THE IMPACT OF STATE AND LOCAL POLICIES ON THE RECYCLING EFFORT

Scott J. Callan
Bentley College

and

Janet M. Thomas
Bentley College

INTRODUCTION

The generation of excess waste, an aging landfill system, and local resistance to new landfill sites have prompted fundamental reform of municipal solid waste (MSW) policy across the U.S. It is commonly argued that the requisite policy response is one that encourages source reduction as well as waste diversion through recycling. The Resource Conservation and Recovery Act (RCRA) assigns primary responsibility for this and all nonhazardous waste policy decisions to state governments. This responsibility is likely well placed, since the risk of MSW mismanagement is expected to be location-specific, affected by such factors as local population, the age of landfill facilities, and their proximity to water resources. In any case, the consequence is that recycling initiatives in the U.S. are not uniform, since they are designed and implemented at the state and local levels. This in turn means that any economic analysis of recycling must rely on local observations and, to assure that the results can be generalized, must control for community- and region-specific influences.

The Commonwealth of Massachusetts is an appropriate context for such an analysis in part because of its "Integrated Solid Waste Master Plan" issued in 1990 and subsequently updated [Commonwealth of Massachusetts 1990; 1994].¹ The plan sets forth the state's ten-year objectives and its strategic policy to promote source reduction and appropriate waste diversion activities. It also outlines a graduated set of recycling rate goals (quantified as tons recycled or composted as a percentage of tons generated), given as 23 percent by 1992, 34 percent by 1994, and 46 percent by 2000.

To achieve these objectives, the Commonwealth supports a wide range of initiatives. Among these is a nine-point "Recycling Plan," funded by unredeemed bottle deposits, which are held in the state's Clean Environment Fund.² Part of the monies are to be appropriated for municipal grants to help finance the distribution of educational materials and the purchase of recycling equipment. Other initiatives include construction grants for recycling facilities and transfer stations, support for research and development on plastics recycling, and cooperative programs with industry to

stimulate demand for recycled materials. Another key component of the Massachusetts plan is the state's endorsement of user fee systems for MSW services. According to a recent state report, 165 towns had established such systems by 1994. Of this number, 55 communities were using a unit pricing scheme, which refers to explicit, quantity-based pricing of MSW collection and disposal. By 1995, this number had grown to 89 cities and towns.

Anecdotal evidence suggests that the Massachusetts program has met with some success. Its 1992 recycling goal has been realized, and there has been significant growth in the number of towns with bona fide recycling programs. When the master plan was initially drafted, only 190 of the state's 351 municipalities had established their own programs. By 1992, that number had increased to 341. Massachusetts officials attribute much of this growth to the establishment and subsequent expansion of a state-owned (but privately run) materials recycling facility (MRF) located in Springfield. This facility provides free recycling and marketing services to 97 communities in western Massachusetts at an approximate rate of 200 tons of materials per day.³ Another relevant observation is the increasing number of municipalities offering curbside pickup for recyclables, which was reported as 126 in 1995, up from only 20 in 1990.

Our objective in this research is to estimate the effectiveness of these initiatives— independently and in combination—in stimulating the recycling effort. The literature in this area is still evolving.⁴ Much of the earlier research uses case studies of one or more municipalities to describe the impact of socio-economic factors on the recycling effort. More recent studies use empirical analysis to identify the determinants of recycling and estimate their individual influence. One such study [Duggal, Saltzman, and Williams, 1991] finds that recycling is stimulated by policies that lower its opportunity cost. Although the findings are interesting, the model uses observations that span two states but does not control for state-specific factors that may influence local decisions. It also relies on 1980 census data, which may not capture current demographic conditions. More importantly, the context is such that the authors are unable to estimate the effect of unit pricing on recycling behavior.

In a related study, Reschovsky and Stone [1994] examine recycling behavior using household survey data from an upstate New York county. Their results suggest that recycling activity is higher in those towns that use unit pricing in combination with curbside recycling services. A drawback of this study is that the policy variables are constructed to reflect *perceived* rather than *actual* initiatives, since survey respondents were not fully informed about which policies were applicable to them. Furthermore, as the authors point out, elements of the survey-generated data are likely biased, since people who regularly recycle would have been more likely to respond to their survey than those who do not.

