Alternatives for Financing Municipal Services: The Case of Unit-Priced Trash Disposal

by

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Abstract

New policy is being developed that incorporates not only innovative means of disposal, including the integration of source reduction and recycling, but also innovative approaches to funding disposal of municipal solid waste (MSW). This study was conducted to determine if a higher marginal price for MSW disposal affected per capita waste generation in New Hampshire towns, how the existence of a pay-as-you-throw (PAYT) program influenced per capita MSW generation, and to attempt to determine which towns were most likely to adopt a PAYT program in the future. The results showed that average household size, existence of a capital improvement plan, and marginal price to dispose of waste were statistically significant influences, regardless of the variation of price in the PAYT program. Towns with PAYT programs currently being implemented produce 0.18 tons of MSW less waste per capita per year than towns without PAYT programs.

Introduction

Local governments in the rural United States are likely facing some of the most severe fiscal management crises in history. Stresses caused by national and regional economic downturns, a steady decline in state and federal support, and antipathy toward the expansion of traditional revenue sources like the local property tax have all negatively affected local cash flows (Knight et al. 2003; McGuire and Steuerle, 2003; Reschovsky 2003). While much of the current fiscal crisis can be attributed to the recent economic recession, the current fiscal picture is particularly difficult for two reasons. First, the rapid and prolonged economic expansion of the 1990s resulted in significant increases in state and local government revenues. As a result, support for public programs, predominantly public education and corrections, increased significantly. Second, even with increases in spending levels, the fiscal situation allowed for significant reductions in tax rates and promotion of one time refunds. The convergence of these three factors (economic

recession, increases in based funding, and tax reduction)—a "perfect storm" of fiscal problems--make the current fiscal picture particularly difficult.

Attempted major tax system overhauls or tax increases in republican-governed states like Alabama, Nevada, South Carolina, and New York have led to public uproar and the threat of curtailment of major public services (Wilson, 2003; Mclaughlin, 2003). Unlike the federal government, most state governments in the U.S. are required to balance their annual budgets, leading to difficult choices whose consequences are often felt at the local level. Nonetheless, local government continues to bear the responsibility for providing educational services, police and fire protection, solid waste management, and much of road maintenance and construction services, among others.

In the face of decreasing revenues, Deller (1998) notes that local government is effectively left with three major options: (1) cut back on services offered; (2) eliminate the service completely and allow market forces to determine if the private sector provides the service; or (3) find more efficient ways to provide necessary services, via consolidation or cooperative agreements among governments for service production. Another option, (4) "quasi-privatization," might be added, wherein governments continue to hold principal responsibility for the service provision but incorporate market-based devices such as fee for services in an effort to ration use.

Lopez-de-Silanes et al. (1997) note that there are three principal determinants of the choice between privatization and public provision: (1) **Efficiency.** There is evidence which suggests that private contracting can save local governments considerable expenses (e.g. Savas, 1987; Kemp, 1991; Johnson and Walzer, 1996). However, in some

respects efficiency may be better served by public sector provision, as social goals may be weighed more appropriately by government rather than private sector managers; (2) **Political patronage.** Politicians may get political support from public sector employees; (3) **Ideology.** This view is generally regarded as opposition to larger government.

Comparing the three determinants of privatization (efficiency, political patronage, and ideology) identified by Lopez-de-Silanes et al. (1997), to the four methods of altering government provision of a service (cut back on services, privatization, cooperative agreements, and quasi-privatization) brings an interesting insight. A local government's menu of options allows it to reduce costs, even if factors like patronage or ideology rule out privatization or one of the other options. For example, a local government that wants to reduce costs, but maintain direct control, could choose to cut services or adopt quasi-privatization.

To represent this distinction in a theoretical model that follows in the spirit of Boyko, Shleifer, and Vishny (1996) and López-de-Silanes et al. (1997), we start with the assumption that a local government official gets utility from having direct control over services, c, from political patronage, p, which comes from public employees, and from representing the interest of her constituents, r.[2] These constituent interests are themselves endogenous and depend on the degree that the official provides services efficiently (eff) and makes decisions that are consistent with voter ideology (i). Finally, the importance of constituent interests depends on fiscal stress (s). At times of fiscal

[2] Alternatively, this variable might represent prospects for reelection.

crisis, the local official feels stronger pressure to satisfy constituents. The local official's utility function is:

(1) $U(g) = u(c, p, r(eff, i, s))$

This formulation allows for the possibility of tension in the local official's maximization problem. For example, if privatization is most efficient or most closely matches voter ideology, then the official must weigh her desire for local control against the desires of her constituents.

