The Determinants of Municipal Solid Waste

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Abstract

The virtues of conservation are much touted; the underlying determinants of waste are less clear. Individuals adopt a broad spectrum of resource-use strategies from sustenance to disregard. Varying local needs and priorities influence a similarly broad set of conservation paradigms in government and industry. The influence of demographics including education, age, land per capita, farming culture, and income are of particular interest as their composition is on course for worldwide change. This study examines the determinants of municipal solid waste generation and anticipates the effects of current demographic trends on resource allocation over the coming decades. Municipal solid waste levels are found to increase with variables including per capita income levels and crime rates (a proxy for moral climate), and decrease with the percent of college graduates and farms per capita.

Keywords: municipal solid waste, conservation, resources, sustainability

I. Introduction

With the new century came the "age of excess" and the "generation of materialism."[1] The economy was growing and inflation was in check. Rapid technological advancement led to the obsolescence of old equipment, and falling agricultural prices threatened the livelihood of those living off the land [Ginger, 1965, 61]. That was the dawning of the *twentieth* century and the so-called excesses were tempered by subsequent world war and depression. The twenty-first century began under parallel circumstances, with continuing growth projected in wealth and education, a dwindling farm population, and hope for relative amity despite ongoing conflicts. If social choice, rather than war or Malthusian famine, is to compensate for the externalities of excess, societal attitudes towards the expenditure of natural resources are of interest.

At present, residents of the United States, Europe, and Japan--representing a relatively wealthy 16 percent of the world population--are responsible for an estimated 80 percent of natural resource consumption on an annual basis. The average American is responsible for the consumption of about 25 tons of raw materials, and the four percent of the world population living in the U.S. operates one-third of the world's automobiles and consumes one-quarter of the global energy supply [Utley, 1999]. Consumption begets waste. In 1986 the EPA estimated that the U.S. generated over 160 million tons of municipal solid waste (MSW), or 3.6 pounds per person per day. At that time they also predicted that the rate of waste generation would increase by about 1 percent per year, to reach 3.9 pounds per capita by the year 2000. This prediction turned out to be conservative, and MSW per capita reached 4.5 pounds by the mid-1990's [EPA, 2005].

The U.S. currently generates more municipal solid waste per capita than any other OECD country [U.S. Bureau of Census, 2004, t. 1332]. The relevance of the determinants of MSW is heightened by the potential for developing countries to follow the U.S. example. For instance, Nie et al. [2002, p. 1] state that "with the rapid urbanization of China's population, the management of municipal solid wastes is fast becoming one of the most important issues facing the country." Given global resource constraints, the advancement of developing countries will necessitate a renewed focus among developed countries on the issues of conservation and municipal solid waste.[2] The results of this study will inform those efforts.

Insert Table I about here.

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[1] See the books with these titles by Ginger [1965] and Hays [1941]. Strasser [2000] is among many recent books in this vein.

[2] For discussions of the problems with solid waste generation and corresponding resource depletion, see Neal and Schubel [1986] or Anderson [2003].

Rising trends in municipal solid waste precipitate three categories of problems: resource depletion, waste storage, and external costs. As an illustration of the resources in the balance, Table 1 specifies the make-up of the 236 million tons of MSW generated in 2003, one-quarter of which originated from non-renewable resources. About 31 percent of MSW is recovered for recycling or composting, 15 percent is incinerated, and the remaining 54 percent is placed in landfills [EPA, 2001, 1]. The problem of waste storage grows inversely with the areas available for disposal. In 2002 there were 1,767 landfills in the U.S., down from 8,000 in 1988 [EPA, 2005], although the average landfill capacity has increased substantially. As the most convenient dumpsites reach capacity and urban sprawl makes new sites within close proximity to urban centers less viable, the direct and external costs of transporting and disposing of MSW increase. The external costs also include groundwater contamination from landfills and ash toxicity from MSW incineration facilities. An EPA-sponsored study of 167 nationally representative landfills found groundwater contamination or adverse trends at 90 percent of the sites, and toxic levels of fly or bottom ash at many of the landfills receiving the 17 percent of MSW that is incinerated [Denison and Ruston, 1990].