In sum, although the knowledge base on MSW recycling is expanding, many issues remain unresolved. To that end, this research uses a comprehensive, statewide database to estimate the primary determinants of the recycling effort. Our empirical model incorporates both state and local policy instruments, including unit pricing, as well as an extensive list of socio-economic attributes. To our knowledge, no other study estimates an analogous recycling function for all municipalities in a single state.

TABLE 1
Annual Recycling Grades for Massachusetts Communities
1994 and 1995

Recycling Grade	Number of Communities by Year	
	1994	1995
A (Rate > 30%)	54	124
B (20% < Rate ≤ 30%)	74	108
C (10% < Rate ≤ 20%)	121	77
D (5% ≤ Rate ≤ 10%)	24	19
F/I (Rate < 5% or nr ^a)	78	23

a: nr = not reported

THE EMPIRICAL MODEL AND DATA

We model the recycling effort of a community as an annual recycling rate, since this is the measure used by the Commonwealth of Massachusetts to annually assess and record local activity in its *Municipal Recycling Report Card*.⁵ The state uses this report card to acknowledge each town's recycling effort and to communicate relative performance. Each community is graded on the basis of percent of wastes diverted in the prior fiscal period. Table 1 shows the distribution of grades across cities and towns for 1994 and 1995 [Commonwealth of Massachusetts, February 22, 1995; March 7, 1996]. As these data indicate, about two-thirds of the 351 cities and towns achieved a recycling rate of at least 20 percent in 1995. It was also reported that 257 communities experienced an increase in their recycling rate over the prior fiscal year.

Determinants of recycling activity are assumed to include both state and local policies as well as socio-economic characteristics. This assumption supports the following empirical model of recycling effort for each Massachusetts community:

$$\begin{aligned}
 \text{RECYCLING RATE} = & \beta_0 + \beta_1 \text{UNIT PRICING} + \beta_2 \text{RECYCLING SERVICES} + \beta_3 \text{MRF} + \\
 & \beta_4 \text{EDUCATIONAL GRANTS} + \beta_5 \text{EQUIPMENT GRANTS} + \\
 & \beta_6 \text{TRASH SERVICES} + \beta_7 (\text{UNIT PRICING} \cdot \text{RECYCLING SERVICES}) + \\
 & \beta_8 (\text{UNIT PRICING} \cdot \text{MRF}) + \beta_9 (\text{RECYCLING SERVICES} \cdot \text{MRF}) + \\
 & \beta_{10} \text{INCOME} + \beta_{11} \text{EDUCATION} + \beta_{12} \text{EDUCATION}^2 + \\
 & \beta_{13} \text{HOUSING VALUE} + \beta_{14} \text{HOUSING AGE} + \beta_{15} \text{DENSITY} + \\
 & \beta_{16} \text{POPULATION} + \beta_{17} \text{POPULATION}^2 + \beta_{18} C_S + \beta_{19} C_R + \epsilon.
 \end{aligned}$$

TABLE 2
Variable Definitions and Descriptive Statistics

Variable Name	Definition	Mean	Standard Deviation
RECYCLING RATE	Ratio of tons of MSW recycled or composted to tons of MSW generated.	26.679	12.312
UNIT PRICING	Dummy variable equal to 1 if the town uses unit pricing for solid waste services, and 0 otherwise.	0.265	0.442
RECYCLING SERVICES	Dummy variable equal to 1 if the town provides curbside recycling services, and 0 otherwise.	0.420	0.494
MRF	Dummy variable equal to 1 if the town has access to the state's materials recycling facility, and 0 otherwise.	0.272	0.445
EDUCATIONAL GRANTS	Dollars per housing unit of state-awarded grants for recycling education.	0.195	0.381
EQUIPMENT GRANTS	Dollars per housing unit of state-awarded grants for recycling equipment.	0.762	1.489
TRASH SERVICES	Dummy variable equal to 1 if the town provides curbside pickup for trash disposal, and 0 otherwise.	0.534	0.500
INCOME	Median household income in thousands.	41.714	12.212
EDUCATION	Number of residents in thousands aged 25 years or older that have attained at least a four-year college degree.	3.496	8.412
HOUSING VALUE	Median value of single-family homes in thousands.	168.046	59.268
HOUSING AGE	Proportion of single-family homes built before 1960.	51.721	14.471
DENSITY	Number of single-family homes per square mile.	227.477	265.874
POPULATION	Population in thousands.	17.786	37.909
C_s	Dummy variable equal to 1 for towns classified as suburban or rural economic centers, and 0 otherwise.	0.617	0.487
C_R	Dummy variable equal to 1 for towns classified as resort, retirement, or small rural communities, and 0 otherwise.	0.244	0.430

The definition and descriptive statistics for each of these variables are provided in Table 2.⁶ As usual, ϵ represents the disturbance term.