From this simple utility framework, we break the official's decision over a local service into two parts. First, the official decides if provision of the service should be changed, and she then decides what form that change should take. The first step involves the ability of the official to match the preferences or demands of the citizenry. Within the public administration literature the ability of the official relates to effectiveness. The second step is a purely production decision where inputs are transformed into outputs. Public administrators focus on efficiency in this process.

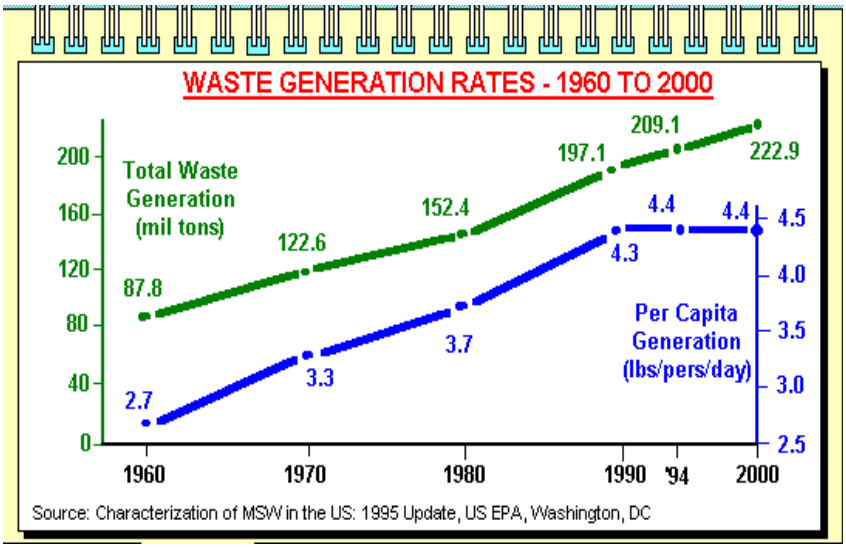
With respect to the first step, the decision to implement a change, we note that local conditions such as voter ideology or political patronage change only slowly over time. Therefore, these factors are unlikely to change the official's optimal choice of service provision. Fiscal stress changes much more rapidly, so we expect fiscal stress to be a strong predictor of change. A second force for change relates to efficiency. While the direct cost savings associated with implementing a new form of production probably stay relatively constant over time, efficiency also includes the cost of gathering information about different options, such as unit-based pricing for services.

A theoretical justification for privatization has been widely accepted in the literature (Ostrom et al. 1961). The basic tenets describe a government that becomes smaller and more responsive to citizen needs. The smaller units of government essentially provide a multitude of service "bundles" at differing prices and allow citizens to vote with their feet by moving to a location with the right mix of services. Others advocate privatization on the grounds that politicians cannot make strictly efficient decisions (Boycko et al. 1996). This theoretical context blends nicely with other general theories of market efficiency, and it has become increasingly popular with federal government. Whether this popularity is driven by empirical evidence is debatable. Lopez-de-Silanes et al. (1997) note that states with "clean government" laws and laws restricting county spending encourage privatization, while strong unions, particularly militant unions, tend to prevent it.

The Case of Municipal Solid Waste Management

Advances in science and technology have led to an increased awareness of the environmental and human health impacts of solid waste disposal. This has forced public managers to rethink solid waste management and policy. New policy is being developed that incorporates not only innovative ways of disposal, including the integration of source reduction and recycling, but also innovative approaches to funding this expensive service. Currently, the issue of solid waste disposal is one of the most complex and pressing issues in the environmental arena, yet often the least discussed. According to data collected by the United States Environmental Protection Agency (USEPA, 1996) and detailed in Figure 1, waste generation has increased at a steady rate since 1960.

