

Alternative Service Delivery in Canadian Local Governments: The Costs of Producing Solid Waste Management Services

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In this paper, key findings are presented from three complementary national surveys of producers in the Canadian solid waste management industry. The surveys, conducted by the Local Government Institute between 1995 and 1999 focused on factors that predict the unit costs (costs per unit of output) of residential solid waste collection, residential recycling and landfills, respectively. Among the variables that were examined was the production arrangement for each service. A key question, based on the existing literature is whether private producers tend to be more efficient than their public counterparts.

The hypothesis that private producers will tend to be more efficient is well entrenched in the literature, which has developed from Ostrom et al's initial formulation (1961) of a polycentric theory of the governance of metropolitan areas. Although most research suggests that private producers are more efficient, existing Canadian research has tended to focus on relatively few services. The only national study of public and private producers of local services was conducted in the early 1980s and focused on residential solid waste collection (McDavid 1985).

The current study offers the first cross-Canada comparisons of the efficiency of three services that are a principal part of the solid waste management industry. For the first time, both smaller local governments and Quebec local governments are included in sufficient numbers to permit regional comparisons on key variables. Because the three services are complementary, it is also possible to combine findings from all three to address the question of whether recycling residential solid waste is more efficient than conventional collection and landfilling practices.

Existing Research

In 1961, Ostrom et al (1961) introduced their theoretical interpretation of the organisation of urban governments for the delivery of services. Their theory, based on the emerging field of public goods economic theory (Tiebout 1956), characterised the existing complex patterns of local governments in metropolitan areas as polycentric systems. Key to their theory was the distinction between the provision and the production of local services.

Local governments, organised on behalf of their residents, can make decisions to provide services to their residents or choose to let residents provide those services for themselves. Providing a service creates options for its production. A local government can undertake production with its own personnel and equipment, contract out production to another local government or to a private company, franchise production by one or more private companies, use volunteers to produce the service, offer vouchers to residents or use combinations of these options (ACIR 1987).

Ostrom et al (1961) contrasted their polycentric theory of local public economies with the then dominant model of metropolitan governance, which they called gargantua. Gargantua was characterised as a metropolitan-wide local government structure, which was intended to capture putative scale economies in the production of all local services. Advocates for consolidation of existing jurisdictions asserted that multiple and overlapping local governments were incapable of cooperation to resolve problems that transcended existing boundaries, and competition among local governments was seen to be a wasteful duplication of services.

Since 1961, the polycentric theory of metropolitan governance has been further developed (Ostrom 1973) and subjected to a variety of empirical tests (Ostrom et al 1978; ACIR 1987; Ostrom et al 1988). Although there continues to be some support for consolidating and simplifying local government structures in the urban areas of the United States, the polycentric theory and its derivatives have become orthodoxy.

An important feature of the polycentric research program has been the emphasis on the efficiency-related consequences of alternative service production methods (Bish 1971). Most of the existing research has compared the unit costs of own-forces and contracted producers of local services. The findings have tended to support the conclusion that private producers of local public services are more efficient than public producers of the same services (Savas 1982, 1987; ACIR 1987).

Most of the research to date has been conducted in the United States and has focused on only a few local services, principally residential solid waste collection. In Canada, Kitchen (1976, 1992), McDavid (1985), Tickner and McDavid (1986) and McDavid and Schick (1987) have compared the unit costs of public and private producers of residential solid waste collection and public transit services.

The Current Study

Between 1995 and 1999, the Local Government Institute at the University of Victoria conducted three national surveys of waste management services. The first focused on producers of residential solid waste collection services and included local governments as small as 1000 population, and included local governments in Quebec. The second survey was the first comparison of the efficiency of landfill operations across Canada and the third survey was the first comparison of public and private residential recycling services across Canada.

Survey Methods

Each survey was prepared with input from local government managers, pre-tested and then mailed to the appropriate local government manager for that service. The residential solid waste collection and the recycling survey were mailed to the chief administrative officers in the local governments in our samples. Because landfills typically serve more than one local government, we compiled a separate list of landfills across Canada and mailed the surveys directly to those addresses.

