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Disposal is Not Free: Fiscal Instruments to Internalize the Environmental Costs of Solid Waste

by Thornton Matheson

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Disposal is Not Free: Fiscal Instruments to Internalize the Environmental Costs of Solid Waste

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Abstract

This paper provides an overview of global solid waste generation, its environmental costs, and fiscal instruments that can be used to encourage waste reduction and finance proper disposal. Countries—especially island nations--struggle to manage an ever-increasing volume of solid waste, generation of which is projected to exceed 2 billion tons a year by 2025. Although solid waste management is usually relegated to subnational governments, externalities from inadequate management, which include greenhouse gas emissions and ocean plastic pollution, reach global scale. National governments thus play a critical role in creating incentives for waste minimization and ensuring adequate resources for waste management. This paper evaluates potential fiscal instruments to achieve these goals, particularly in developing country policy environments.

JEL Classification Numbers: H2, H7, Q5

Keywords: environmental tax, solid waste, plastic pollution, plastic bag tax, recycling, landfill tax, tipping fee, advance disposal fee, deposit-refund, extended producer responsibility, virgin material tax.

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I. INTRODUCTION[1]

Neoclassical economic models traditionally assume free disposal of goods,[2] and in the absence of public policies aimed at clearly pricing solid waste, most industries and consumers comport themselves as if this were indeed the case. Of course, free disposal is a myth: Collection and disposal of discarded goods consumes valuable resources, including labor, fuel and land. Though some of these costs may be priced, those prices often lack transparency, and environmental costs such as carbon and methane emissions are usually not priced at all, while charges for improper disposal are often not enforced. Cheap and obscure prices for waste disposal have encouraged waste-intensive production and consumption patterns, such as a heavy reliance on single-use plastics, rather than recycling. Nonetheless, as human populations continue to burgeon, the increasing relative scarcity of land and water clarifies that "There is no away"[3] where our refuse can be carelessly thrown. Body of the document.

Waste management expenditures currently accounts for about 0.5 percent of global GDP,[4] but that figure does not capture the full social cost of trash generation. In the developing world, a large percentage of trash goes uncollected, and even collected trash is often poorly disposed of. Developed countries, which collect and dispose of a high percentage of their trash, nevertheless often have recycling rates well below 50 percent. Countries at all development levels are struggling to manage an ever-increasing volume of waste, which rises not only with population but also with per capita income. Global waste generation rates are projected to reach more than 2 billion tons each year by 2025, almost double their level in 2012.[5]

Trash generates numerous externalities that affect the quality of human life by polluting land, air and water and by poisoning domestic and wild animal populations. Although solid waste management is usually relegated to local governments, its damages reach national and even international scale: For example, ocean plastic pollution has been valued at $13 billion per year, and methane from anaerobic decomposition of organic waste accounts for about 5 percent of global greenhouse gas emissions. Island nations, which have limited land and often depend on the waste-intensive tourist industry, can find that waste management costs (including environmental externalities) exceed 1 percent of GDP.

Particularly in the developing world, local governments frequently lack sufficient resources to provide adequate waste management, which is often their single largest budget item; they depend on central government transfers rather than local charges, which provides residents with no incentive to reduce trash generation. For all these reasons, waste management is a macro-

[1] I am grateful to Michael Keen, Ian Parry and participants at an IMF Fiscal Affairs Department seminar for their constructive comments on earlier drafts of this study.

[2] See, for example, Debreu (1982).

[3] Leonard (2010).

[4] Based on $400 billion estimate of Le Courtois (2012) and UNEP (2011).

[5] Hoornweg and Bhada-Tata (2014).

(continued)

relevant issue calling for involvement of national governments, if only to provide a policy framework for local governments to improve waste management financing and delivery.

The purpose of this paper is to review the existing literatures on the scope of solid waste externalities and the policy instruments that could be used to address the widespread underpricing of waste management services. Developing countries need to increase domestic resources to meet their sustainable development goals,[6] and this is particularly true of subnational governments, whose capacity is usually even more constrained than that of central governments. This paper therefore focuses on revenue-raising instruments, rather than regulations or subsidies, to create appropriate incentives for waste minimization. The pros and cons of the various instruments are assessed with an eye toward adaption to the developing country context, and country experiences with those instruments are evaluated wherever possible. The conclusion highlights instruments which appear to have the most promise for developing countries and outlines areas where further research would enable better crafting of fiscal instruments for waste management.

II. The Scope of the Problem

A. Waste Generation

1. Global MSW generation amounted to roughly 1.3 billion metric tons in 2012, or an average of 1.2 kilos per person per day.[7] This volume is projected to almost double to 2.3 billion tons in 2025 (Figure 1), driven largely by developing countries' population and income growth. In terms of aggregate volume, more than half of total solid waste is produced by developing countries. However, in per capita terms, higher-income countries generate at least twice as much waste per capita (Figure 2).[8] Higher-income consumers not only consume more goods overall, but also a higher concentration of packaged and complex durable goods such as vehicles, appliances and electronic equipment. The average waste generation rate among OECD countries in 2014 was 1.4 kg/person/day (Figure 3), although there was substantial variation around that average.

[6] See https://www.un.org/sustainabledevelopment/sustainable-development-goals/

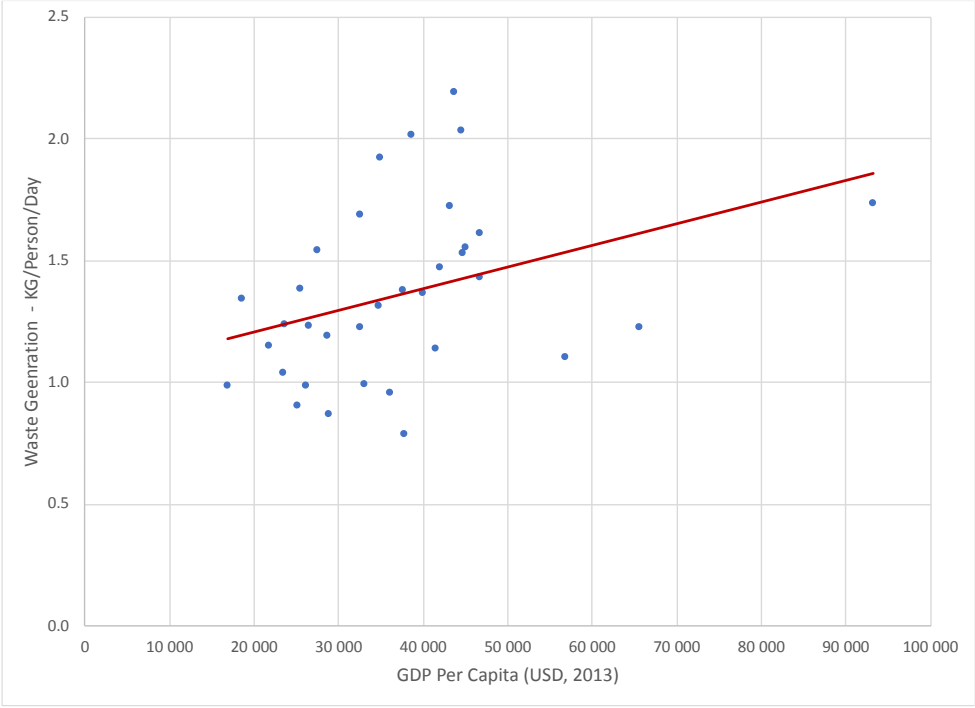
[7] Hoornweg and Bhada-Tata (2014) and Le Courtois (2012). UNEP (2011) gives a somewhat higher figure of roughly 1.8 billion metric tons.