Figure 1 – Waste Generation Rates – 1960 to 2000

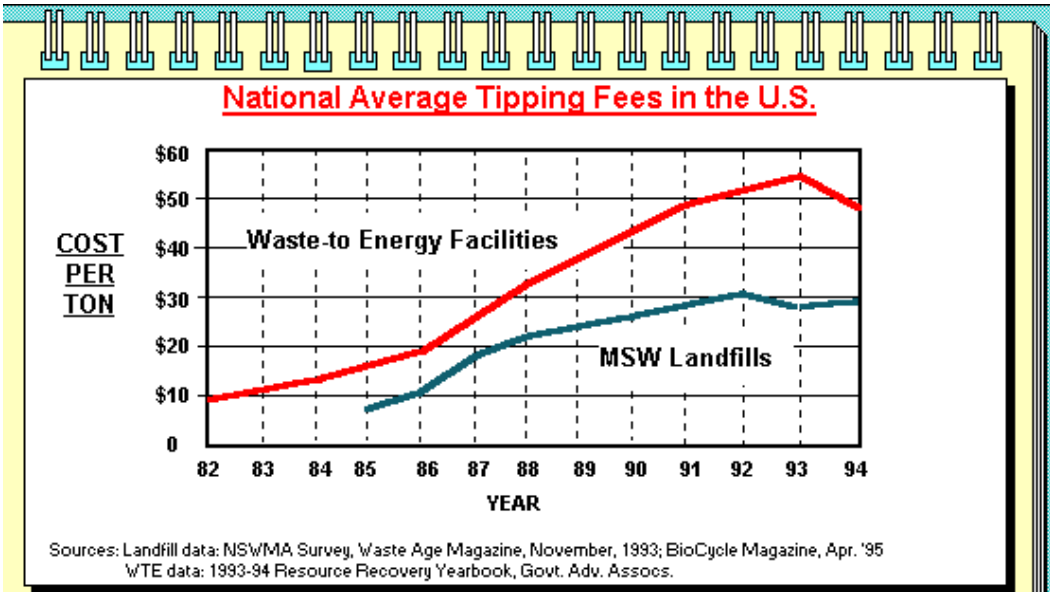


Historically, the policy for municipal solid waste management has been comprised of municipal-tax funded, curb-side trash collection and a local "dump". This kept both collection and disposal locally based. However, many of these local landfills have reached their capacity and closed. Current regulations dictate strict and expensive procedures for closing and capping local landfills. This is especially true in the northeast corner of the United States. As capacity in these states diminishes the export rate from states with less capacity to states with more capacity will increase and the rate of landfill space depletion will increase.

Today's new landfills are state of the art, modern facilities which are regionally, rather than locally based, and in most cases the service has moved from a municipal provision to a privately owned business. Communities rather than providing the service are now forced to buy the service of MSW management from the private sector. As to be expected, the private sector has not only passed the cost of the updated systems largely onto the consumer, but has set prices in order to maximize profits. This has left communities with little choice other than paying the hefty "tipping fees." As of

1994 the EPA cites national averages of tipping fees as increasing at a steady rate as is exemplified by Figure 2.

Figure 2 – National Average Tipping Fees in the U.S.



In 2001 the New Hampshire Solid Waste Task Force found that only 6% of all solid waste management facilities in the state were under private ownership, but this 6% took in nearly 85% of all municipal solid waste. Related was the issue of cost, which the task force found dependent in large part on the small number of firms in the industry leading to near monopoly on business. That combined with a more regional rather than local disposal network with longer transportation routes, a tight labor market and unpredictable fuel prices resulted in average tipping fees in 2000 higher than at any time in the past 10 years. The task force found that one of the most successful programs initiated, which helps both reduce generation rates and increase recycling rates was the Pay-as-you-throw (PAYT) program. This program could help

alter the waste generation and waste diversion amounts in order to combat the shrinking rate in capacity, and lessen the rising tipping fees via quelling the fear of costly expansions of existing facilities, exporting long distances to open facilities or building newer and more high tech, expensive facilities.

Typically, municipal governments have funded local programs and services through taxation. Tiebout in his 1956 article on local expenditures explains that hypothetically the government's job is to "ascertain the consumer's wants for a public good and tax him accordingly" however a "rational consumer will underestimate his preferences and hope to enjoy the goods while avoiding the tax." Because of this phenomenon, a consumers' wants are estimated and combined with an "ability to pay principle", to give a municipality their current budget (Tiebout, 1956, pg 417). Locally, the services and programs are budgeted, approved or accepted through a town meeting or ballot and the tax rate is set accordingly. In this manner, each household pays a certain amount, a portion of which then goes toward solid waste disposal costs. This leaves every household with a marginal cost of zero for every additional unit of solid waste they produce – a system with no financial incentives for reducing the waste stream even when free recycling is offered.

The PAYT Program

In Tiebout's model, fully mobile and educated consumers are the ingredients for an improved allocation of government expenditures (Tiebout, 1956). The "Pay as You Throw" program, sometimes also referred to as a "Bag-and-Tag" program, provides this mobility. PAYT offers consumers flexibility in their choice of the amount of service

needed. The consumer in a PAYT system can choose options to affect the amount of waste produced and thus the amount of service requested.

