.4914 | 0.1969 | -0.4133 | 0.4962 | 0.5289 | 1.0000 | |
| REDEEM | 0.3207 | 0.2244 | -0.6663 | 0.8480 | 0.0180 | 0.2754 | 1.0000 |

# APPENDIX C

Table C-1 Data for the Variable MSWp

| STATE | MSW GENERATION per person (tons) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Alabama | 1.09 | 1.09 | 1.10 | 1.26 | 1.25 | 1.25 | 1.26 | 1.27 | 1.28 | 1.29 | 1.31 | 1.01 |
| Alaska | 0.82 | 0.93 | 0.88 | 0.85 | 0.84 | 0.83 | 0.83 | 0.83 | 0.92 | 1.10 | 1.09 | 1.09 |
| Arizona | 0.86 | 0.85 | 0.77 | 1.07 | 0.90 | 1.01 | 1.04 | 1.10 | 1.25 | 1.10 | 1.09 | 1.12 |
| Arkansas | 0.77 | 0.85 | 0.84 | 0.90 | 0.89 | 0.88 | 0.87 | 0.93 | 1.70 | 1.31 | 1.59 | 0.77 |
| California | 1.51 | 1.68 | 1.48 | 1.44 | 1.43 | 1.44 | 1.40 | 1.39 | 1.40 | 1.71 | 1.81 | 1.95 |
| Colorado | 0.61 | 0.61 | 0.71 | 1.01 | 1.24 | 0.77 | 0.80 | 0.74 | 0.79 | 1.28 | 1.59 | 1.52 |
| Connecticut | 0.88 | 0.88 | 0.88 | 0.89 | 0.70 | 0.89 | 0.93 | 0.90 | 0.90 | 0.93 | 0.97 | 0.95 |
| Delaware | 0.91 | 1.31 | 1.10 | 1.14 | 1.50 | 1.55 | 1.67 | 1.36 | 1.62 | 1.11 | 2.66 | 2.63 |
| Dist. of Columbia | 1.19 | 1.24 | 1.37 | 1.57 | 1.59 | 1.59 | 0.46 | 0.44 | 0.46 | 0.48 | 0.42 | 0.87 |
| Florida | 1.27 | 1.41 | 1.41 | 1.44 | 1.41 | 1.69 | 1.71 | 1.69 | 1.61 | 1.59 | 1.65 | 1.55 |
| Georgia | 0.69 | 0.68 | 0.66 | 0.89 | 1.15 | 1.21 | 1.18 | 1.35 | 1.96 | 1.41 | 1.47 | 1.25 |
| Hawaii | 0.91 | 1.08 | 1.15 | 1.13 | 1.72 | 1.70 | 1.69 | 1.79 | 1.78 | 1.63 | 1.59 | 1.55 |
| Idaho | 0.75 | 0.84 | 0.82 | 0.80 | 0.81 | 0.78 | 0.76 | 0.75 | 0.73 | 0.80 | 0.63 | 0.84 |
| Illinois | 1.31 | 1.15 | 1.27 | 1.22 | 1.26 | 1.27 | 1.20 | 1.12 | 1.12 | 1.10 | 1.11 | 1.22 |
| Indiana | 0.81 | 0.99 | 1.02 | 1.49 | 0.77 | 0.98 | 1.00 | 1.00 | 1.22 | 1.00 | 1.14 | 2.23 |
| Iowa | 0.83 | 0.83 | 0.82 | 0.74 | 0.81 | 0.97 | 1.11 | 1.14 | 1.21 | 0.88 | 1.22 | 0.98 |
| Kansas | 0.65 | 0.65 | 0.96 | 0.95 | 1.08 | 1.37 | 1.36 | 1.64 | 1.63 | 0.91 | 1.13 | 1.12 |
| Kentucky | 1.25 | 1.25 | 0.94 | 1.24 | 0.85 | 0.98 | 0.95 | 0.92 | 1.13 | 1.61 | 1.03 | 1.08 |
| Louisiana | 0.82 | 0.83 | 0.83 | 0.82 | 0.81 | 0.77 | 1.13 | 1.08 | 0.89 | 0.94 | 1.10 | 0.75 |
| Maine | 0.74 | 0.75 | 0.77 | 1.01 | 1.01 | 1.05 | 1.05 | 1.04 | 1.08 | 1.31 | 1.30 | 1.33 |
| Maryland | 1.52 | 1.51 | 1.05 | 1.02 | 1.01 | 1.04 | 1.05 | 1.01 | 1.05 | 1.11 | 1.16 | 1.18 |
| Massachusetts | 1.10 | 1.66 | 1.13 | 1.10 | 1.12 | 1.12 | 1.16 | 1.18 | 1.17 | 1.20 | 1.32 | 1.28 |
| Michigan | 1.26 | 1.26 | 1.25 | 1.37 | 1.42 | 1.43 | 1.40 | 1.39 | 1.38 | 1.99 | 1.98 | 1.88 |