[8] Troschinetz and Mihelcic (2009). These figures include wastes that are recycled.

Figure 1. Urban MSW Generation by Income Level

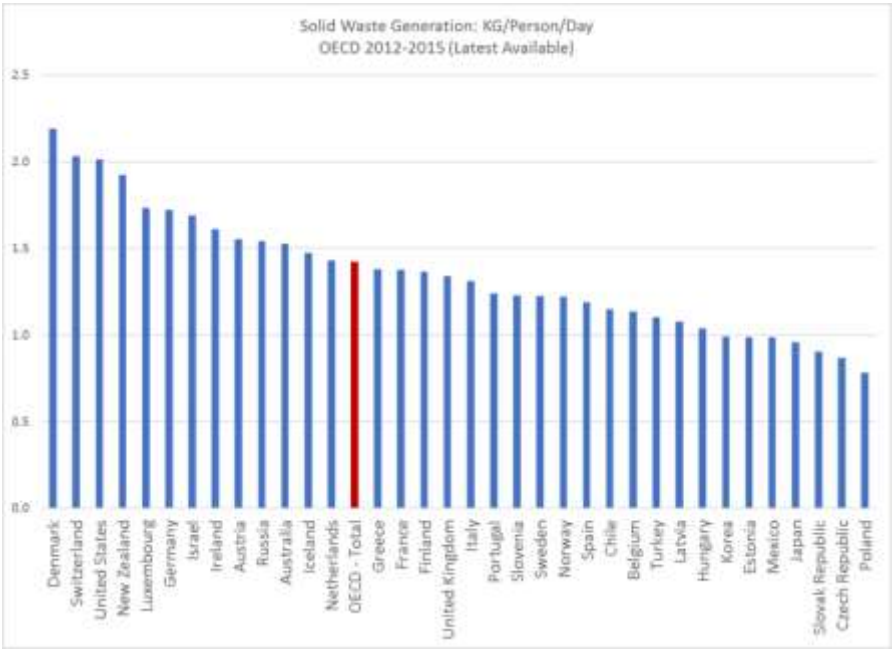
Source: World Bank (2012)

Figure 2. Per Capita GDP and Solid Waste Generation – OECD Countries



Source: OECD Environmental Statistics

Figure 3. Developed Country Waste Generation Rates



Source: OECD Environmental Statistics

2. Although high-income countries generally have higher rates of waste generation, many of the world's highest waste generation rates are found in developing island nations, where tourism plays a large role (Table 1). Scarcity of land—the critical resource for landfilling (or dumping)—makes these countries' waste disposal problems especially acute. Rising sea levels due to global warming of course exacerbate this scarcity.

Table 1. Countries with Highest Per Capita Waste Generation Rates

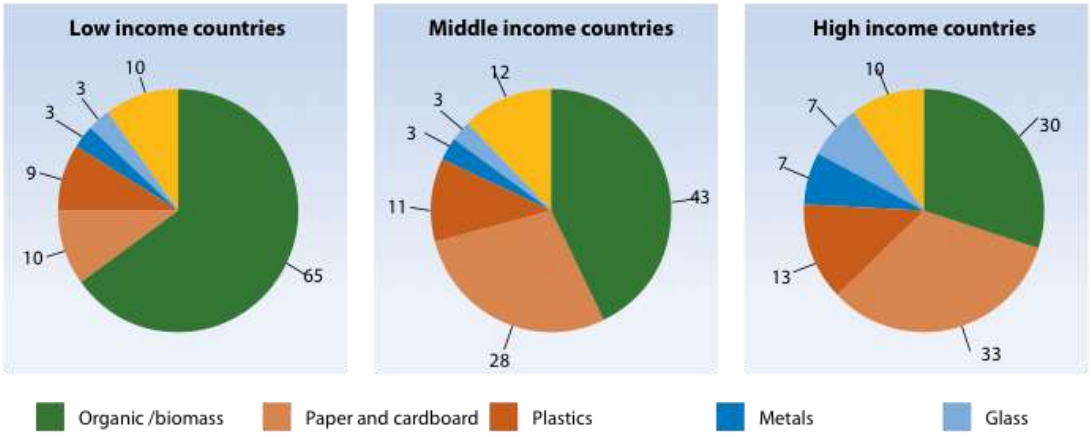
Country	Kg/Person/Day	Income Group	Landfill/dumping rate (%)
Kuwait	5.72	High	na
Antigua and Barbuda	5.50	High	99
St. Kitts and Nevis	5.45	Upper-middle	100
Guyana	5.33	Lower-middle	96
Sri Lanka	5.10	Lower-middle	na
Barbados	4.75	High	na
St. Lucia	4.35	Upper-middle	70
Solomon Islands	4.30	Low	na
Tonga	3.71	Lower-middle	na
New Zealand	3.68	High	85
Ireland	3.58	High	66
Vanuatu	3.28	Lower-middle	na
Bahamas	3.25	High	na

Source: Hoornweg and Bhada-Tata (2012)

3. Not only the volume, but also the composition of solid waste changes as income rises (Figure 4). Whereas most waste generated in lower-income countries consists of biodegradable

organic materials, this share shrinks as income rises. Most waste in middle- and high-income countries thus consists of inorganic materials, notably paper and plastic. At present, the central challenge for low-income countries is safely processing organic materials—for example by composting, a practice which has high coordination costs but generates a valuable output. Higher income countries, by contrast, need to address a growing flow of inorganic materials by transforming production and consumption patterns toward comprehensive recycling. As incomes grow, lower-income countries can also anticipate a rising level of inorganic wastes that will need to be processed.

Figure 4. Composition of MSW by Income Level



Source: UNEP (2011)

B. Waste Management and Finance

4. As for waste generation, collection and disposal outcomes also vary with country income level. At present, much of this waste goes uncollected and/or is improperly disposed of, particularly in developing economies: Medina (2010) estimates that low- and middle-income countries collect only 40-60 percent of their solid waste, and properly dispose of only 5-30 percent. While developed nations have very high collection rates, they nevertheless have room to improve incentives for waste reduction and recycling.