The creation and fate of municipal waste may reflect broader attitudes toward the environment and social responsibility. Coincidentally or not, per-capita MSW generation increased by only 13 percent during the decade of the 1970's that spawned the EPA and Earth Day, by 23 percent during the "me" decade of the 1980's, and 3 percent during the 1990's under the influence of Generation X [EPA, 2001, 4]. Groups and individuals who prioritize the reduction of waste may place similar emphases on recycling, pollution control, and related humanitarian pursuits. To the extent that the selection of a political platform indicates a choice of priorities, the existence of ties between solid waste generation and broader attitudes may be measured by the use of a political party variable in the regressions below.

Ongoing problems with municipal solid waste and demographic trends that may influence MSW generation motivate study of the determinants of MSW levels. In this article I empirically investigate the relationship between MSW creation and county-level demographic characteristics. Section II reviews the existing literature. Section III identifies the trends that may influence the generation of MSW. Section IV provides an overview of the empirical data. Section V describes the model and hypotheses. Section VI presents and discusses the results. Section VII concludes the paper.

II. Previous Research

In his classic article, Lackman [1976] models solid waste production with a household consumption model that incorporates material inputs, time inputs valued at the wage rate, waste, and external effects. Assuming that external effects are indeed paid externally, his model predicts that higher wages and correspondingly higher opportunity costs of time will increase solid waste production as consumers switch to higher-priced time-saving products. Lackman provides TV dinners and non-returnable bottles as examples.

Over the past decade there have been several empirical investigations of the conceptual uncertainties regarding income and pollution abatement. Grossman and Krueger [1995] found

inverted-U-shaped Kuznets relationships[3] between per capita income and fecal contamination, oxygen depletion, heavy metals in rivers, and urban air pollution. Related studies have found Kuznets relationships between income and deforestation, particulates, nitrogen oxides, carbon monoxide, and automotive lead emissions.[4] MSW is among the problems that appear to buck the Kuznets up-and-down scenario.[5] Shafik and Bandyopadhyay [1992] found a monotonic, positive relationship between income per capita and municipal solid waste per capita on the basis of 1985 city-level information from 39 countries. The present study includes an examination of the same relationship using data from over 1000 counties in the U.S.

Citing the importance of waste generation influences to waste policy planning, Annegrete Bruvoll [2001] used state-level U.S. data to analyze the effect of waste management fees, income, and population density on waste management techniques and the amount of waste generated. Her primary results suggest that landfill fees are effective in promoting recycling and incineration over landfill use. She also found a positive relationship between population per square mile and per capita solid waste levels. She did not, however, find a statistically significant effect from landfill fees or income on MSW generation at the state level.

Sterner and Bartelings [1999] studied the determinants of waste disposal for a residential area of southwest Sweden. Their household-level data came from a mail questionnaire and information from a weight-based waste disposal billing system. Their explanatory variables included age, income, and education as in the current study. The nature of their sample did not provide variation in race, region, or any of the other variables included in the current study. Sterner and Bartelings concluded that the most important positive influences on waste disposal at the household level were home size and practical difficulties with recycling, and the most important negative influences were the composting of kitchen waste and advancing age.

Beede and Blom [1995] analyzed country-level panel data to consider the influence of income on waste. They found that MSW generation is positively related to per capita income, but does not vary with population size among countries with comparable per capita income. Beede and Blom project that levels of MSW will increase at a rate of 2.7 percent per year through 2010. The county-level dataset used in the present study provides a check on the robustness of past findings regarding income and population as determinants of MSW levels. At the same time, this study examines the influence of an expanded set of relevant variables on the demand for solid waste disposal.

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[3] Named after Simon Kuznets [1955], who found an inverted-U-shaped relationship between income and income inequality.

[4] See, for example, Hilton and Levinson [1998]. Andreoni and Levinson [2001] present a model that explains the environmental Kuznets relationship on the basis of increasing returns to pollution abatement technology.

[5] As an example of other environmental problems that do not adhere to the Kuznets relationship, Harbaugh, Levinson, and Wilson [2002] found varying relationships between sulfur dioxide emissions and per capita income depending on the assumptions made and the areas and years studied. Many of the curves in their results begin as an inverted U and then spring back up at incomes above $15,000 per year (in 2003 dollars).