Table C-1 Data for the Variable MSWp, Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minnesota | 0.92 | 0.96 | 0.99 | 0.95 | 0.97 | 1.01 | 1.04 | 0.99 | 1.02 | 1.06 | 1.14 | 1.15 |
| Mississippi | 0.70 | 0.70 | 0.54 | 0.54 | 0.68 | 0.83 | 0.89 | 0.89 | 0.86 | 1.12 | 0.82 | 1.55 |
| Missouri | 1.00 | 1.17 | 1.45 | 1.44 | 1.43 | 1.06 | 1.41 | 1.43 | 1.46 | 1.46 | 1.75 | 1.84 |
| Montana | 0.75 | 0.75 | 0.74 | 0.91 | 0.89 | 0.92 | 0.85 | 1.03 | 1.18 | 1.14 | 1.23 | 0.84 |
| Nebraska | 0.70 | 0.70 | 0.82 | 0.87 | 0.81 | 1.02 | 1.04 | 1.21 | 1.21 | 1.20 | 1.09 | 1.08 |
| Nevada | 0.88 | 0.83 | 0.78 | 1.73 | 1.66 | 1.66 | 1.68 | 2.04 | 2.36 | 1.60 | 1.74 | 1.68 |
| New Hampshire | 0.90 | 0.90 | 0.99 | 1.02 | 0.99 | 0.91 | 0.92 | 1.07 | 1.02 | 0.74 | 1.07 | 0.86 |
| New Jersey | 1.23 | 1.81 | 0.91 | 0.96 | 0.93 | 0.93 | 1.07 | 1.16 | 1.02 | 0.96 | 0.96 | 1.09 |
| New Mexico | 0.66 | 0.79 | 0.97 | 0.94 | 0.95 | 1.14 | 1.17 | 0.82 | 0.81 | 1.52 | 1.70 | 1.88 |
| New York | 1.11 | 1.22 | 1.22 | 1.26 | 1.39 | 1.40 | 1.41 | 1.48 | 1.59 | 1.66 | 1.63 | 1.64 |
| North Carolina | 0.91 | 0.90 | 0.89 | 1.14 | 0.99 | 1.10 | 1.39 | 1.36 | 1.32 | 1.67 | 1.70 | 1.68 |
| North Dakota | 0.70 | 0.70 | 0.63 | 0.73 | 0.78 | 0.78 | 0.78 | 0.78 | 0.80 | 0.79 | 0.79 | 0.89 |
| Ohio | 1.28 | 1.29 | 1.44 | 1.49 | 1.58 | 2.03 | 2.18 | 1.02 | 1.10 | 1.10 | 1.07 | 1.26 |
| Oklahoma | 0.86 | 1.14 | 0.95 | 0.94 | 0.90 | 0.77 | 0.76 | 0.76 | 0.75 | 1.06 | 1.06 | 1.10 |
| Oregon | 0.84 | 0.77 | 1.13 | 1.13 | 1.02 | 1.05 | 1.09 | 1.13 | 1.18 | 1.25 | 1.33 | 1.33 |
| Pennsylvania | 0.78 | 0.77 | 0.80 | 0.75 | 0.79 | 0.79 | 0.75 | 0.80 | 0.79 | 0.77 | 0.82 | 0.95 |
| Rhode Island | 1.00 | 1.00 | 1.20 | 1.20 | 1.20 | 1.07 | 1.11 | 0.49 | 0.48 | 0.43 | 0.42 | 1.49 |
| South Carolina | 1.13 | 0.72 | 1.12 | 1.39 | 1.57 | 1.39 | 1.88 | 2.11 | 2.21 | 2.61 | 2.42 | 1.12 |
| South Dakota | 1.08 | 0.72 | 1.13 | 1.12 | 1.16 | 1.15 | 1.14 | 1.14 | 0.69 | 0.69 | 0.70 | 0.68 |
| Tennessee | 0.80 | 1.11 | 1.01 | 1.16 | 1.08 | 1.16 | 1.15 | 1.72 | 1.77 | 1.75 | 1.68 | 0.91 |
| Texas | 1.06 | 1.06 | 1.04 | 0.82 | 1.36 | 1.36 | 1.18 | 1.15 | 1.12 | 1.71 | 1.70 | 2.15 |
| Utah | 0.64 | 0.64 | 0.68 | 0.82 | 1.04 | 1.03 | 1.47 | 1.48 | 1.82 | 1.66 | 1.11 | 1.09 |
| Vermont | 0.59 | 0.62 | 0.69 | 0.96 | 1.22 | 1.21 | 1.03 | 1.02 | 1.02 | 0.93 | 0.62 | 0.95 |
| Virginia | 1.47 | 1.45 | 1.43 | 1.19 | 1.18 | 1.22 | 1.31 | 1.30 | 1.34 | 1.47 | 1.18 | 1.51 |
| Washington | 1.10 | 1.15 | 1.02 | 1.11 | 1.16 | 1.22 | 1.30 | 1.20 | 1.16 | 1.15 | 1.15 | 1.20 |
| West Virginia | 1.38 | 0.95 | 0.95 | 0.94 | 0.94 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 0.72 | 0.83 |
| Wisconsin | 0.74 | 1.43 | 0.69 | 0.67 | 0.99 | 1.07 | 1.06 | 1.05 | 0.70 | 1.07 | 0.76 | 0.69 |
| Wyoming | 1.20 | 0.66 | 0.70 | 0.69 | 0.68 | 1.06 | 1.11 | 1.10 | 1.10 | 1.10 | 1.10 | 1.15 |