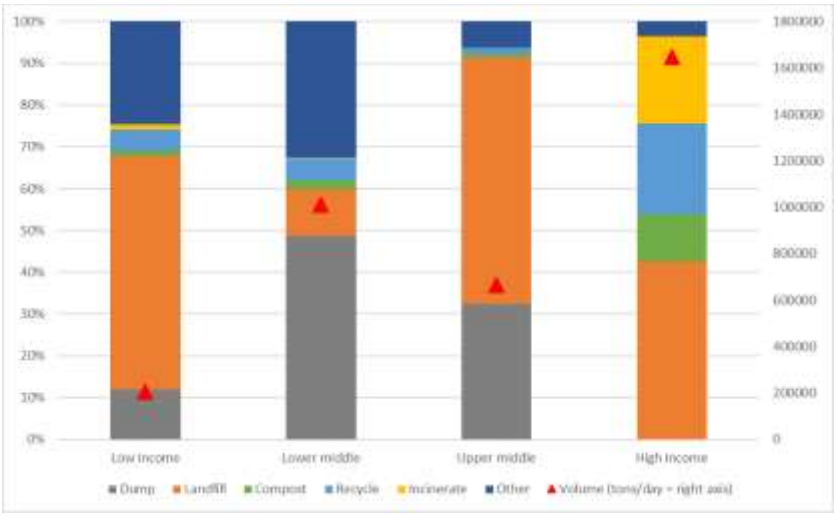
5. Though performance differs widely, most developing countries' systems for collecting and processing solid waste are sorely inadequate. Collection rates in low and lower-middle income countries average only 43 percent, rising to 85 percent in upper-middle income countries (Hoornweg and Bhada-Tata, 2012). In high-income countries, there is currently little significant dumping—legal or illegal—of solid waste. The majority of solid waste is deposited in sanitary or at least controlled landfills,[9] although recycling, incineration, and composting of organic waste

[9] In contrast to dumping, controlled landfilling entails daily coverage of wastes with soil to deter vermin access, as well as perimeter drainage. Modern sanitary landfill further entails entrapment and treatment of liquid (leachate) and gas emissions. Figure 5 does not distinguish between these landfill standards.

also account for significant processing shares (Figure 5). In developing countries, however—even those in the upper-middle income category—dumping is still a common practice.

6. Although formal recycling activities in lower-income countries account for a small share of waste disposal, those countries tend to have active informal recycling sectors. In contrast to most developed countries, where recycling is usually a negative value-added process requiring government subsidies, the lower wage level in developing countries make scavenging a profitable activity. On average, scavengers process about 15 percent of MSW in developing countries, where scavenging can account for as much as five percent of urban employment, making it an important source of income and employment for marginal groups (UNEP, 2011; Le Courtois, 2012).

Figure 5. Disposal Methods by Income Group



Source: Hoornweg and Bhada-Tata (2012)

7. According to the UN Environmental Programme (UNEP), waste management expenditures are approximately 0.5 percent of global GDP.[10] Waste management is typically the responsibility of local governments, where it is often the single largest budget item, accounting for 20-50 percent of operational spending (Medina 2010).

8. Though developing countries produce more than half the world's solid waste, their annual public expenditure on waste processing, about US$46 billion, represents only a little more than one tenth of the roughly $400 billion spent on waste processing worldwide (Le Courtois, 2012; UNEP, 2011). This is partially due to lower labor costs, which render all methods of collection and disposal cheaper, but also to inadequate collection and disposal (Table 2). The absolute costs of waste collection and disposal are lower in developing countries, but they nonetheless account for a higher share of income than in advanced countries. Cointreau (2006) estimates that low-income countries pay 0.7-2.6 percent of income for solid waste management, vs. 0.5-1.3 percent in middle-income countries and 0.2-0.5 percent in high-income countries.

[10] Based on $400 billion estimate of Le Courtois (2012) and UNEP (2011).

This higher cost share is due to several factors, including the high capital cost of inputs (mainly trucks and fuel), process inefficiencies, and the more frequent pickups required in hotter climates.

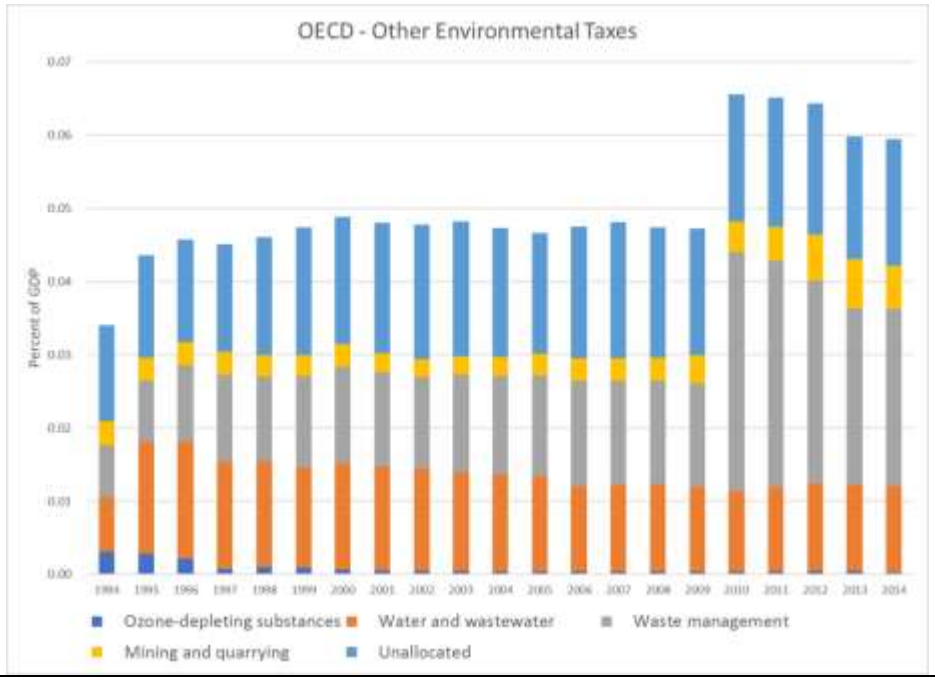
Table 2. Collection and Disposal Costs by Income Level

Income Group	Collect	Dump	Landfill	Compost	Incinerate	Anaerobic digestion	Collection Rate (%)	Volume (Ton/Person/Year)
	USD/ton							
Low	20-50	2-8	10-30	5-30	na	na	43	0.22
Lower middle	30-75	3-10	15-40	10-40	40-100	20-80	68	0.29
Upper middle	40-90	na	25-65	20-75	60-150	50-100	85	0.42
High	85-250	na	40-100	35-90	70-200	65-150	98	0.78

Source: World Bank (2012)

9. Data on global waste-related revenues such as garbage collection fees, landfill taxes, and advance disposal fees are scarce. Nonetheless, waste-specific public revenues are clearly much lower than waste management expenditures. Even in OECD countries, which tend to have higher levels of environmental taxes than developing countries, solid waste-related charges account for only 0.02 percent of GDP on average (Figure 6).