A number of related studies have examined the determinants of recycling and the effects of "pay-as-you-throw" market-based incentives for MSW reduction. For example, Callan and Thomas [1997] examined city-level recycling rates for communities in Massachusetts. Their explanatory variables included income, education, and population density. Inasmuch as increases in recycling correspond with decreases in MSW production,[6] the coefficients on those variables in the current study can be expected to have the opposite sign of those in Callan and Thomas' results. They found that income and education had positive coefficients and population density had a negative coefficient.

Miranda et al. [1994] studied market-based incentives to reduce MSW with data from phone and mail surveys in 21 U.S. cities. They found that pay-per-throw programs offered significant reductions in solid waste generation. Similarly, Reschovsky and Stone [1994] studied the probability of recycling using survey data from an upstate New York county. They found that recycling rates increased significantly when curbside pickup was combined with mandatory recycling, pay-per-throw incentives, or both.

Since most MSW is a byproduct of consumption, and consumption patterns influence the translation of income into waste, there is a bridge between this study and a broad array of research on consumption. Dunlap, Buttel, Dickens, and Gijswijt [2002] describe the role of consumption as a staple concern of environmental sociology. And Shove and Warde [2002] suggest that despite the attention to materialism and the environment, to date there have been only modest efforts to link societal variables with consumption and environmental harm.

III. Notable Trends[7]

Of particular interest are several variables expected to change significantly over the coming decades. Real median incomes are steadily increasing in every region of the country, and mean incomes are on the rise for each income quintile. The relationship between income and MSW is theoretically ambiguous. Although consumption levels generally increase with income, so do expenditures on more-durable consumer goods, recycling infrastructure, education, and other goods and services that may have a negative influence on waste generation. Education levels are on the rise. Between 1970 and 1998 the percentage of the adult population with less than a high school diploma decreased from 44 percent to 17 percent, while the percentage with at least some college education more than doubled, from 22 percent to 58 percent.

The U.S. Census Bureau projects that the U.S. population will continue to migrate south and west over the next century, making regional influences of interest. Age may also play in important role in resource management. Between 1970 and 1999, the under-18 population increased by only 0.8 percent while the 18-64 population increased by 48 percent and the over-65 population increased by 72 percent. Over the next 25 years, the under-20 and 20-64

[6] Wenger, Thyner, and Wagoner [1997] address this issue.

[7] Data on trends were obtained from the U.S. Census Bureau (www.census.gov) and the Population Reference Bureau (www.ameristat.org).

populations are projected to decrease by 1-2 percent, and the over-65 population is projected to increase by 40-56 percent.

The racial and ethnic composition of the U.S. is expected to change as well. Over the next 25 years, the Hispanic population is projected to increase from 11.5% to 17.6% of the U.S. population. The African-American population is projected to increase from 12.1% to 13.0%, the white population is projected to decrease from 71.9% to 62.4%, and the Asian, American Indian, Eskimo, Aleutian, and Pacific Islander population is expected to increase from 4.5% to 7%. This study will examine the relationship between these and other demographic and socio-economic variables and the generation of waste.

IV. Data

The U.S. Census Bureau defines municipal waste as "that which is collected and treated by or for municipalities: household waste and bulky waste as well as comparable waste from small communities or industrial enterprises; and market and garden residue" [U.S. Census Bureau, 2001, 838]. Annual data on municipal solid waste (MSW) were obtained by this author from unpublished reports via correspondence with Environmental Protection Agency regional solid waste managers for 1055 U.S. counties in 17 states.[8] States were omitted only because they did not provide county-level data. In most cases the omitted states collected data by landfill or region rather than by county.[9] Alaska was omitted because it has no counties. All of the data obtained for this study are from the 1990s: Population figures are from 1995, waste data are from 1995-98, employment, income, and industry data are from 1992-94, voting data are from the 1992 presidential election, and some of the demographic data are from the 1990 census. While some states collect data on both waste generated and waste disposed of (the difference being waste recycled), the MSW variable used in this study is in every case the measure of waste disposed of.

Insert Table II about here.

Variable definitions appear in Table 2. The dependent variable is the natural log of WASTE, which is the annual tons of municipal solid waste per capita at the county level. The explanatory variables include education, region, income, age, and race. Land, farms, and

[8] The sample includes data from California, Delaware, Florida, Hawaii, Illinois, Indiana, Kansas, Kentucky, Maryland, Michigan, Montana, New Jersey, New Mexico, North Carolina, South Carolina, Texas, and West Virginia. Contact information for the regional managers was obtained from the EPA at: http://www.epa.gov/epaoswer/non-hw/muncpl/factbook/internet/intro/epa3.htm.