Note: Values made from the division of the data of MSW and POP

Table C-2 Data for MSW Generation

| STATE | MSW GENERATION (1000 tons) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Alabama | 4400 | 4400 | 4500 | 5200 | 5230 | 5310 | 5392 | 5471 | 5549 | 5630 | 5710 | 4500 |
| Alaska | 450 | 511 | 500 | 500 | 500 | 500 | 500 | 500 | 560 | 675 | 675 | 686 |
| Arizona | 3100 | 3100 | 2900 | 4147 | 3600 | 4200 | 4500 | 4886 | 5700 | 5142 | 5187 | 5750 |
| Arkansas | 1800 | 2000 | 2000 | 2154 | 2154 | 2154 | 2154 | 2154 | 4287 | 3316 | 4063 | 2056 |
| California | 44000 | 50000 | 45000 | 44535 | 44513 | 45000 | 44000 | 44000 | 45000 | 56000 | 60000 | 66100 |
| Colorado | 2000 | 2000 | 2400 | 3500 | 4400 | 2800 | 3000 | 2811 | 3084 | 5085 | 6455 | 6535 |
| Connecticut | 2900 | 2900 | 2900 | 2900 | 2301 | 2905 | 3041 | 2951 | 2950 | 3047 | 3168 | 3234 |
| Delaware | 600 | 875 | 750 | 790 | 1050 | 1100 | 1200 | 987 | 1189 | 825 | 2000 | 2065 |
| Dist. of Columbia | 740 | 755 | 815 | 919 | 919 | 900 | 256 | 237 | 246 | 250 | 220 | 500 |
| Florida | 16000 | 18300 | 18700 | 19400 | 19400 | 23561 | 24312 | 24312 | 23617 | 23770 | 24858 | 24800 |
| Georgia | 4400 | 4400 | 4400 | 6000 | 7900 | 8500 | 8500 | 9872 | 14645 | 10745 | 11420 | 10236 |
| Hawaii | 1000 | 1200 | 1300 | 1300 | 2000 | 2000 | 2000 | 2130 | 2125 | 1950 | 1884 | 1884 |
| Idaho | 750 | 850 | 850 | 850 | 886 | 886 | 886 | 886 | 886 | 987 | 794 | 1086 |
| Illinois | 15000 | 13100 | 14600 | 14140 | 14716 | 15000 | 14219 | 13400 | 13386 | 13300 | 13515 | 15102 |
| Indiana | 4500 | 5500 | 5700 | 8400 | 4400 | 5600 | 5800 | 5800 | 7171 | 5876 | 6798 | 13571 |
| Iowa | 2300 | 2300 | 2300 | 2088 | 2280 | 2744 | 3163 | 3237 | 3462 | 2518 | 3500 | 2866 |
| Kansas | 1600 | 1600 | 2400 | 2400 | 2747 | 3500 | 3500 | 4250 | 4250 | 2380 | 3000 | 3000 |
| Kentucky | 4600 | 4600 | 3500 | 4650 | 3221 | 3750 | 3662 | 3580 | 4418 | 6320 | 4077 | 4376 |
| Louisiana | 3500 | 3500 | 3500 | 3484 | 3484 | 3323 | 4875 | 4700 | 3894 | 4100 | 4800 | 3361 |
| Maine | 900 | 922 | 950 | 1246 | 1246 | 1293 | 1293 | 1293 | 1339 | 1635 | 1635 | 1696 |
| Maryland | 7200 | 7200 | 5100 | 5000 | 5000 | 5200 | 5290 | 5124 | 5329 | 5700 | 6000 | 6268 |
| Massachusetts | 6600 | 10000 | 6800 | 6600 | 6750 | 6750 | 7050 | 7160 | 7160 | 7360 | 8142 | 8141 |
| Michigan | 11700 | 11700 | 11700 | 13000 | 13500 | 13700 | 13500 | 13500 | 13500 | 19500 | 19500 | 18717 |
| Minnesota | 4000 | 4200 | 4400 | 4270 | 4400 | 4600 | 4800 | 4600 | 4780 | 5010 | 5445 | 5634 |
| Mississippi | 1800 | 1800 | 1400 | 1400 | 1800 | 2200 | 2400 | 2400 | 2360 | 3070 | 2264 | 4400 |
| Missouri | 5100 | 6000 | 7500 | 7500 | 7500 | 5600 | 7500 | 7661 | 7896 | 7950 | 9560 | 10288 |

Table C-2 Data for MSW Generation, Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montana | 600 | 600 | 600 | 744 | 744 | 790 | 737 | 900 | 1039 | 1001 | 1082 | 757 |
| Nebraska | 1100 | 1100 | 1300 | 1400 | 1300 | 1650 | 1700 | 2000 | 2000 | 2000 | 1820 | 1848 |
| Nevada | 1000 | 1000 | 1000 | 2300 | 2300 | 2420 | 2566 | 3267 | 3955 | 2800 | 3153 | 3356 |
| New Hampshire | 1000 | 1000 | 1100 | 1138 | 1109 | 1032 | 1050 | 1245 | 1200 | 880 | 1284 | 1068 |
| New Jersey | 9500 | 14000 | 7100 | 7513 | 7300 | 7400 | 8500 | 9320 | 8200 | 7800 | 7800 | 9200 |
| New Mexico | 1000 | 1200 | 1500 | 1487 | 1542 | 1880 | 1966 | 1396 | 1400 | 2640 | 2966 | 3418 |
| New York | 20000 | 22000 | 22000 | 22800 | 25200 | 25400 | 25500 | 26800 | 28800 | 30200 | 29650 | 31100 |
| North Carolina | 6000 | 6000 | 6000 | 7788 | 6891 | 7754 | 10000 | 9929 | 9843 | 12575 | 13000 | 13500 |
| North Dakota | 450 | 450 | 400 | 466 | 500 | 500 | 500 | 502 | 510 | 501 | 498 | 573 |
| Ohio | 13900 | 14000 | 15700 | 16400 | 17471 | 22543 | 24304 | 11449 | 12339 | 12335 | 12015 | 14335 |
| Oklahoma | 2700 | 3600 | 3000 | 3000 | 2900 | 2500 | 2500 | 2500 | 2500 | 3545 | 3545 | 3787 |
| Oregon | 2350 | 2200 | 3300 | 3350 | 3103 | 3255 | 3437 | 3624 | 3836 | 4100 | 4415 | 4544 |
| Pennsylvania | 9200 | 9200 | 9500 | 8984 | 9500 | 9500 | 9000 | 9575 | 9440 | 9200 | 9800 | 11620 |
| Rhode Island | 1000 | 1000 | 1200 | 1200 | 1200 | 1062 | 1100 | 484 | 477 | 420 | 421 | 1561 |
| South Carolina | 3900 | 2500 | 4000 | 5000 | 5700 | 5100 | 6963 | 7897 | 8361 | 10010 | 9409 | 4483 |
| South Dakota | 750 | 500 | 800 | 800 | 842 | 840 | 840 | 842 | 510 | 510 | 514 | 514 |
| Tennessee | 3900 | 5400 | 5000 | 5800 | 5500 | 6000 | 6000 | 9117 | 9496 | 9513 | 9213 | 5200 |
| Texas | 17800 | 18000 | 18000 | 14469 | 24504 | 25026 | 22038 | 21859 | 21738 | 33750 | 34023 | 44791 |
| Utah | 1100 | 1100 | 1200 | 1500 | 1947 | 2000 | 2926 | 2996 | 3760 | 3490 | 2362 | 2433 |
| Vermont | 330 | 350 | 390 | 550 | 700 | 700 | 600 | 600 | 600 | 550 | 367 | 578 |
| Virginia | 9000 | 9000 | 9000 | 7600 | 7600 | 8000 | 8648 | 8649 | 9000 | 10000 | 8136 | 10661 |
| Washington | 5200 | 5600 | 5100 | 5708 | 6096 | 6513 | 7078 | 6643 | 6527 | 6540 | 6638 | 7072 |
| West Virginia | 2500 | 1700 | 1700 | 1700 | 1700 | 2000 | 2000 | 2000 | 2000 | 2000 | 1300 | 1500 |
| Wisconsin | 3600 | 7000 | 3400 | 3352 | 5000 | 5434 | 5434 | 5434 | 3622 | 5600 | 4000 | 3710 |
| Wyoming | 550 | 300 | 320 | 320 | 320 | 504 | 529 | 530 | 530 | 530 | 530 | 568 |