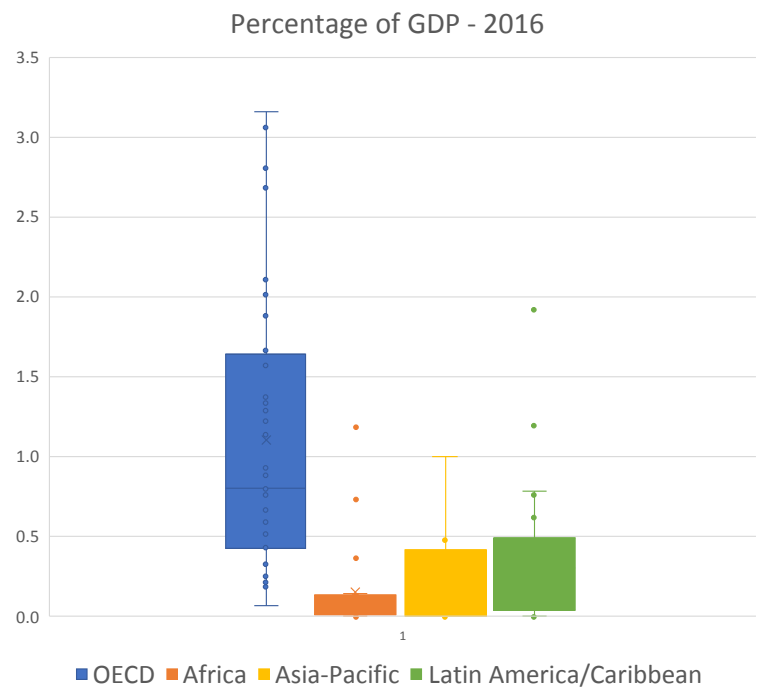
Figure 6. Other Environmentally Related Revenues - OECD



10. Waste expenditure greatly exceeds waste-related revenues charges because most local governments finance waste collection and disposal out of their general revenues. Globally, the most common source of waste management finance is an unspecified portion of the local property tax. Revenues from the property tax average 0.7 percent of GDP worldwide, but vary widely by income and region (Figure 7). Among the 76 countries tracked by the OECD, property tax revenues averaged of 1.1 percent of GDP in developed countries compared to 0.4 percent in developing countries. The major problem with financing waste collection out of general

revenues is that the practice does not confront residents with either an average or marginal cost of waste generation, creating the impression that disposal is free, when in fact it has substantial private and social costs.[11]

Figure 7. Property Tax Revenues by Region



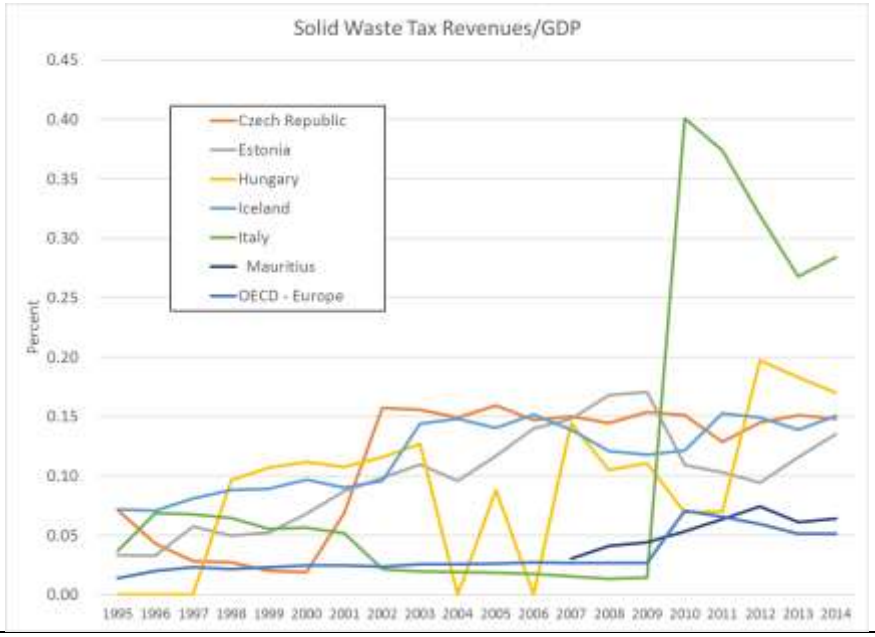
Source: OECD revenue database

11. Despite the overall low level of waste-related charges, several countries have recently expanded this revenue source in an effort to help finance and curb growing trash volumes (Figure 8). Nordic and east European countries figure prominently in this group. The spike in Italy's waste-related revenues in 2010 resulted from its partially replacing its property tax with a waste management tax in that year. Mauritius—the sole developing country among the top tier—has doubled its solid waste-related revenues since 2007 as part of a concerted effort to improve waste management practices and finances. This initiative arose in response to a tripling of waste generation, from 400 tons per day in 1997 to around 1,200 in 2017, due to rising incomes as well as the tourist industry. The central and local governments spend around MUR 1.5 billion (US$ 45 million) annually on waste management, compared to waste-related revenues of roughly US$8.2 million.[12] Most waste disposal is thus still financed out of general revenues, a situation that Mauritian authorities plan to address by charging more businesses directly for waste disposal.

[11] The incentive effects of various waste-related charges will be dealt with in greater detail in the Section III.

[12] http://environment.govmu.org/English/Pages/swmd/SWMD-Solid-Waste-In-Mauritius.aspx; OECD database.

Figure 8. Countries with Highest Solid Waste Revenues



C. Externalities

12. Waste generation is ultimately driven by consumption of goods and services[13], production of which generates a variety of externalities throughout the product lifecycle (TKTK). Extraction of virgin materials such as timber and metallic ores generates various externalities including loss of biodiversity and carbon absorption, watershed pollution and erosion, and aesthetic disamenities. The production process consumes energy, which typically adds to carbon emissions and generates various liquid, solid or gaseous wastes. Finally, end-of-lifecycle product disposal—as well as disposal of solid production wastes--may produce dumping or landfill externalities, which are the focus of this paper.

13. Failure to internalize any of these externalities via appropriate taxation and/or regulation can distort activities throughout the entire production-consumption chain. For example, Conrad (1999) presents a general equilibrium model showing that failure to charge for disposal biases production in favor of virgin materials, and indeed, virgin material taxes have been studied and promoted as a means to encourage recycling.[14] Similarly, Acuff and Kaffine (2013) present a model showing the impact of waste disposal taxes and recycling subsidies on carbon emissions, which they measure as being at least as large as disposal externalities: Carbon savings from using recycled inputs vary across materials, but can be large, especially for aluminum. Such studies

[13] Although solid waste consists of disposed of goods, service consumption also generates material wastes at both producer and consumer levels. For example, dry cleaning services proliferate plastic bags and hangers as well as chemical emissions, and catering services produce food waste as well as packaging and, often, single-use serveware. TKTK also notes that legal and medical services produce paper, plastic and biohazard wastes.

[14] See, for example, Dinan (2001).

concur that externalities associated with each production stage are ideally addressed by a tax applied at that stage: That is, virgin material taxes or royalties are best suited to internalizing extraction damages, and the social cost of carbon emissions is best dealt with through a comprehensive carbon tax. However, in the absence of these instruments, a disposal tax may reduce some of those externalities or vice versa. This paper will generally assume that virgin material royalties and carbon taxes are available to address extraction and production externalities and focus on taxing waste to curb disposal externalities. Disposal externalities do, however, include greenhouse gas emissions from dumps and landfills, where decomposition of organic wastes releases biogas, a roughly 50-50 mixture of carbon dioxide and methane. These emissions, which are not generally covered by carbon taxes, account for about 1.4 percent of total global GHG emissions.[15]

14. Solid waste externalities depend critically on the means of disposal: that is, whether trash is deposited in a sanitary landfill, a non-sanitary landfill, an official dump, or an illegal dump. In the U.S., where the 1976 Resource Conservation and Recovery Act required waste to be disposed of in sanitary landfills, Kinnaman (2006) estimates that disposal externalities range from $5.38 to $8.76 per ton, including greenhouse gas emissions, or only about 0.01 percent of GDP.[16] South Korea, which required separation of organic wastes in 2013, noted a significant fall in waste externalities—specifically, ground water contamination and foul odors—as a result. However, as Figure 5 suggests, much of the world's trash is not subject to these high standards.