Until about 1988, only a handful of cities experimented with unit pricing for solid waste, when coincidently several cities across several states including Illinois, Pennsylvania, New York and New Jersey implemented extensive and successful programs (Miranda, et al. 1994). Since then the use of PAYT has grown and today more than 4,000 communities employ such a program (Miranda, 2002). Miranda et al. (1994), in a study of 21 cities from 1990 – 1992, found significant reductions in MSW disposal at landfills in every town in the study. Reduction levels ranged from 17% to 74%. Most cities had a recycling program prior to the start of a PAYT program and all experienced an increase in the rate of recycling with the institution of a PAYT program. A later study (Miranda and Aldy, 1998) found that in seven of the nine communities studied in the states of California, Michigan and Illinois, MSW waste generation decreased by 20% after a PAYT program was instituted, while in the remaining two communities, waste decreased by 50% and 38%. She found that factors influencing such a reduction included higher unit pricing fees, smaller container size, accompanying yard waste collection programs, and free recycling. Eight of the nine communities had significant increases in the recycling rates, ranging from 30% to a doubling in the recycling level. Reschovsky and Stone's (1994) study of Tompkins County, NY found that a PAYT program combined with a mandatory curbside recycling program, increased recycling between 22-58 percent depending on the material

Geographic location also appears to affect the results of past studies regarding PAYT policies' influence on MSW generation rates and recycling rates. Callan and Thomas (1997) conducted a study in Massachusetts in which they predicted that a community implementing a PAYT program would increase their recycling rate by 6.5 percent, adding an additional 5.5 percent increase if it was a curbside pick-up recycling program. Seguino et. al.'s 1995 study on PAYT programs in the State of Maine compared 29 PAYT communities to a control group of 28 towns located at least 30 miles from PAYT communities to help control for illegal dumping in, or a shift in MSW to neighboring towns. This study found that existence of a PAYT had a statistically significant negative impact on per capita MSW generation; however, all other variables, including mandatory recycling, were not statistically significant influences on per capita MSW generation. Furthermore, curbside pickup had a statistically significant positive effect on per capita MSW generation.

Several studies have examined diversionary means such as illegal disposal, burning, or increased composting. These means of diversion in New Hampshire were not included in this study because of the lack of accurate state level statistics, however, the rural nature of this state certainly leaves illegal dumping or burning as a potential problem then needs further investigation. Miranda and Bynum (2002) found that when she looked closer at the nine towns from her 1998 study, seven cited problems with illegal dumping or burning of trash. Fullerton and Kinneman (1994) conducted a 4-week observation immediately following implementation of a PAYT program in

Charlottesville NC and found that 5.33% of households disposed of garbage illegally and they estimated illegal disposal made up 28% of the overall reduction in MSW.

The second phenomenon that occurs with the implementation of PAYT is a lower cost of service provision resulting from a reduced waste stream. In Van Houtvan's 1999 study, researchers concluded that MSW was reduced by approximately 1.6 lbs. per household per day at a savings cost of $0.06 per household per day.

Jenkins (1993) found price elasticity of demand for residential solid waste services to be -0.12. She estimated that in response to a $1.31 per 32-gallon price for PAYT, MSW will decrease by 20%, or by 183 lbs. annually per capita. Fullerton and Kinnaman (1994) found the price elasticity of demand for garbage disposal Charlottesville, Virginia to be -0.075. Table 1 summarizes price elasticities found in previous studies.

Table 1. Survey of Price Elasticities for PAYT Programs

Author	Year	Elasticity
Fullerton	1994	-0.075
Kinnaman and Fullerton	2000	-0.28
Van Houtven and Morris	1999	-0.26
Morris and Holthausen	1994	-0.51 to -0.60
Albrecht	1977	0.44

Methods

This study tests three basic hypotheses. The first is that the marginal price of a PAYT service is inversely related to waste generation. To test this hypothesis the following equation is used:

(2) GenMSW = f (E, SD, PV, Price PAYT)

where E are economic variables such as property taxes, SD are socio–demographic variables such as mean population and mean per capita income level, PV are political variables such as whether the town already has adopted policies or ordinances on mandatory recycling programs or curbside trash pick-up and **(Price PAYT)** is the cost of MSW disposal.

The second, model was designed to test the effect of merely the existence of a PAYT program on MSW generation rates. To test this hypothesis the following equation is used:

(3) GenMSW = f (E, SD, PV, PAYT)

where PAYT is a dichotomous variable describing whether a town employs a PAYT program or not.

Finally, using the variables from both regression analyses, a logit model was used to predict a community's likelihood of adopting a PAYT program:

(4) PAYT = f (E, SD, PV)

A review of existing literature found no consistent form used across PAYT studies. Researchers such as Callan (1994), Seguino (1995) and Nestor (1998) used a linear functional form, whereas others such as Callan (1999) and Miranda (1999) used a logarithmic functional form. A majority of existing literature on demand functions uses a double log form (Phlips, 1983; Deaton and Muellbauer, 1980). Although this is not a straightforward demand function analysis, this is a study of the demand for a service. In this study, both linear and logarithmic forms are presented. Analyses focused on the year 2000, because of the coincidence with the United States Census data that made an array of social and demographic data specific to 2000 available. Thus, all towns used in this analysis had adopted the PAYT program prior to 2000.