Table C-3 Data for the Variable RECYCLE

| STATE | RECYCLE (%) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Alabama | 5 | 5 | 8 | 12 | 15 | 15 | 15 | 20 | 23 | 23 | 23 | 23 |
| Alaska | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 |
| Arizona | 0 | 5 | 5 | 7 | 10 | 5 | 10 | 14 | 18 | 17 | 26 | 17 |
| Arkansas | 5 | 5 | 5 | 10 | 12 | 25 | 25 | 36 | 36 | 36 | 45 | 45 |
| California | 12 | 11 | 17 | 11 | 11 | 25 | 25 | 26 | 30 | 33 | 37 | 42 |
| Colorado | 14 | 20 | 16 | 26 | 25 | 18 | 18 | 17 | 18 | 18 | n/a | 9 |
| Connecticut | 0 | 0 | 15 | 19 | 21 | 23 | 23 | 23 | 23 | 24 | 24 | 23 |
| Delaware | 4 | 20 | 8 | 16 | 29 | 27 | 33 | 21 | 31 | 22 | 57 | 59 |
| Dist. of Columbia | 5 | 8 | 7 | 30 | 30 | 25 | 15 | 8 | 8 | 8 | 15 | 16 |
| Florida | 4 | 15 | 21 | 27 | 30 | 36 | 40 | 40 | 40 | 39 | 28 | 28 |
| Georgia | 0 | 8.5 | 5 | 12 | 12 | 12 | n/a | 33 | 33 | 33 | n/a | n/a |
| Hawaii | 4 | 4 | 4 | 4 | 11 | 17 | 20 | 23 | 25 | 24 | 28 | 24 |
| Idaho | 3 | 3 | 8 | 10 | 10 | 10 | n/a | n/a | n/a | n/a | n/a | n/a |
| Illinois | 6 | 6 | 12 | 11 | 20 | 19 | 27 | 23 | 28 | 28 | 23 | 28 |
| Indiana | 5 | 5 | 8 | 8 | 8 | 19 | 19 | 23 | 23 | 23 | 32 | 35 |
| Iowa | 8.5 | 8.5 | 10 | 23 | 16 | 16 | 28 | 30 | 32 | 34 | 37 | 35 |
| Kansas | 5 | 5 | 5 | 5 | 6 | 8 | 8 | 11 | 11 | 13 | 12 | 9 |
| Kentucky | 0 | 6.5 | 10 | 15 | 15 | 15 | 15 | 18 | 28 | 32 | 33 | 30 |
| Louisiana | 2 | 3 | 10 | 10 | 17 | 8 | 6 | 15 | 14 | 19 | 17 | 17 |
| Maine | 6 | 16 | 17 | 30 | 30 | 33 | 33 | 33 | 41 | 42 | 42 | 40 |
| Maryland | 0 | 10 | 10 | 15 | 23 | 26 | 27 | 27 | 29 | 30 | 36 | 37 |
| Massachusetts | 7 | 16 | 29 | 30 | 27 | 32 | 31 | 33 | 33 | 34 | 38 | 38 |
| Michigan | 0 | 0 | 25 | 26 | 25 | 20 | 25 | 25 | 25 | 25 | n/a | 18 |
| Minnesota | 15 | 22 | 31 | 38 | 41 | 44 | 44 | 46 | 42 | 45 | 41 | 42 |
| Mississippi | 0 | 0 | 8 | 8 | 10 | 11 | 12 | 12 | 13 | 14 | 14 | 16 |
| Missouri | 7 | 9 | 10 | 13 | 18 | 17 | 18 | 26 | 33 | 30 | 36 | 38 |

Table C-3 Data for the Variable RECYCLE, Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montana | 0 | 6 | 6 | 5 | 5 | 6 | 6 | 5 | 5 | 5 | 11 | n/a |
| Nebraska | 9 | 11 | 10 | 10 | 6 | 19 | 19 | 26 | 27 | 29 | 29 | 23 |
| Nevada | 5 | 5 | 10 | 10 | 15 | 17 | 12 | 12 | 15 | 14 | 11 | 14 |
| New Hampshire | 5 | 8 | 5 | 10 | 10 | 16 | 8 | 20 | 25 | 26 | 24 | 21 |
| New Jersey | 18 | 39 | 30 | 34 | 39 | 41 | 42 | 43 | 45 | 43 | 40 | 38 |
| New Mexico | 1 | 1 | 5 | 6 | 8 | 9 | 12 | 12 | 12 | 10 | 10 | 9 |
| New York | 10 | 15 | 14 | 21 | 23 | 28 | 32 | 32 | 39 | 43 | 42 | 42 |
| North Carolina | 0 | 5 | 17 | 4 | 6 | 8 | 30 | 22 | 26 | 32 | 29 | 26 |
| North Dakota | 1 | 3.5 | 10 | 17 | 17 | 18 | 22 | 27 | 21 | 26 | 20 | 11 |
| Ohio | 5 | 9 | 3 | 19 | 20 | 32 | 31 | 15 | 19 | 17 | 20 | 21 |
| Oklahoma | 2 | 2 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | n/a | 1 |
| Oregon | 22 | 22.5 | 21 | 23 | 27 | 30 | 33 | 29 | 28 | 30 | 30 | 39 |
| Pennsylvania | 2 | 4.5 | 10 | 11 | 18 | 20 | 17 | 20 | 26 | 26 | 33 | 33 |
| Rhode Island | 13 | 18 | 15 | 15 | 21 | 24 | 24 | 23 | 23 | 27 | 28 | 24 |
| South Carolina | 8 | 8 | 5 | 10 | 30 | 9 | 16 | 27 | 34 | 42 | 31 | 31 |
| South Dakota | 1 | 1 | 10 | 10 | 10 | 20 | 20 | 38 | 42 | 42 | 42 | n/a |
| Tennessee | 0 | 0 | 2 | 10 | 8 | 15 | n/a | 40 | 40 | 35 | n/a | 34 |
| Texas | 8 | 8 | 10 | 11 | 12 | 14 | n/a | n/a | n/a | 35 | 35 | 35 |
| Utah | 0 | 10 | 10 | 13 | 13 | 13 | 13 | 19 | 19 | 22 | 20 | 5 |
| Vermont | 12 | 16.5 | 20 | 25 | 28 | 28 | 29 | 30 | 30 | 30 | 35 | 33 |
| Virginia | 10 | 10 | 10 | 24 | 24 | 28 | 33 | 35 | 35 | 40 | 35 | 29 |
| Washington | 29 | 28 | 34 | 33 | 35 | 38 | 38 | 39 | 48 | 33 | 33 | 35 |
| West Virginia | 0 | 7.5 | 10 | 10 | 12 | 12 | 13 | 13 | 20 | 20 | 25 | 25 |
| Wisconsin | 0 | 0 | 17 | 24 | 24 | 28 | 28 | 40 | 36 | 36 | n/a | 36 |
| Wyoming | 5 | 3 | 3 | 4 | 4 | 5 | 4 | 4 | 5 | 5 | n/a | 10 |