15. Non-sanitary landfilling and dumping generate numerous negative externalities for humans and the environment. In addition to emitting foul odors, they also poison wild and domestic animal populations; breed vermin such as rats and insects that spread disease; allow toxins including unprocessed human sewage to leach into ground and surface water; and generate spontaneous fires that create air pollution. Illegal dumping—including trash that escapes from legal dumpsites via wind or water—causes the same problems as legal dumping and also blocks drainage systems, contributing to flooding and waterborne diseases. Plastic waste—and especially thin plastics bags—are of particular concern in this respect due to their non-biodegradability, impermeability, mobility and toxicity.

16. While most of the pollution from improper solid waste disposal is localized, it nonetheless has international spillovers: Approximately five percent of greenhouse gases derive from methane produced by anaerobic decomposition of organic materials in solid wastes. And the UN Environmental Program estimates that 8 million tons of plastic end up in the ocean each year, where they cause an estimated $8-13 billion in annual damages, including poisoning

[15] ICPP (2007). Solid and wastewater emissions total 2.8 percent, approximately half of which come from solid waste and waste incineration. In some landfills, biogas is captured and either flared or used for energy generation. While it is generally agreed that this reduces landfill GHG emissions, estimates vary as to how much.

[16] In 2006, U.S. GDP was $13.86 trillion and the U.S. generated 251.3 million tons of trash. However, not all U.S. trash is deposited in sanitary landfills: For example, roughly 300,000 tons of U.S. plastic waste ends up in the ocean (Jambeck, 2015).

(continued)

marine stocks and littering shorelines, which damages the fishing and tourism industries.[17] Jambeck and others (2015) find that more than 60 percent of ocean pollution originates in only six Asian countries (China, Indonesia, the Philippines, Vietnam, Sri Lanka, and Thailand), suggesting that waste policy reform in only a few countries could have a large positive impact.

17. Comprehensive data on global solid waste externalities are not available (Cointreau, 2006). However, individual studies make it clear that those costs are macro-relevant for at least some countries. Islands, with limited land mass and dependence on tourism and marine activities are particularly vulnerable. For example, Hajkowicz et al. (2005) estimate the total cost of solid waste in Palau, including public collection and disposal and impairments to human health, fishing, and tourism income, at approximately 1.6 percent of GDP (Table 3).

Table 3. Valuation of Solid Waste Externalities in Palau

	('000 US dollars per year)		
Cost categories	Best Estimate	Low Estimate	High Estimate
Healthcare and illness costs	697	669	745
Public waste collection and dump site operation	101	67	136
Litter collection	23	15	30
Vector control (mosquitos, rats)	17	14	21
Loss of recyclable aluminium	7	7	7
Loss of nearshore fish catch (reef fish, crabs, lobsters)	89	28	150
Mangrove timber loss	7	3	10
Lost tourism income	961	0	2,403
Total annual cost	**1,902**	**803**	**3,501**
As percentage of GDP	**1.6%**	**0.7%**	**2.9%**
Cost per household	**0.51**	**0.22**	**0.95**

Source: Hajkowicz et al., 2005

III. Policy Responses

A. Overview

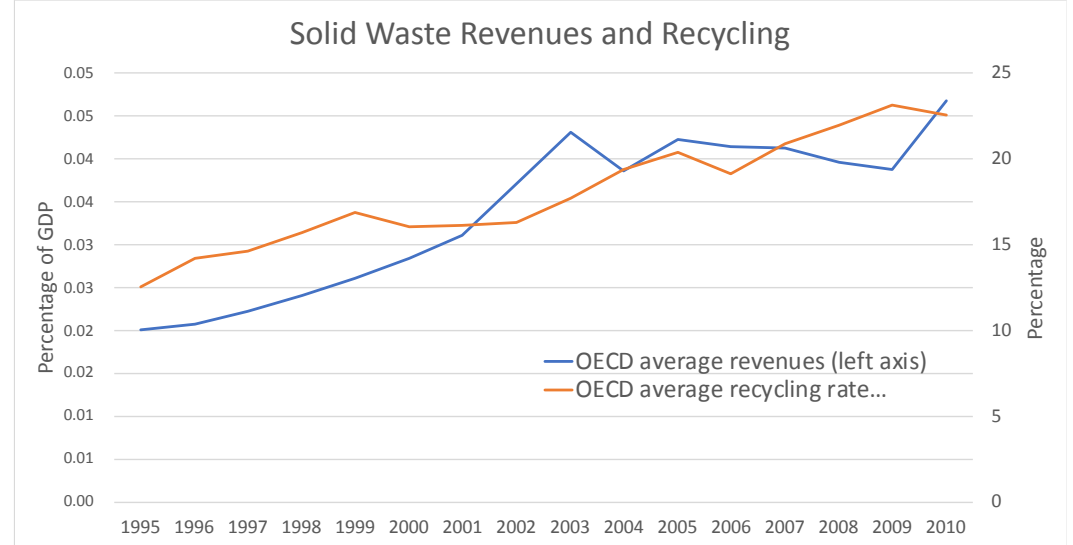
18. In response to a rising tide of solid waste, governments at all development levels are seeking new policy measures to improve solid waste management. Across the globe, a wide variety of regulatory ("command and control") and economic instruments (taxes, fees and subsidies) are used to manage and finance solid waste collection and disposal. Common regulatory instruments include extended producer responsibility (EPR), sanitary landfilling

[17] UNEP (2014) estimates ocean plastic pollution conservatively at $8 billion, while Jambeck and others (2015) estimates $13 billion.

requirements, and recycling quotas, while common fiscal instruments include waste collection charges, advance disposal fees, and deposit-refund schemes. No single policy approach is ideal for all contexts, and regulatory and economic instruments can serve as complements as well as substitutes.

19. This paper focuses on revenue-raising instruments due to developing countries' general need for domestic resource mobilization, which is particularly acute for waste management finance: Waste-related charges in developing countries usually do not cover the costs of collection and disposal, let alone related negative externalities. Also, disposal standards tend to be low, resulting in high solid waste externalities; elevating these standards, for example by requiring sanitary landfilling or composting of organic materials, would reduce externalities but impose additional costs, requiring additional funding. Among OECD countries, higher solid waste taxes are strongly correlated with reduced waste volumes and increased recycling levels (Figure 9).

Figure 9. OECD Solid Waste Revenues and Recycling



20. Although waste management is typically the responsibility of local governments, central governments play an important policy role in setting waste management standards and ensuring adequate financing. Since some externalities from solid waste, such as methane and carbon emissions[18] and aquatic pollution, reach the national and international levels, policies to address them should arguably fall under the purview of central governments, with guidance by multilateral agencies. Also, some economic instruments, such as material charges and hazardous waste excises, are most easily imposed on producers or imports, requiring national-level legislation. National policies can also promote local own revenue generation, which is frequently inadequate in developing countries. Local public services including waste management are often

[18] Anaerobic decomposition of organic waste (which can be avoided by composting) results in methane emissions; solid waste collection (via trucks) and incineration create carbon emissions. Failure to recycle useful materials, particularly aluminum, also worsens carbon emissions.

financed out of central government transfers, which weakens citizen perception of their cost. Central governments should therefore provide a policy framework encouraging effective incentives for waste minimization as well as adequate resources for waste management (Cointreau and Hornig, 2003).