Choice of independent variables used in the estimation was based on previous studies. These variables are summarized in Table 2.

Table 2 – Description of Variables Used in PAYT Models

Variable Notation	Expected Sign* MSWgen/PAYT	Mean (Std. Dev.)	Variable Description
pop00	+/+	5,744.98 (11,030.37)	Population, 2000
AveSize00	- / -	2.55 (0.23)	Average size of households, 2000 (# of persons)
YN MP	0/+	0.97 (0.18)	Master plan exists, 1 if yes, 0 if otherwise
YN CIP	0/ +	0.64 (0.48)	Capital Improvement plan exists, 1 if yes, 0 if otherwise
Curbside	+/+	0.25 (0.44)	Curbside pick-up for solid waste, 1 if yes, 0 if otherwise
MandRec	- /+	0.52 (0.50)	Mandatory Recycling, 1 if yes, 0 if otherwise
Per Capita Inc	+/ -	15,167.81 (3,871.98)	Per Capita Income, 1999 (dollars)
msw00	D/+	2,782.96 (6,170.16)	MSW, Tons per year, 2000
prtax00	+/+	24.09 (5.98)	Property tax rate, 2000 (dollars per thousand dollars of property value)
PAYT	- / D	0.15 (0.36)	PAYT program exists, 1 if yes, 0 if otherwise
PAYT Price per 15 gallon	- / D	0.12 (0.29)	Price in dollars for MSW per 15 gal. Container
median age	- /+	39.32 (4.17)	Median age
Bachelors	+/+	27.96 (12.89)	Percentage of the population possessing a bachelors degree
below pov	- / -	4.09 (2.38)	Percentage of the population below the poverty level
GalPcmsw00	D	0.49 (0.54)	Gallons of municipal solid waste per capita, 2000

* Expected sign: (+) means this particular independent variable is anticipated to positively influence the dependent variables, (-) means this particular independent variable is anticipated to negatively influence the dependent variables, (0) means this particular independent variable is anticipated to have no influence the dependent variables, (D) means this variable is used as a dependent variable.

In order to give this study a more realistic non-PAYT program price the average price of a normal garbage bag was used for the unit price variable for towns that do not have a PAYT program. It was assumed that even without a PAYT program approximately half of the households in town purchased standard trash bags in order to dispose of their waste. The price of

a standard trash bag was obtained from Walmart. This assumption was used based on the fact that Walmart would have competitive prices and is widely distributed geographically around the state. A price of $0.375 cents per 15-gallon bag was used for the price variable in towns without a PAYT program. Existence of a Master Plan **(YN MP)**, especially one that has been in existence for several decades **(Cat MP)**, may be indicative of a community at the forefront of municipal planning strategy, which may be more willing to adopt a new program such as PAYT. Likewise, existence of a capital improvement plan **(YN CIP)** may be indicative of a community with more fiscal awareness that may know of and recognize the fiscal benefit of a PAYT program. Mean per capita waste disposal rates in New Hampshire are 0.488 tons per person, per year. When converted to a pounds-per-day unit this works out to 2.67 lbs. per person, per day. The number captures the amount of waste reported by the MSW industry in terms of tipping fees per ton. It does not capture the total amount of waste generated, which may include recycled and composted materials. This makes it hard to compare with the 4.46 lbs per person, per day national average cited by the EPA in 1998 (NHDES, 2000).

Data including population, municipal tax rate, annual municipal solid waste rate, as well as a series of demographic and political variables were collected for all 235 towns in New Hampshire from the State webpage. Information on the 34 towns which currently employ PAYT programs, and details regarding each program including marginal cost to the homeowner in cents per gallon, were obtained from the State of New Hampshire Governor's Recycling Program. The State of New Hampshire Revenue Department provided the municipal tax rates, while the State of New Hampshire

Department of Environmental Services (DES) provided the annual municipal solid waste disposal rates in terms of tonnage per municipality. Population data were collected from the State of New Hampshire Office of State Planning web page. Unfortunately, most New Hampshire communities do not keep detailed and complete records of solid waste generation rates.

Of the 235 incorporated municipalities in New Hampshire, 186 were included in the analysis. Of the 35 municipalities that had adopted PAYT programs, two had to be dropped because they adopted their programs in 2001 and two were dropped because they did not have MSW generation data for 2000. This resulted in 31 PAYT communities included in the analysis.