The surveys were long (minimum of 32 pages) and included sections on environmental conditions, type of producer, service levels, revenues and costs, technologies and equipment, human resources and management practices and contracting practices. Local government managers who completed the surveys were promised both a national report and an individualised report that would benchmark their operation in comparison to national and regional averages. Extensive follow up was used to clarify data and improve both the overall response rate and the completion rate of the surveys received.

Overall, the response rates for the three surveys varied between 24 % (landfill survey) and 33.5 % (residential solid waste collection). The recycling survey had a response rate of 27.6 %. The analysis in this paper is based on a sample of 279 producers of residential solid waste collection services, 128 producers of residential recycling services and 64 producers of landfill services.

The response rates for the three surveys, although similar to those for mailed surveys conducted by the International City Management Association (ICMA 1998) raise the issue of sample bias. Comparisons of the populations and the samples of responding local governments indicate that the samples tend to under represent the smallest local governments (1000 to 5000 population). In addition, regional differences in response rates indicate that Quebec tended to be low, and British Columbia and the Prairies tended to be higher.

Although the samples we have are not likely to be random, and hence, broadly representative, this is the first time that three complementary waste management surveys have been conducted in Canada. Findings reported can be viewed as a first step towards understanding the costs of collecting, recycling

and TABLE 1 Cost Components for Public Producers Included in the Three Surveys

Solid Waste Survey Cost Components	Recycling Survey Cost Components	Landfill Survey Cost Components
capital expenditures ¹	capital expenditures ¹	capital expenditures ¹
debt retirement ¹	debt retirement ¹	debt retirement ¹
equipment and vehicle replacement	equipment and vehicle replacement	equipment and vehicle replacement
vehicle maintenance	vehicle maintenance	equip. & vehicle maintenance
fuel and lubricants	fuel and lubricants	fuel and lubricants
utility charges ¹	insurance	utility charges ¹
building rental ¹	utilities charges ¹	building rental ¹
salaries and wages	salaries and wages	salaries and wages
fringe benefits	fringe benefits	fringe benefits
administrative overhead	administrative overhead	administrative overhead
insurance		insurance
net costs of operating any recycling programs ¹		insurance
net costs of operating any transfer stations		legal services
		license and permit application fees

Note: 1. Noted cost components were excluded from estimates of total operating costs because too few local governments included them to make estimates possible.

disposing solid waste in Canada.

Estimating the Costs of the Services

Each survey asked managers to provide a breakdown of the operating costs for that service for that year. If the service was produced in whole or in part by their own crews and equipment, managers were asked to indicate which cost components from a list were included in their public operating costs and when a component was included to indicate the amount. In Table 1, the cost components that were included for 'own forces' producers (i.e. public sector personnel and public sector equipment) in each survey are summarised. Because there was considerable variability in the components that respondents indicated were included, it was necessary to estimate missing components for local governments where a component was missing. For example, some respondents in the recycling survey indicated that fringe benefits were not included in their operating costs. We imputed a fringe benefit figure for those cases, using the median percentage that fringe benefits were of salaries for public producers in the sample.

Three methods were used to impute missing cost components for public producers across the three surveys. For annualised vehicle replacement costs, information provided about the numbers of different vehicles, their replacement costs and the number of years between replacements was used to estimate an annualised cost that would be sufficient to replace all existing vehicles on a continuing basis. Multiple regression was used to estimate other missing cost components for public producers of residential solid waste collection services.