[9] It is assumed that a state's unit of observation for MSW data collection is independent of the relationships tested in this paper. Violations of this assumption could potentially bias the results.

business establishments are measured on a per capita basis. The analysis includes a variable for the percentage of firms in the service industries because customers of hotels, sporting events, hospitals, entertainment venues and the like deposit much of their waste on site. In contrast, retail, wholesale, and manufacturing industries, among others, involve products that become waste elsewhere. The rate of serious crimes is included as a proxy for moral climate, and the political party variable may capture other social priorities.

Table 3 provides sample means and standard deviations. The sample is broadly representative of the population at large. For example, 83 percent of the sample completed four years of high school or more, 40 percent voted for the Republican presidential candidate in 1992, and 15 percent were 65 years old or older. The analogous figures for the entire U.S. population during the same time period were 82 percent, 37 percent, and 13 percent respectively. Although every region of the country is represented, only four percent of the counties for which MSW levels were available reside in the East. Thus, the findings in regard to the EAST dummy variable may not be representative of the larger region. The other three regions of the country receive approximately equal representation within the sample. Adults between 22 and 64 years of age represented 53 percent of the residents in the sampled counties on average. Hispanic citizens and African American citizens composed about seven percent of county population on average, and there was an average of one non-farm establishment for every 43 individuals in the counties studied.

Insert Table III about here.

V. The Model and Hypotheses

Following Sterner and Bartelings [1999], this analysis involves log-linear specifications that do not combine income and strong determinants of income (e.g., education) in the same equation. The model can be interpreted as a demand function for waste disposal services. The first specification involves all of the variables except income:

$$\ln WASTE = \alpha_0 + \alpha_1 HIGH\ SCHOOL + \alpha_2 COLLEGE + \alpha_3 ESTABLISHMENTS +$$

$$\alpha_4 SERVICE\ INDUSTRY + \alpha_5 LAND + \alpha_6 FARMS + \alpha_7 SERIOUS\ CRIME + \alpha_8 NORTH$$

$$+ \alpha_9 EAST + \alpha_{10} SOUTH + \alpha_{11} ESKIMO/ALEUTIAN + \alpha_{12} ASIAN/PACIFIC$$

$$ISLANDER + \alpha_{13} AFRICAN\ AMERICAN + \alpha_{14} HISPANIC + \alpha_{15} ADULTS +$$

$$\alpha_{16} SENIORS + \alpha_{17} POLITICAL\ PARTY + \varepsilon.$$

Previous studies (e.g., Anderson, 1994, 653) have demonstrated strong relationships between income and education, race, service occupations, and business centers. For this reason, the second specification includes income and omits the variables most likely to correlate with income (HIGH SCHOOL, COLLEGE, ESTABLISHMENTS, SERVICE INDUSTRY, and the race variables):[10]

$$\ln WASTE = \alpha_0 + \alpha_1 INCOME + \alpha_2 LAND + \alpha_3 FARMS + \alpha_4 NORTH + \alpha_5 EAST +$$

$$\alpha_6 SOUTH + \alpha_7 ADULTS + \alpha_8 SENIORS + \alpha_9 POLITICAL\ PARTY + \varepsilon.$$

In these equations ε is a stochastic error term and *i* subscripts are dropped for simplicity. These equations can be estimated using ordinary least squares given the appropriate assumptions about the normality of the error term. On the basis of a White test performed using the SAS SPEC procedure, the joint null hypothesis of independent and homoskedastic errors and valid model specification is accepted for both models at any conventional level of significance.

The models do not include variables for pay-per-throw programs or gender. Pay-per-throw programs provide incentives for waste reduction by charging per-unit fees for disposal. These programs typically exist at the city level, whereas the unit of observation in this study is the county. A small proportion of the counties in the sample contained cities with pay-per-throw programs, but it was unknown what proportion of those counties' populations the programs affected. Test regressions that included a dummy variable for counties with at least one pay-per-throw program produced no significant results.

