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The Economics of Municipal Solid Waste Management

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Editorial

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1. The environmental Kuznets curve and solid waste

For many years economists studying municipal solid waste (MSW) were hampered by the general lack of data. Only a few municipal governments bothered to keep accurate data on the quantity of waste and recyclable materials generated and no consortia were available for the little data that did exist. Early economic researchers therefore resorted to contacting individual municipal governments or households to collect necessary data, and the reliability and scope of these data were limited. The past decade has seen the emergence of high quality statewide panel data in the United States and national panel data in many other developed countries in Europe and Southeast Asia. Economists have recently utilized these data to better understand the empirical relationships important to MSW policy formation. What has been learned?

The environmental Kuznets curve suggests that although environmental pollution initially increases with per-capita gross domestic product (GDP), at some point GDP and emissions become decoupled. Further increases in GDP can then be associated with decreases in environmental pollution as production and treatment technologies improve with national incomes. In the case of MSW, for example, advances in technologies associated with recycling and green design could improve with growing incomes. Although a number of economic papers have been surveyed, empirical evidence supporting the environmental Kuznets curve for solid waste generation is scarce (Mazzanti et al., forthcoming). As an example, a 1% increase in national income has been estimated to increase the quantity of MSW by 0.69% using macroeconomic data from 30 OECD member countries over 20 years – the relationship between income and MSW quantities is positive and linear (Johnstone and Labonne, 2004). More recently, municipal-level panel data in Japan show a slight decoupling of income and MSW quantities (Yamamoto et al., 2009). MSW quantities are forecasted to eventually decrease with income at income levels exceeding three times their current levels. Given the traditional rate of income growth, it appears likely that MSW quantities will continue to rise with GDP for the next few generations unless major new technological advances are achieved. Perhaps, then, the appropriate question in the short term remains how to best manage the expected global increases in MSW.

2. The external costs of waste disposal

Although local and state governments manage MSW collection and disposal in many parts of the world, private industries have emerged in some nations to collect and dispose MSW. An important question related to market provision is whether firms seeking to maximize profits generate outcomes consistent with social goals. Because external costs are widely believed to be associated with the private disposal of MSW, most countries regulate the disposal process. In the 1970s for example, many developed countries enacted detailed technology-based standards regulating the construction and operation of MSW landfills and incinerators. Although these measures likely reduced significantly the external costs of MSW disposal, very little was known until the past few years about the magnitude of these external costs. New research has provided some important clues. In the Netherlands the external marginal costs have been estimated at $4.26 per ton for landfills and $18 per ton for incineration (Dijkgraaf et al., 2004) with the assumption that the cost of land utilized for landfill disposal constitutes a private cost of disposal. By combining published sources, the external marginal cost of landfilled MSW in Europe was estimated between $5.39 and $8.76 per ton (Kinnaman, 2006). Similarly, the external cost of incineration in the United States has been estimated at $5.26 per ton (Isely and Lowen, 2007). In comparison, the private marginal costs of waste collection and disposal are about $70 per ton in the United States and perhaps as high as $200 per ton in densely populated areas such as the Netherlands and Japan. Taken together, these studies suggest the collection and disposal practices of private firms internalize most of the costs of their activities. These costs are of course reflected in the price levied to dispose MSW, and are therefore internalized by MSW producers. Yet public policy may be necessary to internalize the remaining $4–$18 per ton external costs currently borne by society. What policy approaches are most effective?

3. Pricing garbage by the bag

The external costs of disposal can be internalized by assessing a per-bag user fee on the curbside collection of MSW. If an average bag of MSW weighs about 20 pounds, then based on the results above the optimal curbside per-bag fee should be roughly $0.75 in the US (or $2.15 in the Netherlands). The price of waste disposal would then equal the private ($.70) plus external ($.05) marginal costs of MSW collection and disposal and the market failure is eliminated. Such unit-based pricing programs are common throughout the United States, Europe, and Southeast Asia.

But these programs are costly to operate as municipal governments must devote resources to individually measuring each household's waste generation and to deter illegal dumping by households attempting to avoid paying the per-bag fee. To make such administrative efforts worthwhile, the per-bag fee should induce households to reduce MSW by a sufficient amount. New sources of panel data (repeated observations for each of many municipalities in a sample) have allowed economists to estimate this decrease using advanced estimation techniques that control

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for endogeneity problems inherent in one-year cross sectional data used in the past. This recent and forthcoming research suggests the reduction in household MSW quantities in the Netherlands, in Japan (Usui, 2009), and in South Korea (Kim et al., 2008) is smaller than previously estimated. The administrative costs of operating these programs may exceed the welfare gains (Kinnaman, 2006). But because these programs are revenue earning from the perspective of the local government, they may be politically difficult to remove even where the net benefits of the program are negative.

New data have also allowed economists to estimate other long run effects of curbside per-bag pricing programs. If households require time to change disposal behaviors, then the long run reduction in MSW attributable to the curbside pricing program could exceed the short run reduction. But households in Japan have been estimated to behave in the opposite manner (Usui, 2009). A "rebound effect" was discovered where households in the long run return to old disposal habits following the implementation of unit-pricing. New illegal dumping data are available in South Korea to estimate the effect of unit-pricing on illegal disposal (residents receive a monetary award after reporting an illegal dumping site). A 1% increase in the price of waste is estimated to increase the number of illegal dumping reports by 3% (Kim et al., 2008). Finally, new data from Grand Rapids, Michigan collected both before and after a price increase from $1.00 to $1.25 per-bag was estimated to decrease waste by about 8% (Isely and Lowen, 2007) – a rather substantial amount. Recycling quantities were estimated to increase by two-thirds of this reduction in waste quantity. Taken as a whole, these new empirical results question the effectiveness of using curbside per-bag pricing programs in all municipalities to internalize the social costs of disposal. Household responses may vary across municipalities, making a single policy approach undesirable.