Table C-4 Data for the Variable POP

| STATE | POPULATION (in thousands) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Alabama | 4030 | 4040 | 4090 | 4138 | 4192 | 4239 | 4270 | 4291 | 4322 | 4352 | 4370 | 4447 |
| Alaska | 547 | 550 | 569 | 587 | 597 | 601 | 602 | 605 | 610 | 614 | 620 | 627 |
| Arizona | 3622 | 3665 | 3762 | 3867 | 3994 | 4148 | 4307 | 4432 | 4553 | 4669 | 4778 | 5131 |
| Arkansas | 2346 | 2351 | 2370 | 2394 | 2424 | 2451 | 2480 | 2305 | 2523 | 2538 | 2551 | 2673 |
| California | 29218 | 29786 | 30393 | 30854 | 31124 | 31295 | 31472 | 31762 | 32182 | 32667 | 33145 | 33872 |
| Colorado | 3276 | 3294 | 3368 | 3461 | 3562 | 3654 | 3738 | 3814 | 3892 | 3971 | 4056 | 4301 |
| Connecticut | 3283 | 3287 | 3287 | 3272 | 3270 | 3265 | 3262 | 3264 | 3267 | 3274 | 3282 | 3406 |
| Delaware | 658 | 666 | 680 | 690 | 700 | 709 | 719 | 727 | 735 | 744 | 753 | 784 |
| Dist. of Columbia | 624 | 607 | 594 | 585 | 577 | 566 | 552 | 540 | 530 | 523 | 519 | 572 |
| Florida | 12638 | 12938 | 13290 | 13502 | 13712 | 13954 | 14180 | 14425 | 14677 | 14916 | 15111 | 15982 |
| Georgia | 6411 | 6478 | 6623 | 6760 | 6895 | 7046 | 7189 | 7334 | 7490 | 7642 | 7788 | 8186 |
| Hawaii | 1095 | 1108 | 1132 | 1151 | 1164 | 1176 | 1183 | 1187 | 1192 | 1193 | 1186 | 1212 |
| Idaho | 994 | 1007 | 1039 | 1066 | 1100 | 1134 | 1164 | 1186 | 1209 | 1229 | 1252 | 1294 |
| Illinois | 11410 | 11431 | 11533 | 11630 | 11718 | 11794 | 11866 | 11934 | 11989 | 12045 | 12128 | 12419 |
| Indiana | 5524 | 5544 | 5601 | 5648 | 5701 | 5741 | 5787 | 5827 | 5865 | 5899 | 5943 | 6081 |
| Iowa | 2771 | 2777 | 2791 | 2807 | 2821 | 2829 | 2841 | 2849 | 2854 | 2862 | 2869 | 2926 |
| Kansas | 2473 | 2478 | 2494 | 2518 | 2538 | 2558 | 2575 | 2585 | 2601 | 2629 | 2654 | 2688 |
| Kentucky | 3677 | 3687 | 3716 | 3758 | 3794 | 3824 | 3856 | 3883 | 3910 | 3936 | 3961 | 4042 |
| Louisiana | 4253 | 4222 | 4241 | 4272 | 4286 | 4307 | 4328 | 4340 | 4354 | 4369 | 4372 | 4469 |
| Maine | 1220 | 1228 | 1235 | 1234 | 1236 | 1235 | 1233 | 1238 | 1242 | 1244 | 1253 | 1275 |
| Maryland | 4727 | 4781 | 4856 | 4903 | 4943 | 4985 | 5023 | 5058 | 5095 | 5135 | 5172 | 5297 |
| Massachusetts | 6016 | 6016 | 5997 | 5992 | 6008 | 6027 | 6058 | 6083 | 6114 | 6147 | 6175 | 6349 |
| Michigan | 9253 | 9295 | 9390 | 9465 | 9523 | 9586 | 9663 | 9734 | 9780 | 9817 | 9864 | 9938 |
| Minnesota | 4338 | 4376 | 4428 | 4472 | 4524 | 4566 | 4605 | 4648 | 4687 | 4725 | 4775 | 4920 |
| Mississippi | 2574 | 2575 | 2591 | 2610 | 2636 | 2663 | 2690 | 2710 | 2732 | 2752 | 2769 | 2845 |
| Missouri | 5096 | 5117 | 5158 | 5194 | 5238 | 5291 | 5337 | 5369 | 5408 | 5439 | 5468 | 5595 |