Gender distribution was not included in the sample. Variation in a gender variable at the county level may have been limited, and previous studies by Sterner and Bartelings [1999] and Reschovsky and Stone [1994] found no significant gender effect on waste disposal, newspaper recycling, composting, or waste incineration. Furthermore, in contrast to the above variables, there has been very little change in gender representation. Between 1970 and 1999, the male population of the U.S. increased from 48.7% to 48.9% of the overall population. The female population decreased from 51.3% to 51.1%. No significant trends in regard to gender are anticipated. For these reasons, this study does not focus on gender.

Education and income have theoretically indeterminate effects on MSW generation. Both may foster relatively immodest lifestyles and the pursuit of material possessions. Education may also be environmentally enlightening, and conservation may behave as a luxury good. Composters, recycling bins, and products made from recycled materials all cost more than their less ecological alternatives. Lackman [1976] suggests that individuals with higher incomes will generate relatively more solid waste. Given the higher opportunity cost of their time, he reasons that high-income groups will prefer to spend money on disposable items rather than time on repairable or returnable goods. The results will speak to this hypothesis.

[10] For example, SAS collinearity diagnostics indicate a proportion of variation of 0.875 between income and the HISPANIC variable.

Beyond the income effects of advanced schooling, education may convey the repercussions of waste and teach alternatives to resource exploitation. Some secondary school curricula require students to construct solar water heaters and learn conservation techniques. Some college level courses provide exposure to more advanced conservation methods. And some college campuses bring students into contact with recycling bins and outspoken environmentalists. Thus, education may have a negative effect on waste. In support of this hypothesis, Callan and Thomas [1997] estimated that education had a positive but not statistically significant effect on recycling, and Sterner and Bartelings [1999] found education to have a negative but not statistically significant effect on waste disposal demand.

Establishments represent sources of consumption and subsequent waste generation, suggesting a positive effect. Service industries in particular use a smaller volume of resources than manufacturing, retail, and wholesale industries. However, the latter ship their products to customers around the country, while the waste that service industries do generate is more likely to remain within the county in such forms as medical waste, office waste, and food containers from sporting events, hotels and amusements. For these reasons, the percentage of service industries is expected to have a positive effect on county-level MSW.

Rural areas offer improved opportunities for composting, the use of food waste as animal feed, storage for re-use, and on-site disposal. They also offer inferior access to retail shopping venues, perhaps reducing the temptation to dispose of assets that are maintainable or reusable. The LAND per capita variable will pick up some of the influences of urbanization, and the FARM variable will test related stereotypes of frugality in agrarian culture. Anecdotal evidence includes quilts made from old clothing and tractors built from old parts. Cailas et al. [1996] find a positive correlation between population density and waste, and Callan and Thomas [1997] provide related evidence that population density has a negative and significant effect on recycling levels.

As a gauge of morality, SERIOUS CRIMES is expected to correspond with higher rates of waste. The POLITICAL PARTY variable, a proxy for pro-business versus pro-environment priorities, is hypothesized to have a positive effect on waste. The East and North have relatively more bottle recycling bills, pay-per-throw trash programs, and curbside recycling programs. If these are indications of more aggressive attitudes towards waste reduction, EAST and NORTH should have negative coefficients. Eskimo and Aleutian cultures practice reverence for the animals that sustained their communities,[11] and the concomitant mentality that no flesh or bone should go to waste. If this attitude carries over to resource use more generally, these groups can be expected to produce less waste. African Americans and Hispanics are expected to dispose of more waste as the result of disproportionate representation in relatively poor areas where the quality of education is inferior for any given level of education. Seniors, who lived through the

[11] For example, whaling ship captain Burton "Atqann" Rexford wrote: “The bowhead [whale] is our brother. Our elders tell us that the whales present themselves to us so that we may continue to live. If we dishonor our brother or disturb his home, he will not come to us anymore.” See the *World Council of Whalers News*, http://www.worldcouncilofwhalers.com/Newsletter/NL93.html, accessed October 18, 2001.

imposed frugality of the depression (or were closer to the generation that did), are expected to dispose of less waste than adults or children.

VI. Findings and Discussion

Table 4 presents the results of the first equation. The findings suggest that education has a different effect on waste disposal at different levels of schooling. Relative to no high school, the completion of high school had a positive effect that was not statistically significant ($t = 1.02$), and the completion of college had a statistically significant negative effect. The income effects of a college education are apparently compensated for, perhaps by increased environmental awareness and a willingness to spend some of the added income on conservation efforts. As hypothesized, the number of establishments per capita had a highly significant positive effect, as did the percentage of firms in the service industry.

