

The socially optimal recycling rate: Evidence from Japan[☆]Thomas C. Kinnaman^{a,*}, Takayoshi Shinkuma^b, Masashi Yamamoto^c^a Department of Economics, Bucknell University, United States^b Department of Economics, Kansai University, Japan^c Center for Far Eastern Studies, University of Toyama, Japan

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ABSTRACT

This paper estimates the average social cost of municipal waste management as a function of the recycling rate. Social costs include all municipal costs and revenues, costs to recycling households to prepare materials estimated with an original method, external disposal costs, and external recycling benefits. Results suggest average social costs are minimized with recycling rates well below observed and mandated levels in Japan. Cost-minimizing municipalities are estimated to recycle less than the optimal rate. These results are robust to changes in the components of social costs, indicating that Japan and perhaps other developed countries may be setting inefficiently high recycling goals.

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Introduction

Recycling municipal solid waste has become increasingly common over the past 25 years. This trend can be attributable largely to government initiatives. Many individual states within the United States, for example, either mandate curbside recycling or set recycling targets. In the European Union, the Packaging Directive of 1994 (amended in 2004 and 2005) has made recycling a national priority in many member countries. The Law for the Promotion of Sorted Collection and Recycling of Containers and Packaging (1997) has had a similar impact in Japan. Such policy measures have directly or indirectly resulted in recycling rates of 34.1% in the United States (US EPA, 2010), 19.44% in Japan (Table 2), and 34% in the EU27 (EEA, 2013).

Are these recycling rates socially desirable? Is more recycling always preferred to less recycling? Or might some countries have gone too far in terms of promoting municipal recycling? Using data from Japan and external cost and benefit estimates available in the literature, this paper first calculates the social cost of managing municipal waste and then estimates the average social cost as a function of the recycling rate. Social total costs are defined as (1) the total municipal budgetary costs to manage both waste and recycling collection and disposal systems less any revenue earned from the sale of the collected recyclable materials, plus (2) the total resource costs incurred by households to prepare material for recycling collection – estimated in this paper using novel methods, plus (3) the total external costs associated with landfilled waste disposal or incineration, minus (4) the external benefits associated with manufacturing final goods comprised of recycled materials rather than virgin materials less the external costs associated with collecting, transporting, and processing the recycled material. Available data coupled with results from existing literatures allow each of these four components of social costs to

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be estimated and used to calculate average social costs, which are then estimated as a function of the recycling rate in order to estimate the recycling rate that minimizes average social costs in Japan.

Results suggest that after considering all of the economic and the environmental costs and benefits associated with managing waste and recyclable materials, the estimated optimal recycling rate in Japan is 10%. This estimate is robust to changes in aggregated assumptions regarding the magnitude of the three estimated components of social costs listed above. Cost-minimizing municipalities that externalize costs at landfills and manufacturing centers are estimated to recycle only 7%. Although some of the private and/or external costs that influence these estimated recycling rates may be constant across Japan or even the world such as the production of climate changing gasses or other regional pollutants, other private and external costs may vary substantially across municipalities such as the distance to recycling or disposal facilities. Thus, optimal recycling rates are very likely to vary across municipalities. Yet, the results below suggest that observed and required recycling rates seem to exceed the estimated optimal rate by a substantial margins and may therefore call to question aggressive public attempts to increase recycling rates.

The next section of this paper provides a context for understanding the socially optimal recycling by examining current policy and the economics literature. Section “Deriving the social cost of waste: data sources” then describes separately the four components of the social cost of waste management and the data and processes used to estimate each component. The socially optimal recycling rate under varying assumptions is estimated in Section “Estimating average social costs as a function of the recycling rate”. We vary assumptions regarding the components of external costs in Section “Altering the magnitude of the three components of external costs” to consider the robustness of the main results. The average social cost of recycling specific materials is considered in Section “Average social costs and the recycling of specific materials”. Section “Generalizing results to other countries” discusses similarities and differences between Japan and other developed countries to consider whether results obtained using data from Japan can be generalized. Section “Conclusions and policy implications” discusses other policy implications of the results and concludes the paper.

Recycling policy and the economics literature

What percentage of solid waste should be recycled by municipal governments? Is it none? Is it all? Or is some share in the middle optimal? The answer is unlikely zero because private firms have traditionally found recycling profitable for centuries. If, for example, the market price of scrap aluminum is sufficiently high to cover the resource costs necessary to disassemble old tractor trailers to recover the aluminum siding, then the market will certainly do so. The question must therefore be restated. How much of the otherwise unwanted waste material worth less than the cost to collect and process should society recycle? If the disposal of recyclable materials did no harm to the environment or generate other external benefits or costs and if markets are sufficiently competitive, then the answer is zero – free market internalizes all social benefits and costs of recycling and will find the optimal quantity (Baumol, 1977). But waste disposal facilities have been estimated to generate external costs. Landfills may threaten local groundwater quality, neighborhood property values decline, and climate changing gasses escape from both landfills and incinerators (Davies and Doble, 2004). Although recycling facilities also generate their own external costs, using recyclable materials in industrial production rather than their virgin counterparts is often found to reduce energy demand and the emissions of air and water pollutants (Cleary, 2009). The transportation of both waste and recyclable materials generates road congestion, air pollution, and increases the likelihood of vehicle accidents. Given these factors, rather than rely upon the market recycling rate we must wonder what recycling rate is socially optimal once all economic and environmental costs and benefits are considered.¹

Economists have devoted very little attention to answering this question. Not because the question is not a good one, but perhaps because, given an assumed nature of the external costs of waste disposal and uncertainties in recycling costs, there may be a better one. For the case of solid waste, the better question may not be what rate to recycle but what price to charge for waste disposal.² Economic theory suggests that focusing on pollution prices rather than pollution abatement standards such as required rates of recycling is appropriate wherever the external marginal cost of any given pollutant is constant across quantities of pollutants and marginal abatement costs are unknown to policy makers (Field and Field, 2009). Toxic or hazardous waste associated with the disposal of computers, televisions, and cell phones (such as the lead oxide, cadmium, and mercury imbedded in these products) may generate *increasing* external marginal costs – a threshold can be reached where incremental increases in hazardous waste disposal can mix with existing hazardous waste to form new problems for human health and the natural environment (Kahhat et al., 2008). But solid waste is comparatively benign – adding plastic, food waste, and paper to existing piles of these materials increases environmental costs proportionally, but no new medical or ecological threshold is crossed that results in the emergence of some new problematic issue.

If external marginal disposal costs are assumed constant, then economic theory suggests the policymaker acts efficiently by establishing a tax on waste set equal to the constant external marginal cost of waste disposal with no knowledge of the private recycling costs to municipalities or households. Individual households, firms, and municipalities that know their own recycling costs (even as policymakers do not) will recycle until their own rising marginal cost is equal to the after tax

¹ Only the external costs of energy use are included in the external benefits of recycling category. Changes in private energy costs will be reflected in market prices for recycled materials and are therefore included with municipal costs.

² Weitzman (1974) provides a nice background into the question of setting prices versus setting quantities.

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