Table C-4 Data for the Variable POP, Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montana | 800 | 799 | 808 | 822 | 840 | 855 | 868 | 877 | 879 | 880 | 883 | 902 |
| Nebraska | 1575 | 1578 | 1591 | 1602 | 1612 | 1622 | 1635 | 1648 | 1657 | 1663 | 1666 | 1711 |
| Nevada | 1137 | 1202 | 1285 | 1333 | 1382 | 1458 | 1528 | 1600 | 1679 | 1747 | 1809 | 1998 |
| New Hampshire | 1105 | 1109 | 1107 | 1114 | 1122 | 1133 | 1146 | 1160 | 1172 | 1185 | 1201 | 1236 |
| New Jersey | 7726 | 7748 | 7784 | 7826 | 7873 | 7916 | 7962 | 8008 | 8058 | 8115 | 8143 | 8414 |
| New Mexico | 1504 | 1515 | 1547 | 1581 | 1615 | 1654 | 1684 | 1708 | 1724 | 1737 | 1740 | 1819 |
| New York | 17983 | 17991 | 18028 | 18079 | 18139 | 18152 | 18145 | 18142 | 18146 | 18175 | 18197 | 18977 |
| North Carolina | 6566 | 6632 | 6748 | 6833 | 6949 | 7061 | 7186 | 7309 | 7431 | 7546 | 7651 | 8049 |
| North Dakota | 646 | 639 | 634 | 635 | 637 | 640 | 641 | 643 | 641 | 638 | 634 | 642 |
| Ohio | 10829 | 10847 | 10931 | 11003 | 11063 | 11100 | 11138 | 11170 | 11193 | 11209 | 11257 | 11353 |
| Oklahoma | 3150 | 3146 | 3166 | 3204 | 3229 | 3248 | 3271 | 3296 | 3322 | 3347 | 3358 | 3451 |
| Oregon | 2791 | 2842 | 2919 | 2974 | 3035 | 3087 | 3141 | 3195 | 3243 | 3282 | 3316 | 3421 |
| Pennsylvania | 11866 | 11883 | 11943 | 11981 | 12022 | 12040 | 12040 | 12034 | 12011 | 12001 | 11994 | 12281 |
| Rhode Island | 1001 | 1003 | 1004 | 1000 | 998 | 993 | 989 | 988 | 987 | 988 | 991 | 1048 |
| South Carolina | 3457 | 3486 | 3559 | 3599 | 3635 | 3667 | 3699 | 3737 | 3788 | 3836 | 3886 | 4012 |
| South Dakota | 697 | 696 | 708 | 715 | 723 | 729 | 735 | 737 | 738 | 738 | 733 | 755 |
| Tennessee | 4854 | 4877 | 4946 | 5012 | 5082 | 5158 | 5235 | 5307 | 5372 | 5431 | 5483 | 5689 |
| Texas | 16807 | 16986 | 17349 | 17662 | 18009 | 18348 | 18694 | 19033 | 19386 | 19760 | 20044 | 20852 |
| Utah | 1706 | 1723 | 1771 | 1819 | 1872 | 1942 | 1991 | 2022 | 2065 | 2100 | 2130 | 2233 |
| Vermont | 558 | 563 | 567 | 570 | 574 | 579 | 582 | 586 | 589 | 591 | 594 | 609 |
| Virginia | 6120 | 6189 | 6284 | 6384 | 6467 | 6539 | 6602 | 6667 | 6737 | 6791 | 6873 | 7079 |
| Washington | 4746 | 4867 | 5015 | 5143 | 5249 | 5336 | 5433 | 5519 | 5614 | 5689 | 5756 | 5894 |
| West Virginia | 1807 | 1793 | 1798 | 1806 | 1817 | 1819 | 1822 | 1820 | 1815 | 1811 | 1807 | 1808 |
| Wisconsin | 4857 | 4892 | 4953 | 5005 | 5056 | 5095 | 5137 | 5174 | 5201 | 5224 | 5250 | 5364 |
| Wyoming | 458 | 454 | 458 | 464 | 469 | 475 | 478 | 480 | 480 | 481 | 480 | 494 |

Table C-5 Data for the Variable INCOME

| STATE | Per Capita Personal Income ($) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Alabama | 13967 | 14903 | 15612 | 16863 | 17482 | 18271 | 19524 | 20133 | 20891 | 21913 | 22706 | 23460 |
| Alaska | 19631 | 20881 | 21570 | 22131 | 22819 | 23521 | 25659 | 25889 | 26876 | 27610 | 27947 | 29597 |
| Arizona | 15639 | 16265 | 16755 | 17664 | 18417 | 19250 | 20059 | 20890 | 21896 | 23121 | 23738 | 24991 |
| Arkansas | 13085 | 13784 | 14454 | 15853 | 16460 | 17158 | 18179 | 18982 | 19670 | 20531 | 21191 | 21945 |
| California | 19620 | 20654 | 20877 | 22246 | 22532 | 23024 | 24374 | 25409 | 26555 | 28277 | 29818 | 32225 |
| Colorado | 17767 | 18814 | 19744 | 21083 | 22263 | 23138 | 24314 | 25536 | 27088 | 28783 | 30225 | 32441 |
| Connecticut | 24548 | 25427 | 25905 | 28451 | 29460 | 30496 | 31423 | 32814 | 34803 | 37190 | 38506 | 40870 |
| Delaware | 18867 | 19719 | 20399 | 23196 | 23875 | 24782 | 24996 | 26143 | 26812 | 28694 | 29625 | 31074 |
| DC | 22794 | 24648 | 25988 | 28760 | 30178 | 31440 | 31479 | 32455 | 33811 | 35568 | 36254 | 38374 |
| Florida | 18043 | 18788 | 19192 | 20060 | 21340 | 21979 | 22974 | 23942 | 24901 | 26159 | 26560 | 27836 |
| Georgia | 16250 | 17123 | 17645 | 18945 | 19774 | 20723 | 21840 | 23090 | 23945 | 25481 | 26522 | 27790 |
| Hawaii | 19146 | 20906 | 21648 | 23021 | 23842 | 24279 | 25211 | 25212 | 25714 | 26135 | 26658 | 27819 |
| Idaho | 14321 | 15301 | 15836 | 16658 | 17792 | 18264 | 19419 | 20091 | 20525 | 21622 | 22387 | 23640 |
| Illinois | 19071 | 20159 | 20621 | 22366 | 23153 | 24225 | 25375 | 26667 | 27942 | 29491 | 30274 | 31842 |
| Indiana | 15972 | 16816 | 17286 | 18826 | 19763 | 20831 | 21634 | 22511 | 23427 | 24908 | 25682 | 26838 |
| Iowa | 15647 | 16684 | 17091 | 18441 | 18592 | 20077 | 20991 | 22469 | 23503 | 24531 | 24945 | 26376 |
| Kansas | 16399 | 17642 | 18251 | 19541 | 20213 | 20784 | 21777 | 22978 | 24183 | 25538 | 26312 | 27408 |
| Kentucky | 13756 | 14747 | 15429 | 16761 | 17309 | 17958 | 19061 | 19960 | 20982 | 22123 | 22712 | 24057 |
| Louisiana | 13254 | 14281 | 15079 | 16427 | 17218 | 18158 | 19321 | 19981 | 20875 | 21954 | 22292 | 23041 |
| Maine | 16467 | 17039 | 17304 | 18085 | 18606 | 19311 | 20102 | 21118 | 22091 | 23352 | 24220 | 25399 |
| Maryland | 21105 | 22090 | 22481 | 23634 | 24436 | 25456 | 26678 | 27574 | 28892 | 30496 | 31860 | 33621 |
| Massachusetts | 21688 | 22247 | 22764 | 24644 | 25524 | 26591 | 27711 | 29188 | 30799 | 32748 | 34482 | 37710 |
| Michigan | 17546 | 18237 | 18703 | 19936 | 21069 | 22469 | 23931 | 24394 | 25505 | 26870 | 27886 | 29071 |
| Minnesota | 17843 | 18779 | 19271 | 21208 | 21631 | 22927 | 24320 | 25930 | 27112 | 29109 | 30127 | 31913 |
| Mississippi | 11915 | 12571 | 13214 | 14198 | 14963 | 15941 | 16990 | 17799 | 18588 | 19674 | 20180 | 20856 |
| Missouri | 16552 | 17409 | 18099 | 19207 | 19784 | 20749 | 21887 | 22840 | 23937 | 25176 | 25815 | 27186 |