Insert Table IV about here.

Land per capita had a significant negative coefficient.[12] As the amount of undeveloped land decreases and fewer property owners can dispose of waste *locus rei sitae*, there will be greater needs for landfills and other disposal methods. The LAND variable picks up the increased options for composting, disposal of food waste in livestock feed, and informal dumpsites in rural areas, all of which allow lower rates of solid waste disposal by the municipality with or without lower rates of solid waste generation. Evidence of the relative frugality and resourcefulness of rural agrarian populations comes from the negative coefficient on FARMS, which is significant at the 1-percent level. Controlling for land per capita, a decrease in the number of farms constitutes a decrease in the number of farmers. These estimates suggest that current trends toward larger farms and fewer farmers will coincide with increasing resource expenditure.

The findings suggest that moral decay as signified by crime rates is reflected in MSW levels. The coefficient on SERIOUS CRIMES was positive and significant at the 5-percent level. This may result from differing moral values among the citizens that lead some to care less about the environment, or from differing priorities in high-crime areas that bring expenditures on security that might elsewhere be spent on conservation. The hypothesized negative coefficient on EAST was significant at the 5-percent level, although the other regions did not have significant effects.

As expected, ESKIMO / ALEUTIAN had a negative effect, although it was only significant at the 15-percent level. The highly significant positive coefficient on AFRICAN

[12] These regressions were also run with population per acre in place of land per capita. The results were substantially the same, although the R-squared values were lower and the statistical significance was slightly weaker for the majority of variables in each regression.

AMERICAN may reflect the quality of schooling in predominantly African American counties more so than any cultural phenomenon. It might be safe to assume that conservation is a learned behavior, and under-funded urban school systems may place less emphasis on recycling than suburban schools. HISPANIC was expected to have a positive coefficient for the same reasons, although this value was only significant at the 25-percent level. ASIAN / PACIFIC ISLANDER had no statistically significant effect on the level of waste disposal.

The hypothesized frugality of senior citizens was not statistically significant at any acceptable level, but may be evident in the weak (t = -0.84) negative coefficient on the SENIORS variable. The influences of the adult and senior age levels are measured relative to the effect of youth, and the weak (t = 1.39) positive effect of the ADULT variable compared with the negative SENIORS coefficient may indicate a meaningful difference between adults and seniors. As a unique contribution to the literature, and as expected, POLITICAL PARTY had a positive and significant coefficient.

As indicated in Table 5, the inclusion of income in the second model yielded a positive and statistically significant coefficient. As incomes increase worldwide, the amount of waste is likely to increase. Among the variables that appeared in both models, each of those found to have significant effects in the first model were again found to have significant effects of the same sign in the second model. As one would expect with a decrease in the number of explanatory variables, several of the variables appeared more significant in the second model. For example, the proportion of adults again had a positive effect, this time at the 10-percent level of significance.

Insert Table V about here.

VII. Conclusion

Over the next century, the population of the United States will become older, wealthier, more diverse, and better educated. The overall population will double, and regions in the South and West will experience even more substantial increases in population. These and related socio-economic trends are echoed throughout the world, and involve influences on the environment including resource depletion and subsequent expansion in municipal solid waste production. With per-capita municipal solid waste levels rising by over one percent annually and a concurrent decrease in the number of available landfills, the objective of this project is to examine the relationship between demographics and the amount of waste generated but not recycled.

The findings suggest that municipal solid waste disposal at the county level decreases with the number of farms per capita, the amount of land per capita, and the percent of the population with a college education. The number of establishments, the percent of firms in the

service industry, per-capita income, the percent of republican voters, the percent of African Americans, and the serious crime rate all exhibit significant positive coefficients. An understanding of these relationships may permit the anticipation of future solid waste crises, and the targeting of policy initiatives toward the most profligate groups. Further research could determine the most effective ways of introducing, for example, the resourceful values of farming culture to inner-city youth, and policies that address the particular solid waste issues of service establishments.