Model Specification. The analysis used both double log form and linear form. The equations used in the analysis are as follows:

(5) Adoption of PAYT = $\alpha + \beta_1$pop00 + β_2AveSize + β_3Curbside + β_4MandRecy + β_5PerCapitaInc + $\beta_6$prtax00 + β_1Median Age + β_7Bachelors + β_8Below pov + ε

(6) MSW Per Capita = $\alpha + \beta_2$AveSize + β_3Curbside + β_4MandRecy + β_5PerCapitaInc + $\beta_6$prtax00 + β_7Median Age + β_8Bachelors + β_9Below pov + β_{11}PAYT Price + ε

(7) LnMSW Per Capita = $\alpha + \beta_2$LnAveSize + β_3Curbside + β_4MandRecy + β_5LnPerCapitaInc + β_6Lnprtax00 + β_7LnMed Age + β_8LnBachelors + β_9LnBelow pov + β_{11}LnPAYT Price + ε

Linear and Logarithmic PAYT program existence function:

(8) MSW Per Capita = $\alpha + \beta_2$AveSize + β_3Curbside + β_4MandRecy + β_5PerCapitaInc + $\beta_6$prtax00 + β_7Median Age + β_8Bachelors + β_9Below pov + β_{10}PAYT + ε

(9) LnMSW Per Capita = $\alpha + \beta_2$LnAveSize + β_3Curbside + β_4MandRecy + β_5LnPerCapitaInc + β_6Lnprtax00 + β_7LnMed Age + β_8LnBachelors + β_9LnBelow pov + β_{10}PAYT + ε

where variables are as described in Table 2.

RESULTS

Results of the various models are shown in Tables 3 - 5. A Breusch-Pagen test confirmed that heteroskedacticity was a problem in the model. The final least squares models used White Corrected Standard Errors for calculating confidence intervals.

In order to answer the question: "does marginal price for waste disposal affect average per capita generation rates across towns?" the analysis included average annual per capita municipal solid waste production as the dependent variable and marginal price per 15 gallon bag as one of a series of independent variables. Both towns with PAYT and towns without PAYT were included in this analysis. In towns without a PAYT program the estimated value for an over the counter generic 15-gallon trash bag, $0.0375 was used. PAYT program prices ranged from $0.43 to $1.50 per 15-gallon bag. Results are shown in Table 3 with both linear and logarithmic forms of the equation presented.

Table 3. Determinants of Per Capita MSW Generation Rates, New Hampshire Towns. Dependent Variable: Per Capita MSW, in Gallons

Independent Variable	Linear Model	Logarithmic Model
	Coefficient (Standard Error)	Coefficient (Standard Error)
Constant	6554.29 (2776.3)	2.13 (-1.84)
AveHHSize	-1325.92* (772.07)	-1.38 (0.84)
YNMP	527.65 (428.88)	0.11 (0.11)
YNCIP	-662.66* (326.81)	-0.96 (0.61)
Curbside	342.52 (292.70)	0.5 (0.75)
MandRecy	99.26 (254.18)	-0.59 (0.49)
PerCapInc	.132 (0.113)	0.39 (0.52)
PrTax00	-37.66 (28.51)	-0.19 (0.25)
Price15g	-1052.55*	-0.63*

	(582.84)	(0.25)
MedAge	-57.80 (39.66)	-0.22 (0.71)
Bachelor	-14.96 (17.65)	-0.66 (0.17)
BelowPov	35.39 (60.09)	-0.28 (0.99)
N	188	184
Adjusted R^2	0.08	0.05631
Breusch-Pagen with 12 DF	166.68	12.97
*** Significant at the 90% level** *** * Significant at the 99% level**		

Several of the variables that were significant in other studies were not statistically significant in our New Hampshire study. Van Houtven (1999) found MSW generation was lower in higher income households in Georgia, however this study found that income (**PerCapInc**) was not a statistically significant influence. Miranda and Aldy (1998) found relationships between recycling and PAYT and Callan and Thomas (1997) specifically focused on curbside recycling and found it a negative influence on MSW generation. Neither the mandatory recycling *(***MandRecy**) nor the curbside pick-up (**Curbside**) variable had any statistical significance in this study.

The coefficient for average size of the household ***(AVEHHSIZ)***, was –1325.92 and the coefficient for existence of a Capital Improvement Plan ***(YNCIP)*** was –-662.66. The coefficient for the price of a PAYT program ***(PRICE15g)*** in dollars per gallon in the linear form was –1052.54 and in the logarithmic form was –0.633. The results show that of the variables included in this study, average household size *(***Avehhsiz***)*, existence of a capital improvement plan *(YNCIP)*, and marginal price to dispose of waste *(***PRICE15G***)* were statistically significant influences, at the 90% level.