Table C-5 Data for the Variable INCOME, Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montana | 14152 | 14741 | 15772 | 16618 | 17709 | 17709 | 18588 | 19165 | 19909 | 21235 | 21511 | 22541 |
| Nebraska | 16050 | 17379 | 18023 | 19230 | 19843 | 20471 | 21908 | 23672 | 24146 | 25558 | 26663 | 27658 |
| Nevada | 19370 | 20254 | 20831 | 21813 | 22530 | 23504 | 24908 | 26009 | 26836 | 28190 | 28883 | 29551 |
| New Hampshire | 19977 | 20227 | 21023 | 22348 | 22918 | 24282 | 24775 | 25751 | 27254 | 29297 | 30690 | 33042 |
| New Jersey | 23114 | 24182 | 24745 | 26875 | 27678 | 28532 | 28881 | 30296 | 31757 | 33646 | 34666 | 37112 |
| New Mexico | 13388 | 14213 | 14817 | 15809 | 16652 | 17221 | 18435 | 18963 | 19610 | 20520 | 20920 | 21883 |
| New York | 20983 | 22321 | 22928 | 24903 | 25550 | 26394 | 27190 | 28594 | 29694 | 31522 | 32620 | 34502 |
| North Carolina | 15233 | 16275 | 16802 | 18299 | 19263 | 20027 | 21476 | 22361 | 23478 | 24667 | 25314 | 26842 |
| North Dakota | 13735 | 15321 | 15572 | 16917 | 17137 | 18240 | 18890 | 20908 | 20506 | 22785 | 23053 | 24780 |
| Ohio | 16644 | 17548 | 18017 | 19567 | 20379 | 21370 | 22791 | 23495 | 24770 | 25918 | 26725 | 27914 |
| Oklahoma | 14187 | 15119 | 15653 | 16888 | 17510 | 18064 | 19174 | 19876 | 20771 | 21966 | 22576 | 23582 |
| Oregon | 16287 | 17199 | 17768 | 18747 | 19651 | 20620 | 22355 | 23257 | 24365 | 25406 | 26192 | 27649 |
| Pennsylvania | 17844 | 18883 | 19640 | 21052 | 21816 | 22496 | 23441 | 24465 | 25630 | 27005 | 27971 | 29533 |
| Rhode Island | 18441 | 19032 | 19438 | 20897 | 21875 | 22432 | 23427 | 24349 | 25685 | 26870 | 27813 | 29158 |
| South Carolina | 13884 | 15106 | 15482 | 16497 | 17242 | 18072 | 19227 | 20093 | 21005 | 22127 | 22903 | 23952 |
| South Dakota | 14139 | 15630 | 16399 | 17113 | 17705 | 18651 | 19597 | 21407 | 21893 | 23484 | 24491 | 25993 |
| Tennessee | 15074 | 15905 | 16501 | 18305 | 19226 | 20167 | 21462 | 22032 | 22821 | 24106 | 24722 | 25878 |
| Texas | 15695 | 16749 | 17450 | 18925 | 19681 | 20360 | 21239 | 22197 | 23777 | 25426 | 26266 | 27722 |
| Utah | 13201 | 14060 | 14733 | 15596 | 16426 | 17200 | 18514 | 19519 | 20618 | 21624 | 22335 | 23364 |
| Vermont | 16891 | 17442 | 17822 | 18987 | 19581 | 20356 | 21147 | 22029 | 23037 | 24557 | 25514 | 26904 |
| Virginia | 18768 | 19537 | 20099 | 21370 | 22296 | 23174 | 24230 | 25213 | 26418 | 28032 | 29208 | 31065 |
| Washington | 18085 | 19265 | 20168 | 21515 | 22168 | 22806 | 23658 | 25007 | 26457 | 28287 | 29783 | 31129 |
| West Virginia | 12926 | 13967 | 14666 | 15735 | 16403 | 17029 | 17882 | 18528 | 19342 | 20235 | 20720 | 21767 |
| Wisconsin | 16438 | 17398 | 17962 | 19467 | 20227 | 21228 | 22373 | 23303 | 24484 | 26018 | 26863 | 28066 |
| Wyoming | 15270 | 16902 | 18284 | 18808 | 19723 | 20028 | 21210 | 21724 | 23348 | 24687 | 25960 | 27436 |