The model includes six MSW state and local policy instruments currently used in Massachusetts communities, separately or in combination. With the exception of *TRASH SERVICES*, each is expected to positively influence recycling activity, either by lowering its cost relative to land-based disposal or illegal diversionary activities or by developing environmental literacy. Several interaction terms involving policy variables also are specified to capture the incremental effects of policy combinations. For example, the β_7 parameter estimates the combined effect of implementing unit pricing and curbside recycling services, beyond their independent influence on the recycling rate.⁷

Socio-economic attributes are included to empirically isolate the policy influence and to explicitly identify factors beyond the control of local public officials. Two of these attributes, median income and educational attainment, characterize the residents of each town, while the remainder, median housing value, housing age, density (used to capture urbanization), population, and the community classifications depict the demographics and economics of the town itself. Following the literature, squared terms for *POPULATION* and *EDUCATION* are used to capture nonlinearities in the effects of these variables on the recycling effort.

Data for each town's recycling activity and the policy instruments are obtained from the Massachusetts Department of Environmental Protection (DEP).⁸ Annual recycling rates and the type of trash and recycling services available to residents are reported in the Massachusetts *Municipal Recycling Report Cards* [1995; 1996]. The recycling rate used in the estimation is for fiscal year 1995 and is measured as the ratio of tons of MSW recycled or composted to tons of MSW generated.⁹ Unit pricing data are obtained from the Commonwealth of Massachusetts [1993] with updates for the 1995 fiscal year provided through direct communication with DEP representatives. The grant variables are constructed from reported dollar and unit values awarded for fiscal year 1995 [Commonwealth of Massachusetts, March 16, 1995]. Calculated dollar values for each type of grant are then divided by the number of housing units in the community to account for the allocation of funding across households.

With the exception of the community classifications, the socio-economic variables utilize 1990 census data [U.S. Department of Commerce, 1990; Horner, 1994]. The community classifications are based on seven categories derived by the Massachusetts Department of Education from a series of socio-economic attributes.¹⁰ Table 3 gives the description of each category (labeled C_1 through C_7), as reported by Massachusetts [Commonwealth of Massachusetts, 1985]. To maximize the variability across observations and simply the analysis, we elected to form three broadly-defined dummy variables from these seven categories. The two included variables are C_s (for communities categorized as C_2 , C_3 , C_4 , or C_5), and C_R (for those classified as C_6 or C_7). The suppressed classification dummy represents urbanized centers as defined by the state's C_1 category.

TABLE 3

Socio-Economic Classifications for Massachusetts Communities

Variable	Classification	Description
C_1	Urbanized Centers	Manufacturing and commercial centers; densely populated; culturally diverse.
C_2	Economically Developed Suburbs	Suburbs with high levels of economic activity, social complexity; relatively high incomes.
C_3	Growth Communities	Rapidly expanding communities in transition.
C_4	Residential Suburbs	Affluent communities with low levels of economic activity.
C_5	Rural Economic Centers	Historic manufacturing and commercial communities; moderate levels of economic activity.
C_6	Small Rural Communities	Small towns; sparsely populated; economically undeveloped.
C_7	Resort/Retirement and Artistic	Communities with high property values, relatively low income levels, enclaves of retirees, artists, vacationers, and academicians.

ESTIMATION AND RESULTS

Ordinary least squares is used to estimate the model.¹¹ Of the 351 towns in Massachusetts, 324 are in the sample after excluding observations with missing data. The parameter estimates and standard errors are presented in Table 4. Overall, the model performs well, with an F-statistic significant at the one percent level. Thus, for a cross-section model, a respectable degree of variation in the dependent variable is explained by the independent variables. Furthermore, the significance and algebraic signs of the parameters are in keeping with theoretical expectations and generally consistent with existing empirical research.¹² While not our focus, the socio-economic determinants serve as important control variables in the model, and the specific estimates add to the evolving literature on recycling and MSW markets.¹³ With this more complete specification of control variables, the policy results can be more readily generalized.