The significance of household size may imply that households with more people tend to buy in bulk resulting in less packaging. Also, larger households may tend to share many "common" items such as light bulbs and newspapers, again resulting in less packaging. It is difficult to tell why the existence of a Capital Improvement Plan ***(YNCIP)*** may have influenced generation rates. Towns that do have a Plan may exhibit characteristics of a more forward-thinking policy-making regimen and may be more apt to adopt a new program such as PAYT. The significance of the price variable suggests that, indeed, New Hampshire communities are vulnerable to price-effects, in that a shift in price will shift behavior.

The results indicate that marginal price for MSW disposal can lower annual per capita MSW generation rates. A conversion factor obtained from regional waste management professionals (Ellis, 2003), where 15 gallons of household MSW equals 10 pounds in weight, was used to relate the coefficient to pounds. Our coefficient for the linear form was –1052.54 suggesting that a one-dollar increase in the price of disposal will lead to a decrease in annual per capita municipal solid waste of approximately 1052.54 gallons per year. However, a one-dollar increase in the price of disposal is close to a 250% increase in the average unit price of this study (2.9 cents per gallon). In order to apply the coefficient we took one percent of the coefficient, to show that a one percent of a dollar increase in the price of disposal per gallon, or 1 cent, will lead to a decrease in annual per capita municipal solid waste of approximately 10.53 gallons, or 7.0 pounds average per capita per year. The average per capita MSW generation rate in NH, derived from our database is 0.488 tons or 976 lbs. If we apply this to a community of 26,000 (approximately the size of Portsmouth, NH) this would result in an overall reduction in household MSW of 91 tons per year, based on our conclusions.

Own price elasticities of demand were calculated for the both the linear and logarithmic coefficients. For the linear model, own-price elasticity at mean variable values was - 0.31. Elasticity for the logarithmic form (as illustrated by the estimated coefficient) was - 0.633. Thus own price elasticity of demand for waste disposal is relatively inelastic and comparable to those found by previous studies (Table 1).

Examining only PAYT programs, differences in per bag prices between towns with PAYT had no significant effect on the generation rate of MSW between these same towns. This may mean that towns implementing PAYT with higher marginal prices have no less waste generation than towns implementing PAYT with lower marginal prices, or that the variation of waste generation between towns with PAYT was too small for this study to capture. To explore the possibility that simply the *existence* of a positive marginal price, or the program itself and not necessarily the *difference between pricing amounts* influenced the average per capita MSW generation across the sample, models were estimated using only existence of PAYT (**PAYT**) as a dichotomous variable rather than price per gallon. The results are shown in Table 4.

Table 4. Determinants of MSW Generation Rates, Dependent Variable: Per Capita MSW, in Gallons

Independent Variable	**Linear Model**	**Logarithmic Model**
	Coefficient (Standard Error)	**Coefficient (Standard Error)**
Constant	6437.14 (2771.96)	2.64 (1.895)
AveHHSize	-1374.58 (777.0)*	-1.40 (0.870)
YNMP	537.31 (431.42)	0.112 (0.110)
YNCIP	-657.11 (321.73)*	-0.972 (0.595)
Curbside	-657.11 (321.73)*	0.471 (0.752)
MandRecy	87.08	-0.631

	(247.97)	(0.473)
PerCapInc	0.128 (0.114)	0.377 (0.525)
PrTax00	-37.63 (28.32)	-0.202 (0.255)
PAYT	-532.16 (210.46)*	-0.183 (0.650)**
MedAge	-60.67 (40.67)	-0.117 (-0.757)
Bachelor	-13.39 (17.92)	-0.529 0.174)
BelowPov	34.39 (59.78)	-0.336 (0.100)
N	190	186
Adjusted R^2	0.084	0.051
Breusch-Pagen with 12 DF	174.097	15.622
*** Significant at the 90% level** *** * Significant at the 99% level**		

This analysis yielded results very similar to the results obtained when price was used as an independent variable. The coefficient for existence of a PAYT program (PAYT) was significant at the 90% level in the linear form and at the 99% level in the logarithmic form. These results indeed indicate that simply existence of a PAYT program has a statistically significant impact on MSW generation whereas relatively small price changes between PAYT programs do not. For example, according to our results towns with PAYT programs currently being implemented produce 532 gallons less waste per capita than towns that do not have the PAYT program. Using the conversion factor of 15 gallons equaling 10 lbs, 532 less gallons per capita equals 354.6 pounds per capita of MSW, or 0.18 tons. This equates to a reduction in per capita generation of about 37 percent, which is within the range found in other studies.