For both the recycling and landfill surveys, missing costs were estimated by

TABLE 2 Cost Per Household by Population and Producer Type

Producer Type	1,000-4,999		5,000-9,999		10,000-49,999		50,000+		Overall	
	Cost	N	Cost	N	Cost	N	Cost	N	Cost	N
Private	\$59.36	50	\$46.00	38	\$51.02	67	\$38.56	30	\$50.22	185
Public	\$81.39	24	\$60.76	17	\$50.48	22	\$50.84	27	\$60.42	94
Overall	\$66.51	74	\$50.60	56	\$50.41	91	\$44.49	58	\$53.66	279

Note: 1. Differences in average costs are statistically significant at the .001 level for both independent variables. There is no significant interaction effect.

substituting a figure that corresponded to the median percentage that a particular component represented of costs for producers that had included it.

Where local governments contracted out all or part of the service, we asked for total contract costs, as well as any contract administration costs incurred by the local government or landfill. For residential recycling services, it was important to take into account the revenues earned from the sales of recyclables. For both public and private producers, revenue from sales was subtracted from gross costs and net costs were used in the analysis.

Findings

Public-Private Comparisons of the Efficiency of Residential Solid Waste Collection

The findings from the national survey indicate that there are substantial differences in the cost per household for residential solid waste collection by producer type, by population and by region of Canada. The differences between public and private producers for different sized local governments in the sample are summarised in Table 2. In each of the population categories, public producers tend to be more costly per household than private (contracted) producers. Overall, public producers are 20.3 % more costly, and cost per household tends to decrease as population size increases. The smallest local governments in the study (1000 to 4999 population) pay an average of 49 % more per household than local governments over 50,000.

The differences between public and private producers across Canada are presented in Table 3. With the exception of Quebec, public producers in all regions tend to be more costly than private producers. The largest percentage difference is in Atlantic Canada, where public producers are 69.8 % more costly per household.

Generally, the findings in Tables 2 and 3 accord with previous research (McDavid 1985). There are substantial public-private differences, and they are

generally consistent across population categories and most regions. The situation in Quebec is anomalous, and since this is the first national survey that has in

TABLE 3 Cost Per Household by Region and Producer Type

Producer Type	BC		Prairies		Ontario		Quebec		Atlantic		Overall	
	Cost	N	Cost	N	Cost	N	Cost	N	Cost	N	Cost	N
Private	\$52.23	17	\$49.05	23	\$42.61	62	\$59.74	69	\$36.54	14	\$50.22	185
Public	\$62.67	16	\$67.92	28	\$53.20	29	\$51.38	8	\$62.05	13	\$60.42	94
Overall	\$57.29	33	\$59.41	51	\$46.14	91	\$58.87	77	\$48.82	27	\$53.66	279

Note: There is no significant difference in average cost per household across regions and no significant interaction effect between the independent variables.

TABLE 4 Significant Differences Between Quebec Producers and All Others In Canada

Factors Which Distinguish Quebec Producers	Quebec		Other Provinces	
	Average	N	Average	N
Private producers (yes = 1, no = 0)	.90	77	.57	202
Private producers in mixed settings (yes = 1, no = 0)	.013	77	.074	202
average crew size	1.88	47	1.66	176
average truck age	7.04	30	5.27	150
unionised work force (yes = 1, no = 0)	.39	47	.60	144
frequency of collection	1.28	77	1.02	196

Note: The test used in this table is a 2 sample t-test and all differences in means are significant at the .05 level or greater.

cluded Quebec local governments, some additional analysis is appropriate to clarify why private producers in Quebec tend to be more costly than public producers.

In Table 4, all producers are divided into two groups: those in Quebec and those elsewhere in Canada. They are then compared on factors that are significantly different between Quebec and producers elsewhere in Canada. The comparisons in Table 4 indicate that Quebec producers are more likely to be private, operate with larger crews and operate older vehicles. In addition, they also offer a higher level of service, as indicated by the frequency of collection.

Previous research (Tickner and McDavid 1986) has indicated that more frequent collection tends to cost more per household. Given that the average number of collections per week is generally uniform across Canada with the exception of Quebec, it is worthwhile looking at collection frequency and cost within Quebec.