Table C-6 Data for the Variable CURB

| STATE | Curbside Programs (Numbers) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Alabama | 3 | 6 | 8 | 25 | 30 | 35 | 35 | 35 | 37 | 38 | 39 | 39 |
| Alaska | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| Arizona | 1 | 6 | 13 | 15 | 20 | 27 | 33 | 28 | 33 | 32 | 25 | 27 |
| Arkansas | 2 | 3 | 2 | 12 | 17 | 20 | 29 | 41 | 41 | 41 | 59 | n/a |
| California | 103 | 254 | 369 | 446 | 464 | 496 | 503 | 511 | 496 | 511 | 521 | 546 |
| Colorado | 2 | 7 | 20 | 65 | 65 | 70 | 77 | 70 | 70 | 70 | n/a | n/a |
| Connecticut | 47 | 80 | 150 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 169 |
| Delaware | 0 | 0 | n/a | 0 | 1 | 1 | 3 | 4 | 2 | 3 | 2 | 2 |
| Dist. of Columbia | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Florida | 42 | 150 | 200 | 215 | 351 | 366 | 296 | 296 | 300 | 315 | 372 | 299 |
| Georgia | u/a | 20 | 20 | 80 | 123 | 129 | 122 | 153 | 148 | 179 | 194 | 459 |
| Hawaii | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Idaho | 0 | 1 | 2 | n/a | 3 | 5 | 5 | 6 | 6 | 6 | n/a | 20 |
| Illinois | 65 | 175 | 200 | 260 | 435 | 435 | 450 | 450 | 450 | 450 | 474 | 474 |
| Indiana | 9 | 28 | 40 | 54 | 54 | 82 | 97 | 98 | 104 | 169 | 169 | 168 |
| Iowa | 1 | 17 | 35 | 240 | 481 | 500 | 490 | 543 | 569 | 574 | 583 | 608 |
| Kansas | 0 | 5 | 10 | 10 | 12 | 15 | 15 | 70 | 90 | 101 | 99 | 109 |
| Kentucky | 0 | 10 | 10 | 40 | 55 | 55 | 55 | 30 | 42 | 43 | 35 | 45 |
| Louisiana | 3 | 10 | 17 | 21 | 28 | 28 | 22 | 40 | 33 | 33 | 23 | 25 |
| Maine | 2 | 7 | 16 | 18 | 47 | 64 | 64 | 80 | 84 | 84 | 100 | 34 |
| Maryland | 5 | 37 | . | 40 | 79 | 95 | 95 | 100 | 100 | 100 | 100 | 99 |
| Massachusetts | 7 | 23 | 82 | 109 | 115 | 141 | 138 | 166 | 155 | 156 | 159 | 159 |
| Michigan | 5 | 40 | 100 | 200 | 123 | 192 | 200 | 200 | 200 | 200 | 264 | 347 |
| Minnesota | 185 | 381 | 488 | 571 | 651 | 674 | 679 | 717 | 731 | 771 | 758 | 765 |
| Mississippi | 0 | 12 | 25 | 15 | 15 | 20 | 18 | 16 | 9 | 15 | 15 | 14 |
| Missouri | 8 | 16 | 30 | 40 | 122 | 122 | 129 | 192 | 197 | 197 | 199 | 177 |

Table C-6 Data for the Variable CURB, Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Montana | 0 | 4 | 3 | 3 | 3 | 2 | 4 | 4 | 6 | 6 | 2 | n/a |
| Nebraska | 2 | 1 | 4 | 4 | 4 | 11 | 11 | 15 | 15 | 15 | 11 | 11 |
| Nevada | 0 | 1 | 2 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 3 | 3 |
| New Hampshire | 2 | 18 | 26 | 25 | 27 | 30 | 33 | 38 | 38 | 38 | 38 | 39 |
| New Jersey | 452 | 492 | 525 | 515 | 530 | 530 | 530 | 530 | 510 | 510 | 510 | 510 |
| New Mexico | 0 | 2 | 3 | 7 | 8 | 8 | 31 | 7 | 3 | 3 | 5 | 8 |
| New York | n/a | 162 | 200 | 250 | 362 | 399 | 399 | 1472 | 1472 | 1472 | 1472 | 1500 |
| North Carolina | 3 | 25 | 58 | 95 | 128 | 247 | 240 | 250 | 260 | 271 | 279 | 279 |
| North Dakota | 0 | 2 | 5 | 10 | 12 | 23 | 25 | 24 | 26 | 25 | 50 | 50 |
| Ohio | 26 | 56 | 130 | 144 | 247 | 246 | 288 | 286 | 372 | 372 | 372 | 232 |
| Oklahoma | 1 | 8 | 11 | 14 | 8 | 6 | 8 | 9 | 7 | 8 | 9 | 7 |
| Oregon | 106 | 108 | 115 | 118 | 118 | 117 | 123 | 123 | 123 | 122 | 123 | 139 |
| Pennsylvania | 245 | 412 | 603 | 709 | 755 | 761 | 772 | 866 | 873 | 879 | 892 | 892 |
| Rhode Island | 8 | 23 | 19 | 20 | 21 | 22 | 27 | 26 | 25 | 26 | 25 | 25 |
| South Carolina | 2 | 4 | 6 | 27 | 30 | 28 | 32 | 31 | n/a | 186 | n/a | 135 |
| South Dakota | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | n/a |
| Tennessee | 0 | 8 | 3 | 29 | 15 | 40 | 45 | 39 | 40 | 35 | n/a | n/a |
| Texas | 2 | 10 | 10 | 90 | 120 | 120 | 130 | 120 | 140 | 159 | 186 | 160 |
| Utah | 0 | 1 | 3 | 13 | 10 | 12 | 12 | 14 | 14 | 14 | n/a | 7 |
| Vermont | 1 | 8 | 12 | 16 | 25 | 78 | 78 | 80 | 80 | 80 | 94 | 93 |
| Virginia | 15 | 25 | 61 | 62 | 64 | 64 | 81 | 78 | 78 | 79 | 62 | 62 |
| Washington | 16 | 34 | 81 | 98 | 100 | 100 | 100 | 100 | 100 | 102 | 100 | 283 |
| West Virginia | 2 | 14 | 50 | 50 | 30 | 67 | 69 | 75 | 75 | 75 | 51 | 51 |
| Wisconsin | 50 | n/a | 190 | 450 | 590 | 600 | 600 | 600 | 600 | 600 | 600 | 631 |
| Wyoming | 0 | 1 | 0 | 1 | 1 | 4 | 3 | 2 | 2 | 2 | n/a | 1 |

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