To organize the economic analysis of the policy findings, we first examine the estimates for *local* initiatives, i.e., the use of unit pricing and the availability of alternative types of recycling and disposal services. Then, we consider the effect of *state* policy instruments, i.e., the provision of free recycling and marketing services at the state's MRF and the municipal grant awards for education and equipment.

TABLE 4

Recycling Model Parameter Estimates

Parameter	Variable	Estimate	Standard Error
β_0	CONSTANT	6.824	5.057
β_1	UNIT PRICING	6.583 ^a	2.119
β_2	RECYCLING SERVICES	4.150 ^b	2.058
β_3	MRF	9.544 ^a	2.324
β_4	EDUCATIONAL GRANTS	2.548 ^c	1.506
β_5	EQUIPMENT GRANTS	0.482	0.380
β_6	TRASH SERVICES	-2.482	2.066
β_7	(UNIT PRICING · RECYCLING)	5.521 ^c	3.004
β_8	(UNIT PRICING · MRF)	1.018	3.092
β_9	(RECYCLING · MRF)	-3.648	3.128
β_{10}	INCOME	0.146 ^c	0.084
β_{11}	EDUCATION	1.757 ^a	0.567
β_{12}	EDUCATION ²	-0.029 ^b	0.012
β_{13}	HOUSING VALUE	0.001	0.017
β_{14}	HOUSING AGE	0.079 ^c	0.048
β_{15}	DENSITY	-0.006 ^c	0.003
β_{16}	POPULATION	-0.264 ^b	0.129
β_{17}	POPULATION ²	0.001 ^b	0.0006
β_{18}	C_S	3.621	2.455
β_{19}	C_R	6.254 ^b	2.838
R^2		0.3919	
R^2 (adjusted)		0.3538	
F		10.309	
Prob > F		0.0001	
n		324	

a. significant at the .01 level.

b. significant at the .05 level.

c. significant at the .10 level.

Analysis of Local Policy Determinants

For our purposes, it is important to determine whether unit pricing is an effective policy tool and to ascertain if its effectiveness is influenced by the complementary use of other policy instruments. We therefore allow the *UNIT PRICING* variable to affect *RECYCLING RATE* both independently and in combination with other policies through two interactive terms — one with *RECYCLING SERVICES* and one with *MRF*. Based on our estimates, the β_1 parameter on *UNIT PRICING* is positive and significant, as is the β_7 parameter on (*UNIT PRICING · RECYCLING*). Qualitatively, this set of results suggests, not only that unit pricing stimulates a community's recycling effort, but also that the effect is greater if used in combination with curbside recycling services. These are logical and highly intuitive findings when one considers how unit pricing restores the market incentive to MSW decisions.

Quantity-based, explicit pricing schemes displace the more conventional practice of charging each household a flat fee for waste services that is "hidden" in the property tax. Because flat fees are not quantity-dependent, they give households no incentive to economize on waste generation or disposal, and a classic market failure results. Conversely, unit pricing links the fee for MSW services directly to the amount of waste disposed and communicates the non-zero cost of managing the waste stream. Hence, waste generators are able to assess the cost of disposal relative to that of source reduction and waste diversion and rationally choose the least-cost option. The policy dilemma is that diversion can be accomplished through illegal disposal, such as burning and littering, as well as through recycling.¹⁴ Thus, local governments like those in Massachusetts sometimes complement unit pricing with initiatives such as curbside recycling services to lower the cost of recycling relative to undesirable diversionary tactics.

The quantitative interpretation of the *UNIT PRICING* estimates has particular relevance for local policymakers. For towns that do *not* offer curbside recycling services, β_1 represents the increase in the annual recycling rate solely from implementing quantity-based pricing of MSW services. According to the estimate, the expected increase is 6.6 percentage points, or 24.7 percent of the mean recycling rate in Massachusetts for the study year. Our review of the literature found no empirical study that successfully estimates this relationship. For towns that *do* provide curbside recycling services along with unit pricing, the estimated increase is the sum of β_1 and β_7 , or 12.1 percentage points. This is equivalent to 45.4 percent of the mean recycling rate in our sample.