Among the 77 producers in Quebec who indicated how frequently they collect garbage, 27 offer collection more frequently than once a week. Of those, 17 offer twice a week collection. When cost per household is correlated with

collection frequency in Quebec, the correlation is slightly negative ($r = -.095$) and not significant. Further, when the same correlation is run for private producers only, the result is unchanged. This result suggests that frequency of collection

TABLE 5 Significant Differences In Producer Technologies Between Quebec Private Producers and Other Private Producers

Technology Variables	Quebec		Other Provinces	
	Average	N	Average	N
Percent of side loading trucks	16.38	48	35.03	87
Percent of rear packers	68.60	48	47.65	87
Percent of half ton trucks	2.52	48	7.89	87
Average crew size	1.93	39	1.65	93
Average age of trucks	7.41	23	5.24	66
Percent of dump trucks	8.47	48	2.73	87
Average weight capacity in tons	10.40	21	8.58	47

Note: These differences in means are all significant at the .05 level or higher.

is not a factor in explaining higher costs per household in Quebec, particularly among private producers.

Given the dominance of private producers in Quebec, comparisons of technology variables between Quebec private producers and other private producers across Canada are shown in Table 5. The seven variables in Table 5 indicate that Quebec-based private producers tend to have larger crews, use more rear packers (and fewer side loaders) and use larger and older vehicles.

The mix of technologies used by Quebec private producers suggests a need for higher productivity levels, to offset the costs of operating larger, older vehicles with larger than average crew sizes. But when productivity levels are compared and the level of service is matched so that only producers are included which offer once a week service, Quebec private producers are significantly less productive in serving households per truck (2055 households per truck for the 29 Quebec private producers versus 2638 households per truck for the 85 non-Quebec private producers).

In summary, although Quebec producers tend to offer a higher level of service, this factor does not account for the higher costs per household. Instead, the differences are likely due to uses of technologies by Quebec private producers which are more costly. These costs are not offset by higher productivity levels.

The Efficiency of Residential Recycling Services for Public and Private Producers

Unlike residential solid waste collection, which has been researched extensively

in the United States and to some extent in Canada, there has been relatively little research that compares the unit costs of public and private producers of residential recycling services. The current study is the first of its kind in Canada, and the findings are quite different from those just reported.

For the sample of producers of recycling services, there is no discernable

TABLE 6 Net Costs per Tonne for Residential Recycling by Population and Producer Type

Producer Type	< 10,000		10,000-24,999		25,000-74,999		≥75,000		Total	
		N		N		N		N		N
Public	\$134.54	10	\$204.10	6	\$60.59	4	\$88.17	9	\$124.34	29
Private	\$169.21	18	\$132.81	31	\$111.93	27	\$92.64	23	\$124.40	99
Total	\$156.83	28	\$144.37	37	\$105.31	31	\$91.38	32	\$124.39	128

Note: There is a significant difference in average costs across population categories (.05 Level, F test) and no significant interaction effect.

TABLE 7 Net Costs per Tonne for Residential Recycling by Region and Producer Type

Producer Type	BC	Prairies	Ontario	Quebec	Maritimes	Total
	Public	\$174.29 (6)	\$173.41 (8)	\$62.99 (10)	\$149.99 (1)	\$98.23 (4)
Private	\$112.99 (20)	\$153.57 (7)	\$102.93 (28)	\$151.70 (33)	\$99.34 (11)	\$124.40 (99)
Total	\$127.14 (26)	\$164.15 (15)	\$92.42 (38)	\$151.65 (34)	\$99.05 (15)	\$124.39 (128)

Note: There are no significant differences in regional averages and no significant interaction effects.

overall difference in net cost per tonne between public and private producers. An analysis of the averages across categories of population shows no consistent pattern for different sized local governments, although the largest difference suggests that private producers tend to be more efficient for communities in the 10,000 to 24,999 population range (Table 6).

When public and private costs are compared across regions (Table 7), there are differences among cells in the table, for example, British Columbia and the Prairies have lower costs for private producers but in Ontario, private producers are considerably more costly. Although there are differences in the overall averages across regions (bottom row of Table 7), they are not statistically significant (.05 level, F-test).