In order to predict the likelihood of a town adopting a PAYT program based on the variables collected for this study, a Logit model was run using PAYT as the dependent variable. Table 5presents the results.

Table 5. Factors Affecting Adoption of PAYT Program. Dependent Variable: PAYT Program Existence

Variable	**Maximum Likelihood Estimates (β/std. Error)**
Constant	-13.06 (0.00)
AveHHSize	-5.34 (-3.272)**
YNMP	27.23 (0.000)
YNCIP	0.87 (0.178)
Curbside	0.45 (0.140)
MandRecy	-0.53 (-0.123)
PerCapInc	-0.69 (-0.624)
MedAge	-0.67 (-0.915)
Bachelor	0.10 (0.420)
BelowPov	-0.70 (-0.653)
GALPCMSW	
N	207
Chi Squared (12 d.f.): 28.412 **McFadden's R^2:** 0.159	
*Significant to the 90% level ** Significant to the 95% level	

Prediction Success Table

	Predicted	
Actual	**0**	**1**
0	171	4
1	28	4
Total	199	8

Although three variables had coefficients statistically significant at either the 90 or 99% levels, average household size, (**AVEHHSIZ**), property tax (**PrTax00**) and per capita MSW generation (**GALPCMSW**), the signs of the coefficients raised some questions. The coefficient for Average household size, (**AVEHHSIZ**) was –5.34, the coefficient for property tax (**PrTax00**) was 0.704 and the coefficient for per capita MSW generation (**GALPCMSW**) was –0.443, According to the analysis, the larger the average household size in a town the less likely that town was to adopt a PAYT program. Additionally, the lower the per capita waste generation rate, the more likely a town was to adopt a PAYT program. This raises the issue of causality. It has already shown been that PAYT and average household size do, in fact, have statistically significant negative influences on per capita waste generation rates. This logit analysis questions whether a town with low per capita MSW generation rates is more likely to adopt a PAYT program or whether the existence of the PAYT program is the reason the per capita MSW generation rate has a negative coefficient . This question may be explored in follow-up studies.

The logit analysis results also suggest that the higher the property tax in a town the more likely a town may be to adopt a PAYT program. This result suggests some sort of "fiscal stress" category of influence. Additional data should be gathered to more accurately define fiscal stress in communities and assess whether they support this result. Overall the analysis provided little to no predictive power using the variables in this particular analysis. The prediction success analysis shows that using the variables selected for this study, only 4 of the 31 towns that adopted a PAYT program could be correctly predicted.

Policy Implications

This study is an important step to better understand the dynamics of managing the State of New Hampshire's solid waste stream. Using the variables that were collected, the analysis found that an increase in marginal price for solid waste disposal above and beyond the normal price of store bought garbage bags, and a pro-active approach to community planning, such as the existence of a Capital Improvement Plan reduce annual per capita waste generation. It was also apparent that certain characteristics in a community, such as average size of households can affect solid waste generation.

Although results show that an increase in marginal price may reduce per capita MSW generation rates, PAYT may not be right for every town. This study presents results gleaned from analyses using mean annual data taken from all towns in New Hampshire. Each town must look at the specific characteristics and variables that may influence solid waste policy and make a determination based on that specific data.

The OLS regressions showed that an increase in the price of waste disposal as imposed by a PAYT program had a statistically significant effect on MSW disposal amounts in New Hampshire towns. This decrease in MWS disposal rates may translate into an overall lower cost of disposal to a specific municipality as was shown in the example of Portsmouth at the end of Chapter 4. This is because most towns pay a private firm for disposal by the ton. Less tons mean less cost of disposal. However, this is not to say this study necessarily shows an *overall* decrease in cost to the town. The design and implementation of a PAYT program is not without administration costs. Administration costs may be anything from staff time to record keeping to education and outreach to residents regarding program specifics. Further work needs to be done

analyzing these costs. Although this study shows that implementing a PAYT program lowers solid waste generation *rates*, the overall savings will only be beneficial to the community if they outweigh the *cost* of program implementation. These cost analysis studies should look at all aspects of solid waste management options, such as recycling programs and local level composting.

As previously mentioned, this study shows that any increase in annual per capita disposal costs negatively influences annual per capita disposal rates. However the question of *why or how* disposal rates decreased was not explored. Further research is needed to explore where the decrease in MSW generation originates. Are households in towns where a PAYT program exists more environmentally conscious with tendencies to buy in bulk or make purchasing choices of items with less packaging or re-use value? Or do these communities choose to participate in the option of illicit dumping or burning because of the increase in cost?

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