Based on related research, these quantitative estimates are not unreasonable. Miranda, Everett, Blume, and Roy [1994], for example, use a descriptive analysis to suggest that towns employing unit pricing (some of which also offer recycling services), can expect to achieve a recycling rate of between 2 and 39 percent. Although Reschovsky and Stone [1994] do not obtain a significant estimate for the isolated effect of unit pricing, they do find that the policy combination of unit pricing and curbside recycling services significantly increases the probability of recycling glass, plastic, and cardboard by 27, 36, and 58 percent, respectively.

Public provision of recycling services, either singularly or in combination, should directly reduce the opportunity cost of recycling activity and therefore positively influence a community's recycling rate.¹⁵ Thus, analogous to our specification of unit pricing, the *RECYCLING SERVICES* variable enters the model singularly as well as through two interactive terms — the one with *UNIT PRICING* discussed above and another with *MRF*. Since we cannot attribute any statistical significance to the parameter on the latter interaction term, the interpretation of the *RECYCLING SERVICES* estimates follows that for *UNIT PRICING*. For towns that do *not* use unit pricing, the β_2 parameter on *RECYCLING SERVICES* represents the expected increase in the annual recycling rate due to the provision of curbside services. Based on the estimate, this increase is predicted to be 4.15 percentage points on average. For towns that *do* use unit pricing, the comparable estimate is the sum of the two relevant parameters (i.e., $\beta_2 + \beta_7$), or 9.67 percentage points on average.

Public provision of trash services is expected to decrease the opportunity cost of disposal relative to alternative options, including recycling [Duggal et al. 1991]. Hence, the availability of these services should be linked to a *lower* recycling rate.¹⁶ Although the sign of the estimated parameter on *TRASH SERVICES* is negative, it is not statistically significant. It should be noted, however, that the excluded dummy variable for *TRASH SERVICES* represents provision of drop-off services. Hence, the absence of a significant estimate means that the offering of curbside disposal services does not negatively influence the recycling effort *relative* to the provision of drop-off disposal. This does *not* rule out the possibility that a town offering any type of disposal services would achieve a lower recycling rate than one offering none at all.

Analysis of State Policy Determinants

Among the state initiatives specified in the model is the Massachusetts-owned MRF. Although we find no evidence that this facility is incrementally effective as part of a policy combination, we do find that the *MRF* parameter itself is significant at the one percent level. Its estimated value suggests that a community using the state facility can expect to achieve an average increase of 9.5 percentage points in its annual recycling rate. Qualitatively, this finding validates the expectation of Massachusetts officials, who believe that the state's MRF is important to its recycling program. Economies of density may be responsible for the outcome. Carroll [1995] provides some preliminary statistical evidence to suggest that residential recycling costs decline as population density increases. In our study, joint access to the MRF may allow relatively small communities to experience savings in recycling costs typically associated only with more densely populated communities. If so, the cost savings should translate to higher levels of recycling activity. This result has important policy implications for other state officials who may be considering the construction of similar facilities for local access.

We also estimate the influence of state-awarded conditional grants to municipalities. Both the dollar amount and the intended use of these grants are captured through two variables, *EDUCATIONAL GRANTS* and *EQUIPMENT GRANTS*.¹⁷ Qualitatively, both are expected to have a positive effect on the recycling effort, although each is motivated differently. Educational grants should improve residents' environmental literacy, which should in turn encourage recycling. This assertion is validated by existing studies that link environmental awareness to proenvironmental behaviors like recycling [Iwata, 1981; Hopper and Nielsen, 1991; and Lansana, 1992]. On the other hand, municipal grants for recycling equipment should encourage public provision of recycling services by lowering the cost of doing so. This response should in turn lower residents' opportunity cost of recycling, leading to a higher recycling rate.

Based upon our estimates, we can attribute no statistical significance to the effect of *EQUIPMENT GRANTS* and only marginal significance to that of *EDUCATIONAL GRANTS*. The estimated parameter for the latter implies that each additional dollar awarded per household for recycling education should increase a community's annual recycling rate by an average of 2.55 percentage points. In both cases, however, the predictions

are guarded, since the impact of grant funding may be time-dependent. That is, there is likely to be a considerable lag between the awarding of a grant and a community's expenditure on equipment or educational materials, and still more time before such an expenditure would affect behavior. Thus, it is not unreasonable to expect that these policy instruments have measurable effects that are realized only over the long term. Because the Massachusetts grant program has been in existence only since 1994, our estimates capture only the immediate influence of these grant awards. Furthermore, our finding on educational grants is counter to conclusions reached by Judge and Becker [1993], who assert that educational initiatives aimed specifically at stimulating recycling appear to have no impact on participation. Hence, further empirical investigation of grant awards is warranted.