What is different about residential recycling services? Why do the cross-Canada findings fail to support the findings that are reported for residential solid waste collection producers?

Provision of residential recycling services is relatively new in Canadian communities. In fact, half of the local governments that responded to our national survey in 1997-1998 indicated that they did not provide residential recy-

clinging services of any kind. The growing importance of this service reflects an emerging concern by governments and advocacy groups with environmental matters more generally. Provincial governments across Canada have established goals for reducing the quantity of solid waste that is land filled and recycling programs are expected to make a major contribution.

Related to the newness of residential recycling is the fact that markets for recyclables are shallow and quite volatile. Paper products were marketed in 1996 for as much as \$78.00 per tonne in the Maritimes and as little as \$54.88 per tonne in BC. Metals varied in price from \$823.62 per tonne in Ontario to \$140.90 per tonne on the Prairies. Under these conditions, producers and local governments that provide residential recycling services must absorb considerable uncertainty in an environment where meeting provincially mandated goals is the top priority.

Because the service is new, public producers are in a position to acquire new equipment and technologies and combine them in ways that are very similar to private producers. In fact, among the producers in our sample, there are virtually no differences in productivity (607 tonnes per vehicle per year for public producers and 610 for private producers). This contrasts with the situation for residential solid waste collection where public producers collected from an average of 1964 households per year compared to 2339 for private producers.

It is also possible that production and service level arrangements (whether to contract the service out, whether to make the contractor responsible for selling the recyclables that are collected, whether to provide household pickup, whether to make recycling mandatory or whether to collect more kinds of recyclables) can have unintended effects, one of which is to increase costs. The newness of the service and its linkages to markets which are not stable may well add up to an environment wherein public and private producers have not operated differently and hence perform at similar unit costs.

The Efficiency of Landfills in Canada

The *Solid Waste Landfill Survey* asked managers to indicate how they used their own forces, contractors and other private companies at their landfill facility in 1995. When the surveys were reviewed, it became evident in nearly all cases that the landfill was operated with a mix of own forces and private contractors. In fact, the nature of the work at a typical landfill site made it impractical to distinguish own forces from contractors with respect to the one main task -- effectively and efficiently disposing of solid waste. Unlike the other two surveys included in this analysis, the analysis of landfill efficiency cannot compare the efficiency of own forces and contractors in different landfills, but instead examines the effects of the percentage of own forces' involvement in landfill operations on unit costs.

To categorise the type of production arrangement, responses to four key

survey questions were used to determine the percentage of own forces (public) involvement. Total own forces and contractor costs were added together, and the percentage that own forces costs were of total costs was calculated. The same thing was undertaken for own forces and contractor vehicles and for personnel on the landfill site. In addition, landfill managers were asked whether own forces or contractors did each of 21 possible activities at their landfill. The percentage of own forces involvement was again calculated. These four percentages were

TABLE 8 Population Comparisons of Cost per Tonne for Landfills

Population	Number of landfills	Average cost per tonne
Small (< 25,000)	34	\$24.45
Medium (25,000 - 99,999)	18	\$20.38
Large (> 99,999)	12	\$17.31
Overall	64	\$21.97

Note: Average differences not significant at the .05 level, F test.

TABLE 9 Regional Comparisons of Cost per Tonne for Landfills

Region	Number of participants	Average cost per tonne
Ontario	26	\$28.49
Quebec	3	\$26.78
British Columbia	10	\$19.17
Prairies	19	\$17.22
Maritimes	6	\$10.97
Overall	64	\$21.97

Note: These differences in means are significant at the .05 level (F test).

averaged to come up with an index of local government involvement in each landfill.

This index was divided into categories to facilitate tabular comparisons (primarily public forces, mixed forces and primarily private forces) based on the percentage of public involvement. If the level of own forces involvement (as determined by the index) was less than 25 %, the producer type was called “primarily private”. If the level of involvement was between 25 % and 75 %, production was “mixed”. If the level was greater than 75 %, the producer was called “primarily public”.