21. Waste stewardship involves multiple parties with different objectives and constraints. Producers design, produce and sell products, and wholesalers and retailers buy products to resell at a markup, both with the goal of generating profits. Consumers buy products and dispose of used products and packaging to enhance their welfare while minimizing costs. Local governments are often charged with responsibility for waste collection and disposal (including recycling), to which end they levy taxes and/or fees or receive subsidies from higher levels of government. Private or non-profit entities may also be involved in waste disposal or recycling with the goal of generating profits or covering costs, respectively. A well-designed product stewardship program must take into account the interests and incentives of all these parties to achieve the desired outcome.[19] A growing literature on the game theory of sustainability explores these interactions.[20]

22. Developing countries have certain distinguishing characteristics that should be taken into account in designing waste financing policies. First, they tend to have high poverty rates, so regressivity of any tax measure is an important concern. Second, despite lower labor costs, they tend to have relatively high per capita collection costs, which depend heavily on the prices of fuel and capital equipment. Third, they tend to have very limited administrative capacity, particularly at the local level. And fourth, they have significant private recycling activities.

B. Fiscal Instruments

Disposal Level

23. Excessive waste generation stems from the fact that the full cost of waste disposal—private cost plus externalities--is seldom fully compensated. This problem begins at the disposal site and works its way up through the entire production chain. The private costs of landfilling—land rent, capital and operating costs—may be compensated by **tipping fees**: charges levied by the landfill owner, whether public or private, per ton of material deposited. Tipping fees often have variable rates, with reduced rates for waste streams with lower externalities or higher reuse value (e.g., construction debris, separated compost) and increased rates for hazardous wastes. Although tipping fees are paid by immediate users of the dumpsite, such as public and private waste haulers, they ultimately burden consumers by increasing the cost of disposal. Waste haulers recoup the fees by charging more to households, businesses, and local governments (who must then levy higher waste charges on constituents, etc.) While private landfill owners

[19] See U.S. Environmental Protection Agency (2011) for a detailed discussion of how different waste disposal taxes and regulations affect different types of actors.

[20] See, for example, Grimes-Casey and others (2007) and Kaushal and others (2015).

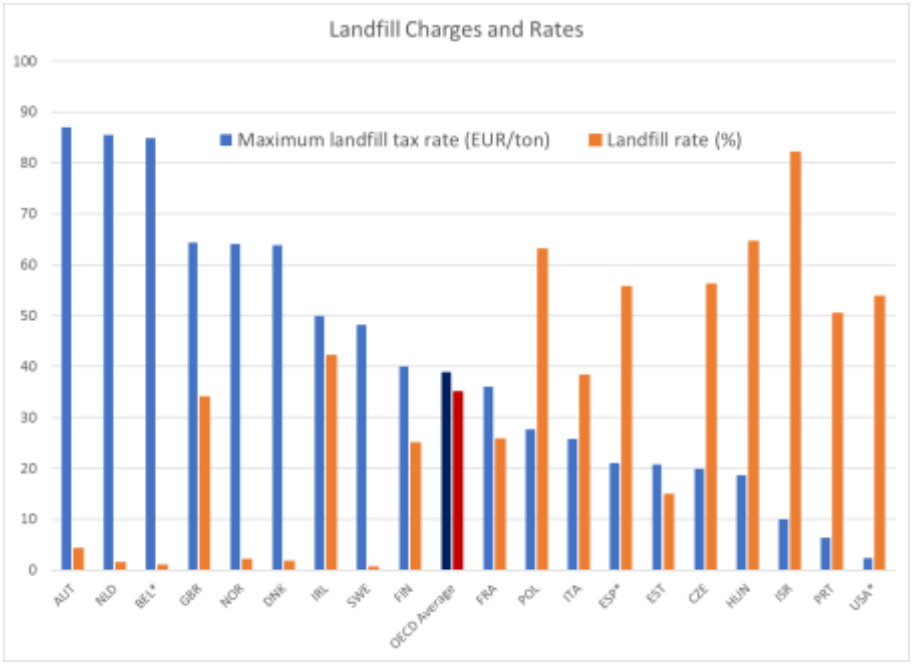
(continued)

generally charge adequate fees to cover their costs, publicly owned landfills may undercharge, providing an implicit subsidy to waste generation.[21]

24. Even if the private costs of a landfill are fully compensated, its public disamenities—odor, groundwater contamination, greenhouse gases, truck traffic, vermin, etc.—usually are not. Numerous hedonic studies of property values have shown that proximity to a landfill negatively impacts property values, even in countries with relatively stringent environmental standards. According to a U.K. survey, properties located within one mile of a landfill are worth an estimated 5-10 percent less than comparable properties located elsewhere (DEFRA, 2003). To compensate communities for this loss, U.S. landfills often pay "host fees" to local governments per ton of trash deposited in their jurisdiction. Kinnaman (2006) finds that these fees partially offset waste disposal externalities and recommends imposition of a landfill tax to internalize any residual externalities. In general, there will be a tradeoff between landfill taxes and tipping fees: If landfill environmental standards are raised, it will reduces environmental externalities but raises landfill operating costs, resulting in a shift from taxes to tipping fees.

25. In the OECD, higher landfill charges (taxes and tipping fees) are strongly correlated with lower rates of landfilling (Figure 10). In Europe, landfill taxes became popular in the 1990s as one means of reducing solid waste volumes. Since 2000, European landfill tax rates have generally declined—sometimes sharply—as other fiscal and regulatory measures reduce solid waste and its environmental externalities, and reduced waste volumes threaten the financial viability of existing landfills (Park and others, 2018).

Figure 10. OECD Landfill Charges and Rates



Source: OECD Environmental database

[21] One reason why publicly owned landfills may undercharge for trash disposal is fear of creating an incentive for illegal dumping. This issue is discussed further in the section on unit-based disposal pricing.

Household Level

26. Globally, the most common waste-specific fiscal instruments are fees and taxes levied by local governments on households and smaller businesses to finance solid waste collection and disposal. (Larger businesses, by contrast, typically manage their own waste streams through some combination of recycling and on- or off-site disposal.) There are variety of ways these charges can be structured that affect waste reduction and recycling incentives as well as distributional incidence. Although household-level charges are most common, waste-related fees can also be applied earlier in the consumption cycle, at the retail or production stage. The institutional constraints of a particular environment—for example, the extent of trade or local administrative capacity—will make some instruments more effective than others.