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Table 1

Composition of U.S. Municipal Solid Waste, 2003

Material	Percent
Paper / Paperboard	35.2
Yard Trimmings	12.1
Food Scraps	11.7
Plastic	11.3
Metals	8.0
Rubber / Leather / Textiles	7.4
Wood	5.8
Glass	5.3
Other Waste	3.4

Source: EPA [2005]

Table 2

Variable Definitions

WASTE	Annual tons of municipal solid waste disposed of per capita in county
HIGH SCHOOL	Percent high school graduates, but not college graduates
COLLEGE	Percent college graduates
ESTABLISHMENTS	Private non-farm establishments per capita
SERVICE INDUSTRY	Percent of firms that are in service industries
LAND	Land area in square miles per capita
FARMS	Number of farms per capita
SERIOUS CRIMES	Serious crimes per 100,000 population
NORTH	Regional dummy variable: 1 if county resides in northern U.S., 0 otherwise
EAST	Regional dummy variable: 1 if county resides in eastern U.S., 0 otherwise
SOUTH	Regional dummy variable: 1 if county resides in southern U.S., 0 otherwise
ESKIMO / ALEUTIAN	Percent of population that is American Eskimo or American Aleutian
ASIAN / PACIFIC ISLANDER	Percent of population that is Asian or Pacific Islander
AFRICAN AMERICAN	Percent of population that is African American
HISPANIC	Percent of population that is of Hispanic origin
ADULTS	Percent of population between the ages of 22 and 64 inclusive
SENIORS	Percent of population 65 and over
POLITICAL PARTY	Percent of Republican votes in presidential election
INCOME	Income per capita in dollars

Table 3

Sample Means and Standard Deviations (N=1055)

Variable	Mean	Standard Deviation
WASTE	1.33	5.78
HIGH SCHOOL	69.31	10.22
COLLEGE	13.49	6.62
ESTABLISHMENTS	0.023	0.0068
SERVICE INDUSTRY	31.27	4.81
LAND	0.079	0.22
FARMS	0.030	0.034
SERIOUS CRIMES	2,892.01	2,549.22
NORTH	0.31	0.46
EAST	0.04	0.20
SOUTH	0.31	0.46
ESKIMO / ALEUTIAN	1.06	4.39
AFRICAN AMERICAN	7.48	11.94
ASIAN / PACIFIC ISLANDER	0.92	3.59
HISPANIC	7.03	14.69
ADULTS	53.07	3.21
SENIORS	14.75	4.50
POLITICAL PARTY	40.31	8.71
INCOME	17,171.79	4076.70

Table 4

Estimate of Log Waste Equation*

Variable	Coefficient	t – ratio
INTERCEPT	-2.72[a]	-3.31
HIGH SCHOOL	0.0048	1.02
COLLEGE	-0.012[c]	-1.78
ESTABLISHMENTS	17.15[a]	3.38
SERVICE INDUSTRY	0.021[a]	3.11
LAND	-0.30[b]	-2.02
FARMS	-3.77[a]	-3.03
SERIOUS CRIMES	0.000028[b]	1.98
NORTH	0.059	0.67
EAST	-0.32[b]	-2.04
SOUTH	-0.0089	-0.08
ESKIMO / ALEUTIAN	-0.0090	-1.42
ASIAN / PACIFIC ISLANDER	0.0045	0.58
AFRICAN AMERICAN	0.0059[b]	2.04
HISPANIC	0.0032	1.18
ADULTS	0.019	1.39
SENIORS	-0.0076	-0.84
POLITICAL PARTY	0.0075[b]	2.24

* R-square = 0.15, adjusted R-square = 0.14.

[a] Significant at the .01 level.

[b] Significant at the .05 level.

[c] Significant at the .10 level.

Table 5

Estimate of Log Waste Equation with Income Variable*

Variable	Coefficient	t – ratio
INTERCEPT	-1.71[b]	-2.46
INCOME	0.000017[b]	2.13
LAND	-0.32[b]	-2.24
FARMS	-7.19[a]	-6.67
NORTH	-0.096	-1.32
EAST	-0.41[a]	-2.70
SOUTH	-0.057	-0.71
ADULTS	0.022[c]	1.71
SENIORS	0.0014	0.17
POLITICAL PARTY	0.0067[b]	2.06

*R-square = 0.119, Adjusted R-square = 0.111

[a] Significant at the .01 level.

[b] Significant at the .05 level.

[c] Significant at the .10 level.