The primary measure of efficiency was the total cost per tonne of solid waste disposal at each landfill. Landfills were also divided into three categories based on the population served by the landfill. Small landfills served a population of less than 25,000 (a total of 34 landfills), medium landfills served a population of 25,000 to 99,999 (18 landfills) and large landfills served a population of 100,000 or greater (12 landfills). The cost comparisons are summarised in Table 8. The landfills serving the largest populations tended to have the lowest cost per

tonne, whereas landfills serving small populations tended to have higher costs per tonne. These differences are not significant at the .05 level (F test).

The five regions of Canada can be compared with respect to their average cost per tonne although the relatively small number of cases limits the validity of these comparisons. The findings, with costs displayed from highest to lowest, are presented in Table 9. The region with the highest costs was Ontario, followed by Quebec, British Columbia and the Prairies. The lowest average costs were in the Maritimes.

TABLE 10 Cost per Tonne Comparisons Among Three Producer Types

Type of producer	Number	Average cost per tonne
Primarily public forces	32	\$23.75
Mixed forces	19	\$23.21
Primarily private forces	13	\$15.75
Overall	64	\$21.97

Note: Not statistically significant at the .05 level, F test.

Table 10 illustrates cost per tonne comparisons across the three producer mixes in the landfills in the sample. As the Table shows, landfills having primarily private contractor forces tend to have lower unit costs, although this bivariate association is not statistically significant in the sample.

Multivariate Comparisons of Variables That Predict Efficiency for the Three Services

The analyses reported thus far, although useful for describing key findings, are limited in the sense that they do not take into account the influences of other variables on the associations between producer type and efficiency. In the National Survey Reports that were prepared for the local governments that participated in each survey (McDavid and Eder 1997; McDavid and Laliberté 1998, 1999) non-recursive causal models were estimated. These models were developed and tested to identify the most important predictors of efficiency and rank their importance.

The independent variables in the three causal models were selected to represent key factors in the production of waste management services: producer type; service levels; equipment and technology; human resource and management practices; and productivity. Empirically, these variables also tended to be correlated with other variables in the surveys, including measures of scale and environmental factors. Where the latter variables were significantly associated with production-related factors or with unit costs they were included in the models. Although type of producer was not a key variable in all the models, it was nevertheless included to facilitate gauging its importance once other key

factors are controlled.

Models were developed and tested for the statistical significance of each path, and the overall goodness of fit of the model (adjusted goodness of fit, root mean square error and overall Chi Square) (Arbuckle 1995). In the models reported in this article, all endogenous paths were significant at the .10 level or higher.

To summarise the total effects of each predictor in the models, their direct and indirect effects were calculated by multiplying the standardised coefficients for each path in the model and adding them together for each variable. The **TABLE 11 Total Standardised Effects Ranked from Largest to Smallest for the Solid Waste Collection Causal Model Which Predicts Cost Per Household**

Variable	Total Direct Plus Indirect Effects
Households served per truck	-.356*
Tonnes per household	.207*
Number of days lost to strikes in the past five years	.149*
Private production of the service	-.148*
Average crew size	.140*
Average vehicle capacity in cubic meters	-.088
Whether the producer is in Ontario	-.081
Frequency of waste collection	.042
Average salary of weighted full time equivalent workers	-.028
Whether a producer is in Quebec	-.021
Was the workforce unionised?	.015
Population of the local government	.004

Note: The asterisked variables directly and significantly (.10 level or higher) predicted cost per household.

importance of each predictor is indicated by the relative rank of the total effects for that variable. Its overall effect on unit costs is indicated by the sign of the total effect.

In Table 11, the total standardised effects for the residential solid waste collection causal model are summarised. There is a total of 12 predictors; their overall effects on cost per household are indicated by the signs of the total effects. Private production of the service is among the top five predictors, and its total path coefficient indicates that in the model, private production is associated with lower costs per household. In the causal model that predicts cost per household, we can say that private production is associated with lower costs, controlling for households served per truck, tonnes collected per household, days lost to strikes and average crew size.