POLICY IMPLICATIONS AND CONCLUSIONS

We believe that our model and our empirical findings offer a number of contributions to the evolving literature on recycling. Unique to this study is the use of comprehensive statewide data to analyze the recycling effort at the community level. This approach generates empirical estimates that are meaningful from a public policy perspective, while avoiding the inherent biases of household survey data. Furthermore, because the Commonwealth of Massachusetts has outlined a broad-based solid waste program, the model includes a fairly extensive list of both state and local policy instruments.

Central to the results on local initiatives is the finding on unit pricing. Based on our literature review, no empirical study has successfully estimated the independent effect of unit pricing on the recycling effort. From a fundamental perspective, this result supports the use of market-based initiatives advocated by economists. Specific to this model, the estimated parameters imply that a community implementing a unit pricing system can expect its annual recycling rate to be 6.6 points higher than if it had used an alternative pricing approach. An additional increase of 5.5 points is predicted if the pricing plan is accompanied by the provision of curbside recycling services, which by itself should increase the rate by 4.15 points.

The collective findings on local policy instruments suggest that opportunity cost is an important determinant of waste generators' decisions. If public policy improves the convenience of recycling and lowers its opportunity cost, aggregate recycling rates should rise. Similarly, if initiatives elevate the cost of disposal, the *relative* cost of recycling falls, and the same outcome should occur. Recognizing and responding to this observation through policy reform may measurably improve recycling performance. Of course, in practice, public officials and their constituents evaluate the social and political implications of policy decisions as well as the economic considerations [Feiock and West, 1993; Reschovsky and Stone, 1994]. This observation may explain why incentive-based instruments like unit pricing have not been adopted by more communities in the U.S.

With regard to state-level policy, the significant findings on the state's MRF offer new evidence about the effectiveness of such a broad-based initiative. Massachusetts

is looking to expand access to its existing facility and to fund the construction of mini-MRFs and transfer stations. Hence, these results and those of future studies should be invaluable in guiding these plans as well as similar efforts in other states. More research is needed, however, on the effectiveness of state-awarded grants. Although educational grants appear to stimulate recycling, an analogous effect could not be attributed to equipment funding. It is not clear, however, whether the link between grant awards and a measurable change in the recycling effort is time-dependent, an issue requiring more extensive data.

Further analysis should also be directed toward the importance of policy combinations. Since the Massachusetts program is still evolving, a relatively small number of communities have experimented with such combinations, limiting the extent to which this practice could be analyzed in this model. We expect to revisit this issue in future research.

Beyond the policy implications of our results, the findings on socio-economic determinants also are of interest. Certain of our estimates, such as those on income, education, and urbanization, support the accumulating evidence on these commonly-specified attributes. Other results, such as the significant parameters for housing age, population, and community classification, suggest that the set of demographic factors influencing recycling may be more extensive than originally theorized. Public officials need to be aware of how economic and demographic variables can influence the success of a recycling program. In so doing, they can make more informed policy decisions, set more reasonable objectives, and, where possible, tailor initiatives to accommodate and better respond to their constituents.

NOTES

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1. This plan follows the U.S. Environmental Protection Agency's recommended use of an "Integrated Waste Management System" which uses a combination of initiatives aimed at source reduction, recycling, combustion and land disposal, ranked in order of priority [U.S. Environmental Protection Agency, 1989].
2. Massachusetts officials estimate that \$10 million per year will be available for the recycling program.
3. When the facility opened in 1990, it was the only one in Massachusetts (although three privately-owned plants are now operating or under construction), and the largest in the U.S. It is still the only state-owned facility in the state and is therefore an important element of the state's solid waste plan [Commonwealth of Massachusetts, 1994].
4. Jenkins [1993] provides an overview of this literature and presents a thorough exposition of MSW markets and user fee systems.
5. As an anonymous referee pointed out, any measure of recycling effort is subject to inaccuracies. A common subject of debate is whether recycled or discarded wastes should be measured by weight or by volume. A weight-based measure would favor a community recycling a relatively large proportion of paper and cardboard, while a volume-based measure would favor a town that recycled more plastics. There are other possible errors, such as the inadvertent exclusion of materials sold to private recyclers or the mixing of wastes among neighboring communities. In this model, although the recycling rate variable is subject to certain of these biases in an absolute sense, it is defensible as a relative measure because it is uniformly reported by all towns in Massachusetts.