4. Curbside recycling – a recycling subsidy

Many theoretical models developed by economists support subsidizing recycling at the curb rather than taxing waste (Shinkuma, 2003). Curbside recycling programs offered by many municipalities throughout the developed world are examples of such subsidies. Although the subsidy is in-kind rather than monetary – the municipality pays to collect, transport, process, and market the recyclable materials for households – it increases the opportunity cost of generating waste and can therefore solve the problem of market failure. The number of municipal recycling programs in developed countries increased substantially during the 1990s but has generally leveled off since.

The marginal cost of operating a municipal recycling program are roughly $120 per ton for the first ton recycled but decrease with economies of scale by an estimated $2.13 per 1000 tons recycled (Kinnaman, 2009). Because the private marginal cost of MSW disposal is only about $70 per ton and the external cost ranges between $5 and $10 per ton (in the United States), the question arises why many municipalities agree to pay more per ton to recycle material than the social cost of simply disposing it. The answer may lie in the tastes and preferences of local households, who may value and therefore be willing to pay for the opportunity to recycle (Kinnaman, 2005). These tastes may be based upon altruistic preferences or may be related to some entertainment value associated with recycling. Regardless of the origin, economists have repeatedly estimated a positive willingness to pay by households for recycling. Using contingent ranking surveys, for example, households have recently been estimates to be willing to pay $3.27–$4.91 for access to separate yard waste collection and $6.44–$9.66 for the opportunity for separate collection of yard waste and recyclable materials in the United States (Caplan et al., 2002). Households in China are estimated to pay $2.40 per month for access to curbside collection of recyclable materials (Jin et al., 2006). This willingness to pay among households both in the United States and in China is estimated to increase with household income. Alternatively, although costs to the municipality in Nova Scotia are estimated to increase by nearly $36 per person per year with the implementation of recycling, the social net benefits are estimated to increase by $33–$175 per person per year (Wagner, 2007) – the first study to find positive social net benefits associated with municipal recycling without including household preferences. Apparently empirical differences exist across municipalities in the costs and benefits of recycling as well.

5. Host fees and disposal taxes

MSW disposal facilities are owned and operated by private industries in the United States and perhaps in a few other countries. Firms in these industries often operate under technology-based standards issued by both state and federal governments. A private firm interested in establishing a new landfill must convince local governments to grant zoning and other legal permissions to site the landfill. These negotiations often include a monetary payment to the local governments (Jenkins et al., 2004). For example, private landfills in Pennsylvania pay an average "host fee" of $4.05 per ton of waste disposed to local governments. Assuming local governments behave rationally and are therefore unwilling to grant permission to site a new landfill unless the terms are favorable, the host fees should equal or exceed the expected external costs of MSW disposal expected by local residents. In a competitive market, the fee these firms charge for waste disposal is equal to the private marginal cost of waste disposal. Private marginal costs include the costs of land, labor, machinery, and other resources used to accept and process waste using methods acceptable to state and federal governments. Host fees increase the private marginal cost of disposal and therefore the price of disposal. The social costs of MSW waste disposal are therefore internalized by waste generators. Public policies beyond the technology-based standards designed to alter household disposal patterns are not necessary. Curbside user fees, curbside recycling program, producer extended responsibility measures (Germany's green dot program), recycling content standards, and landfill taxation are all unnecessary policy instruments if garbage generators pay the social marginal costs of MSW at these private landfills.[1]

6. Developing countries

Empirical economic research has also emerged in developing countries. Using contingent valuation method (CVM) surveys, households in three squatter Malaysian villages are estimated to be willing to pay $3.42 per month for regular waste collection rather than having to discard waste in streets or transport waste to area open dumps (Murad et al., 2007). Similarly, using 200 CVM surveys low-income households in Nigeria are estimated to be willing to pay $1.70–$1.80 per month for regular waste collection (Fonta et al., 2008). Willingness to pay for basic MSW collection in both of these areas is estimated to increase with household income. Thus, establishing proper collection and disposal methods appear to be the primary concerns in developing countries. Developing strategies to increase recycling are not yet policy concerns.

[1] Waste generators pay more than the social marginal cost of waste disposal if the disposal industry is not perfectly competitive. Waste generators pay less than the social marginal cost of waste disposal if landfills or incinerators contribute to climate change. Presumably whatever federal legislation is passed to mitigate climate change could also apply to MSW landfills and incinerators.

7. The shape of future empirical research

Thus, the economics empirical literature over the past several year suggests (1) the external costs of MSW disposal are perhaps smaller than previously expected, (2) the change in household behavior attributable to unit-pricing programs is smaller than previously estimated, and (3) curbside recycling remains valuable to households, even if the net benefits of recycling programs are not otherwise positive. More research is needed to understand the robustness of these conclusions. Furthermore, we are learning that the external costs of MSW disposal, the disposal behavior of households, and preferences for recycling vary across municipalities and countries. What is necessary, then, are more local and regional empirical studies of household disposal behavior and especially new estimations of the external costs of MSW to form optimal MSW policy within each region. Finally, household preferences for recycling opportunities are largely responsible for the benefits of curbside recycling to exceed the costs. If these preferences are permanent, then curbside recycling policies will continue to be efficient. But if preferences for recycling opportunities fade with time, then many municipal recycling programs may become inefficient unless program costs diminish with maturity and experience.

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