The comparable summary of predictors of net cost per tonne for residential recycling are displayed in Table 12. Private production of the service is relatively weak as a predictor. It does not have a significant direct effect on net cost per tonne, which corroborates the findings reported in earlier. The most impor-

tant predictor overall is whether residents are required to put out full recycling bins -- full bins tend to reduce net cost per tonne.

Finally, a similar summary of the direct and indirect effects of variables which were important as predictors of the total cost per tonne of landfilling solid waste is presented in Table 13. Percent of public involvement is a moderately important predictor overall. The direction of its overall effect indicates that greater public involvement is associated with higher total cost per tonne. Unlike the finding presented earlier in Table 10, once other direct predictors are controlled, percent of own forces involvement is a statistically significant direct predictor of total cost per tonne.

TABLE 12 Total Standardised Effects Ranked From Largest to Smallest for the Recycling Causal Model Which Predicts Net Cost Per Tonne

Variable	Total Direct Plus Indirect Effects
Residents are required to set out full bins only	-.336*
Monthly residential participation rate	-.245*
Tonnes collected per vehicle	-.160*
Percentage of vehicles that are side loaders	.116*
Number of materials accepted	.109*
Curbside recycling service only	.103
Workforce is unionised	.078
Population of the local government	-.073
Producer is in Ontario	.071
Producer is in Quebec	.058
Collection frequency	-.049
Private production of the service	-.017
Recycling and garbage collection is done by the same crews at the same time	.008

Note: The asterisked variables directly and significantly (.10 level or higher) predicted net cost per ton.

TABLE 13 Total Standardised Effects Ranked From Largest to Smallest For the Landfill Causal Model Which Predicts Total Cost Per Tonne

Variable	Total Direct Plus Indirect Effects
Tonnes collected per vehicle	-.630*
Percent of all vehicles that are dump trucks	-.260*
Percent of equipment (not vehicles) that are compactors	.240*
Landfill was in Ontario	.231
Population served by the landfill	-.226
Landfill workforce was unionised	-.190
Number of restrictions on materials to be landfilled	.150*

Percent of public (own forces) involvement in the land fill	.103*
Average salary of landfill workers	-.075
Average years of work experience with the local gov. or company	-.072
Number of activities that occur at the land fill	-.035
Weighted average annualised replacement cost	-.020
<u>Number of hours per day that the landfill operated</u>	<u>-.002</u>

Note: The asterisked variables directly and significantly (.10 level or higher) predicted total cost per ton.

Integrating the Findings from the National Surveys: Comparing the Efficiency of Recycling and Conventional Solid Waste Collection Strategies

A key finding from the residential recycling survey is the relatively high cost of recycling compared to conventional collection of solid wastes. Among the survey participants, there were only 10 local government managers who reported that their recycling operations made money or broke even. Nevertheless, recycling advocates continue to assert that recycling is less costly than conventional land-filling of solid wastes (Gomberg 2000) which makes it worthwhile comparing the costs of recycling to the costs of conventional collection and disposal.

Nationally, the average net cost per tonne was \$124.39 for recycling producers. In the residential solid waste study, the average cost per household was \$53.66, and when that figure is converted to cost per tonne (using the national average of 1.12 tonnes of residential solid waste per household), the cost is \$47.91 to collect a tonne of garbage, making residential recycling 160 percent more expensive.

Using findings from the three surveys, it is possible to estimate the relative costs of collecting and disposing of one tonne of solid waste with and without recycling. The key question is whether recycling reduces the total cost of collecting and landfilling garbage (McDavid 2000).

Using the national averages reported in this article, the relative costs of collecting and disposing of a tonne of solid waste with or without recycling are summarised in Table 14. The second column in Table 14 assumes that 50 % of a typical tonne of residential solid waste has been recycled. This figure reflects the goal of most provincially mandated recycling programs in Canada.