6. Note that recycling and trash services are distinguished by whether they are provided at the curbside (the explicit dummies) or at drop-off facilities (the suppressed dummies) and not by whether they are publicly or privately provided, since this latter distinction is not relevant to this study.
7. We elected to limit the number of interaction terms in the model to those involving *UNIT PRICING*, *MRF*, and *RECYCLING SERVICES*. Since these variables can take on a value of only 0 or 1, the interpretation of empirical results is greatly simplified. Despite the added complexity, we attempted to include other interaction terms involving the two grant variables (which are not binary), but the findings complicated the interpretation without adding significantly to the results.
8. We appreciate the efforts of Joseph Lambert and John Crisley at the Massachusetts DEP for assisting us in data collection and for guiding us through the variable definitions and calculation methods used by the Commonwealth of Massachusetts.
9. Because this measure is weight-based, it would negatively bias the recycling effort of any community that recycled a high proportion of light-weight materials relative to other Massachusetts towns, all else held constant (including the composition of MSW generated). In the absence of materials-specific recycling data at the local level, the existence of any such bias is unknown. Hence, in specifying this model and subsequently interpreting the results, there is an implicit assumption that the materials composition of recycled waste is fairly homogeneous across Massachusetts communities.
10. Among the attributes used to define the categories are economic measures, such as the unemployment rate, a composite index of commercial activity, and a manufacturing index. Also included are demographic data, such as the percentage of minorities and the percentage of the population residing in rental units.
11. Since the dependent variable is defined such that its value is constrained to be within 0 and 1, we also specified and estimated a logistic transformation model. This specification converts the dependent variable to the natural log of the odds that a particular result occurs. In so doing, the variable can take on any value along the real number line. This avoids the problem of predicted values falling outside the 0 to 1 interval. Using this specification, the estimated parameters are qualitatively consistent with the simpler linear regression model. To facilitate interpretation, we present the estimates from the simpler specification.
12. As is common in cross-sectional studies, heteroskedasticity of the error term was tested using White's [1980] suggested method. The resulting test statistic indicates that the null hypothesis of homoskedasticity cannot be rejected. In addition, the model was tested for parameter stability between "urban" and "other" community classifications. The F-test indicates that the model can be estimated using pooled data across these two groups.
13. Notice that the algebraic signs of the more conventionally specified attributes, such as income, education, and urbanization, validate existing findings [Duggal et al., 1991; Jenkins, 1993; Lansana 1992; and Smith, 1995]. Also, the more extensive list of attributes used in this model, including housing value, housing age, and community classifications, improves the characterization of economic and cultural factors that may influence the recycling effort.
14. Jenkins [1993] outlines three possible responses to a unit pricing system: (i) altering consumption behavior to reduce the amount of waste generated; (ii) maintaining current generation levels but reducing disposal by recycling; or (iii) maintaining existing generation levels but engaging in illegal disposal activity and/or littering.
15. This assertion follows the logic of Miranda et al. [1994].
16. Although the wisdom of this initiative may appear questionable, consider the following. Strathman, Rufolo, and Mildner [1995] illustrate that higher disposal costs (e.g., tipping fees), act as an incentive to reduce generation and increase diversion through recycling or possibly through illegal disposal. While this discussion is motivated by an increase in explicit costs, it is also applicable to implicit time costs. Thus, towns might be motivated to improve the convenience of trash disposal to reduce the risk of improper disposal, such as burning or littering. This in turn suggests that policymakers must attempt to balance the incremental benefits of offering convenient trash services (i.e., reduced risk of illegal disposal), against the associated incremental costs (i.e., decreased recycling effort), when setting policy.
17. The Commonwealth reports educational grants in units of materials, representing charts, postcards, stickers, and brochures, valued at \$0.43 per unit. The capital grants are awarded for such equipment as recycling trucks, curbside collection boxes, storage containers, and composting bins.

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