27. Local waste charges may be either explicit or implicit, which affects their salience. Explicit charges typically take the form of a **flat fee** charged per residence, or the fee may vary scaled somehow to property size or value. In some countries, waste disposal fees are charged as a **utility surcharge**, such as an ad valorem markup on an electricity or water bill. The most common implicit charge is for waste collection to be financed out of local government general revenues, which may include intergovernmental transfers and the largest source of which is usually the **property tax**. In all these cases, waste disposal charges are independent of the amount of trash actually generated; the marginal cost of disposing of an additional unit of trash is therefore zero, and residents have no financial incentive to reduce their waste output. Where charges are implicit, consumers will likely be unaware of even the average cost household cost of waste disposal.

28. While none of the abovementioned instruments encourages waste reduction at the margin, their salience, administrability and proportionality to household consumption—that is, their fairness—varies. Flat fees have the advantage of being relatively easy to administer, but they are unfair in the sense that they are not proportional to household consumption.[22] Under a flat fee scheme, smaller and lower-income households cross-subsidize larger, higher-income households. Utility surcharges, which are used in several developing countries (Cointreau and Hornig, 2003), are both easy to administer and proportional to a measure of household consumption. Larger and higher income households are likely to have higher consumption levels both of goods and services that generate solid waste and of water and energy. Levying the waste charge on the utility bill eases administration and improves compliance: The bills can be paid simultaneously, with the water or electric company acting as collection agent for the waste management authority, and households are more likely to pay in order to ensure that their water and power supply is not cut off.[23] Both flat fees and utility surcharges are salient.

29. Property tax rates are set proportionate to some measure of property value, sometimes with a progressive rate schedule and/or an exempt value threshold. They thus tend to be quite progressive, as property ownership correlates strongly with both wealth and income. However,

[22] For example, some Ethiopian municipalities charge a flat fee for waste collection. Lohri et al., (2014).

[23] Where developing countries provide a "lifeline" level of electricity and/or water free of charge to poor households, they must decide whether to also provide trash collection free of charge or to charge a flat fee below the utility threshold.

property values do not necessarily correlate closely with consumption and are therefore a poor proxy for waste generation. A large family living in a modest-sized home may generate far more trash than a large house occupied by a small family, and property tax is due even on unoccupied properties that generate no waste. Moreover, property taxes usually finance a variety of local public services, so residents paying for waste management in this manner do not receive a clear signal of even its average cost.

30. Creating a financial incentive for waste reduction requires imposing a non-zero marginal cost for waste disposal. Under **unit-based** or "**pay-as-you-throw"** (PAYT) pricing, residents are charged per unit of trash collected. This can be done in several ways: Under a bin-based system, residents pay for a certain number of size-regulated trash bins that they can fill for regular collection. Depending on the system, they are charged for all bins each period or, where administrative capacity allows, only for those that are set out for collection. Alternatively, residents are required to purchase special trash bags or bag stickers to pay for the cost of trash disposal; only trash set out in appropriately marked bags in accepted for collection. The most administratively sophisticated systems charge residents for the weight of trash collected, which is the measure most relevant to landfill costs.

31. The appropriate PAYT charge would cover the full cost of collecting and disposing of each unit of trash as well as any environmental externalities generated in that process.[24] In reality, fees charged are often much lower, causing Cointreau (2003) to question their incentive effects. Nonetheless, international studies show that unit-based pricing schemes have a significant negative impact on waste volume generated, with an average arc elasticity of -0.34, according to a meta-analysis conducted by Bel and Gradus (2016). The meta-analysis shows no significant difference in effectiveness between bin-based and bag-based systems, although weight-based systems perform substantially better, with an additional marginal elasticity of -0.4. Surprisingly, systems offering curbside pickup of recycling materials did not perform significantly better, but those offering compost collection did, with an additional marginal elasticity of -0.2.

32. The major disadvantages of PAYT are its high administrative/compliance costs and the incentive it creates for illegal trash disposal. Under bin- and weight-based systems, charges must be tailored to each household. Bag-based systems are simpler insofar as they put the burden of compliance on consumers to purchase bags or stickers, but they create an incentive for counterfeit bags/stickers and dumping unpaid bags in collective bins. Imposing PAYT is thus easiest in suburban settings dominated by single-family homes and more difficult both in urban settings, where residents have access to collective bins, and in rural areas, where trash can be dumped in remote areas. Where dumping risk is high, Fullerton and Kinnaman (1995) posit that the best alternative to unit-based pricing is pre-charging for goods disposal upon purchase (e.g., through a local sales tax) and collecting garbage for free.

33. Several advanced countries have unit-based pricing regimes, which can raise a significant amount of revenue that is frequently earmarked for disposal costs (Table 4). South Korea's

[24] This would include landfill externalities and anti-dumping enforcement costs, and any untaxed vehicular externalities (carbon emissions, road damage and accidents, and congestion).

(continued)

experience is illustrative: Unit-based pricing was introduced in 1995 in response to a rapid rise in solid waste generation due to rising incomes as well as changing consumption patterns.[25] Under the volume-based waste fee (VBWF) system introduced, consumers and smaller businesses are required to buy official bags to dispose of waste. The charge for the bags varies among municipalities, reflecting local disposal costs; in 2014, the average cost of a 20 liter household bag was KRW 482 (about US$0.46), with local prices ranging from KRW 299-813 (US$0.28-0.77); businesses pay higher rates; the average cost of a 20-liter business bag in 2014 was KRW 766 (US$0.73).[26]

Table 4. Unit-Based Pricing Regimes

Country	Instrument	Year	Base	Rate	Earmarking	Revenue (US$ mns.)
Finland	Charge on municipal waste collection / treatment	1979	Ton or m³ of waste collected	3-75€ per container; varies by type of waste and size of the container.	100% - waste management costs	242.6 (2014)
Korea	Volume-based waste fee	1995	Municipal wastes	Varies between municipalities. National averages 2008 were 238 KRW per 10 litres bag and 447 KRW per 20 litres bag.	-	484.2 (2014)
Latvia	Municipal waste user charge	NA	Volume of collected waste	5.27-7.51 € per m³	-	NA
Norway	Charge on municipal waste collection / treatment	1981	Volume of collected waste	Municipalities are urged to apply full cost charging	-	NA
Switzerland	Charge on municipal waste collection / treatment	1950	Waste collection bags	1.15 - 2.88€ per 5 kg bag.	100% - disposal costs	NA

Source: OECD PINE Database

34. Although Korea's VBWF system generally does not charge consumers for the full cost of waste disposal, it has nonetheless been instrumental in triggering a significant change in consumer behavior. According to KEI (2016), waste generation fell from 1.3 kg per person per day in 1994 to 0.95 kg in 2014, while total waste generation fell from 58.1 tons per day to 49.9 tons. The recycling rate rose from 15.4 percent to 59 percent over the same period. In 2013, an additional composting program for the separation of food wastes was added (although many households began separating food wastes prior to that year in order to reduce their trash output). Landfilled food waste has fallen from 97 percent in 1994 to only about 2 percent in 2014, which has greatly reduced landfill externalities (air and water pollution as well as methane emissions).

Retail Level

35. **General consumption taxes**, such as the value-added tax (VAT) or retail sales tax (RST), raise the general cost of consumption compared to other activities (e.g., leisure) and thus

[25] Korea Environment Institute (2016), henceforth cited as KEI, notes that, as Korea's growth engine shifted from exports to domestic consumption, shopping evolved from a necessity to popular leisure activity, leading producers to shorten their expected product lives.