There is a clear difference in overall operating costs, and recycling appears to be more expensive, even if it succeeds in diverting 50 % of solid waste from landfills.

One objection to these figures is that local governments that collect solid waste are confronted by tipping fees which can exceed the operating costs of landfills.

In fact, our national data supports this assertion. The average tipping fee in 1995 for general refuse was \$45.69 per tonne (n = 42 landfills reporting). This was more than double the average operating cost of landfills (\$21.97 per tonne) in that year.

The total costs of collecting and disposing of a tonne of residential solid waste are presented in Table 15, except that tipping fees are substituted for landfill operating costs. Even when disposal costs are more than doubled by substituting average tipping fees for average operating costs, the use of recycling continues to be more costly than conventional waste disposal. Although recycling is undoubtedly a key part of a broader strategy to factor environmental values into our production and consumption decisions, the data from the three national surveys indicates that supporting recycling increases the total cost to taxpayers of collecting and disposing residential solid waste.

TABLE 14 Total Operating Costs Per Tonne of Collecting and Disposing of Residential Solid Waste With and Without Recycling

	With Recycling (50 % diversion from landfills)	
	Without Recycling	
Average Collection Cost	\$47.911	\$86.15
Average Landfill Cost	\$21.97	\$10.98
Total Cost Per Tonne	\$69.88	\$97.13

TABLE 15 Total Costs Per Tonne of Collecting and Disposing of One Tonne of Residential Solid Waste Based on Average Tipping Fees

	With Recycling (50 % diversion from landfills)	
	Without Recycling	
Average Collection Cost	\$47.91	\$86.15
Average Landfill Cost	\$45.69	\$22.84
Total Cost Per Tonne	\$93.60	\$108.99

Conclusions

The findings from the three national surveys offer mixed support for a key hypothesis proposed by polycentric theorists: private producers of local government services are more efficient than public producers of the same service. The findings from the residential solid waste collection and landfill surveys generally support this hypothesis. In both studies, public producers (or greater reliance on public crews and equipment) are associated with higher unit costs.

The exception in the residential solid waste collection study is Quebec. There, private producers tended to be less efficient than their public counterparts, due to a combination of factors which suggest that in Quebec, private producers use combinations of equipment and technologies that demand higher

levels of productivity -- which are not achieved.

The findings for the residential recycling survey offer a contrasting picture. Public and private producers offer their services at virtually the same unit cost, and even though residential recycling is dominated by private sector producers, this has not translated into more efficient services.

Because residential recycling is a relatively new service for the Canadian local governments that undertake it, it is possible that optimal production functions have not yet been worked out. A key variable is the level of uncertainty in the prices for recyclables. Regional and secular variations suggest that producers will continue to operate in environments where it is difficult to establish stable expectations, and hence, will tend to inflate prices to offset the uncertainty.

The newness of residential recycling also suggests that public producers may have started out with more efficient mixes of inputs, and closed the gap with private producers. There is some evidence for this from the solid waste collection and recycling surveys.

Nationally, we may be seeing the results of local government managers' efforts to improve efficiency by starting a new service with up-to-date equipment and crewing practices. For recycling, both public and private producers may be choosing technologies that yield similar unit cost results. A key issue will be whether public producers can innovate. Berenyi and Stevens (1988) have suggested that a lack of managerial flexibility in public operations tends to result in rigidities that translate into higher costs over time.

Finally, when we combine the unit cost findings from the three services, we see that even if recycling programs achieve their objective of reducing landfilling by 50 %, recycling is more costly. We are paying more to recycle than we would have paid to dispose of solid waste in landfills. But that finding is not really surprising. If we think of recycling as part of a broader process of capturing the costs of our producing and consuming society that heretofore have been ignored or undervalued (treated as externalities), the costs of the goods and services we consume will go up, at least until we implement technologies that do not create negative production or consumption externalities in the first place.

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