[26] KEI (2016).

produce some source reduction of waste. However, since consumption of different goods and services produces waste streams of varying cost to the environment, general consumption taxes are a blunt instrument for internalizing those costs. General consumption taxes are therefore better suited to general revenue raising than to internalizing environmental costs. However, where household-level waste charges are not feasible, a retail sales tax is a reasonable proxy for household consumption and could be used to prepay for disposal; if varied at the local level, it could be tailored to local disposal costs.

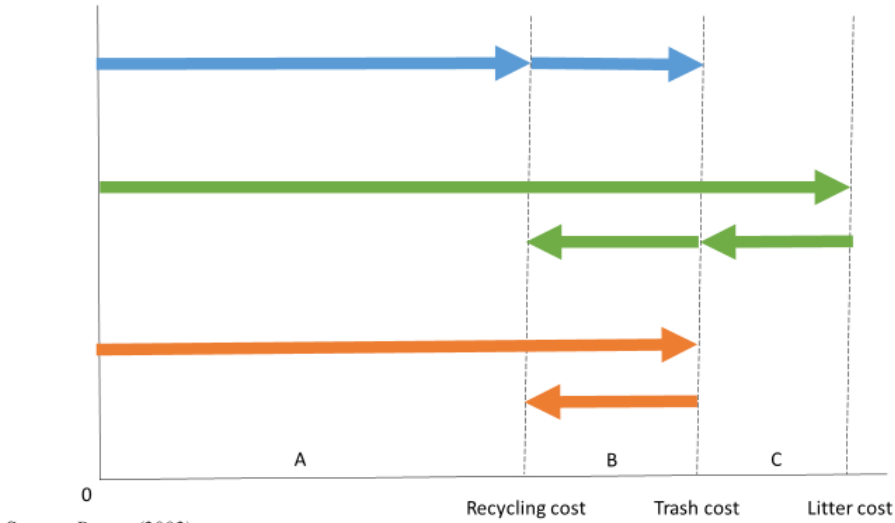
36. Jamaica's Environmental Protection Levy (EPL), introduced in 2007, is an example of a general consumption tax imposed for waste management purposes. The 0.5 percent ad valorem charge was originally imposed on all imports (except those from CARICOM countries) to offset the environmental costs of waste materials, particularly plastic packaging. Revenues from the EPL were supposed to be earmarked to improve waste management, but given Jamaica's fiscal pressures they were actually swept into general revenues. In 2015, the government extended the base to include imports from CARICOM countries and domestic manufacturing, with credit given for EPL paid on inputs; however, it did not reform the use of revenues. The EPL thus came to resemble an additional 0.5-point surcharge on Jamaica's General Consumption Tax (a credit invoice-type VAT).

37. Because different products, depending on their material composition and production process, generate waste streams with differing environmental impacts, a system of goods-specific excises could internalize those environmental costs. Such excises, **known as advance disposal fees (ADFs)**[27] can be levied at either the retail or the production (or import) level (Walls, 2011); in either case, they pass through into consumer prices, so their burden falls on consumers and discourages consumption of goods with more costly waste streams.

38. ADFs can reflect different levels of disposal costs, from recycling (lowest) to trash disposal to littering (highest) (Figure 7). If ADFs internalize only the cost of recycling, then an additional charge should be levied for disposal (and a stiffer penalty for dumping—if detected). A more reasonable practice is for ADFs to reflect the cost of legal disposal, with rebates given for delivering goods for recycling (a deposit-refund scheme, discussed below). Where the environmental costs of improper disposal are very high, it may be reasonable to incorporate them into the ADF, with rebates given for recycling. Porter (2002) proposes that the best model may be incorporating legal disposal costs into the ADF and controlling dumping by non-fiscal means. Determining appropriate levels for ADFs on highly pollutive goods could be administratively challenging for many developing countries but could be facilitated by the development of product- and context-specific norms.

[27] These are sometimes referred to as advance recycling fees (ARFs).

Figure 11. Alternative ADF Structures



Source: Porter (2002)

39. Since retailers are more numerous than manufacturers (or importers) and many are retailers are small, retail ADFs will generally be more costly to administer than production-stage ADFs. On the other hand, retail-level ADFs may be more visible to consumers, which can increase their behavioral impact. Retail ADFs can either be included in the retail price (implicit) or stated separately as a specific charge (explicit). Both implicit and explicit ADFs increase the price of taxed goods, resulting in waste reduction at source, but explicit ADFs can also raise consumer awareness of a good's pollutive externalities, which can further dampen demand for the taxed good and/or increase recycling.

40. An example of implicit ADFs are the tire and battery fees imposed in many U.S. states. These taxes are typically collected and paid by the dealer when a tire or vehicle is sold. (The dealer will often retain a small percentage of the revenue to offset its collection costs.) Because the dealer pays the fee, the consumer is usually unaware of it unless the retailer chooses to itemize it on the sales invoice. Proceeds from tire and battery taxes are often earmarked to fund recycling or other environmental programs.

41. The best known type of explicit ADF is the plastic bag tax or fee, which is now in use across a broad swath of countries (Table 5). Thin plastic bags and are now globally recognized as a serious environmental threat whose damages extend far beyond unsightly litter. Carbon and air pollution emissions from production account for about a third of bags' environmental costs (UNEP, 2014). Because of their physical structure, thin plastic bags escape easily from poorly handled waste deposits into the environment, where they cause numerous harms. Plastic bags poison both wildlife and livestock, with toxins feeding back to humans. They also clog drainage systems, which spreads disease and causes floods, and contribute to ocean plastic pollution (Xanthos and Walker, 2017).

42. In the absence of a plastic bag tax, retailers typically include the cost of plastic bags in their overhead and provide them "free" to consumers, recouping the expense through their general price margin. Consumers thus already pay for plastic bags, although the price is not explicit and does not include the environmental costs of bag proliferation. Charging consumers explicitly for bags thus has both a price and a signaling effect, serving to raise consumer awareness of plastic bag pollution.

Table 5. Countries with Plastic Bag Charges and Bans

Charge or Charge/Ban	Ban Only
Argentina (2009) 1/	Australia 1/
Botswana (2007)	Bangladesh (2002)
Colombia (2016)	Canada 1/
Denmark (2003)	China (2008)
Germany (2016)	Eritrea (2005)
Hong Kong (2015)	France (2016)
Indonesia (2016) 1/	India (2002) 1/
Ireland (2002)	Italy (2011)
Israel (2017)	Kenya (2011)
Malaysia (2011) 1/	Mauritania (2013)
Mauritius (2006)	Morocco (2016)
Mexico (2010)	Myanmar (2009)
Netherlands (2016)	Papua New Guinea (2016)
Romania (2006)	Rwanda (2008)
South Africa (2004)	Taiwan (2003)
Uganda (2007)	Tanzania (2006)
UK (2011-2015) 1/	Tunisia (2017)
USA 1/	

1/ Policy varies subnationally

43. Plastic bag consumption per person per year varies dramatically across countries, in part due to public policies: Denmark, which imposes an average charge of about EUR 0.37 per bag levied on retailers, has one of the world's lowest consumption rates of only 4 single-use plastic bags per person per year.[28] In the United States, where there is no national level policy but a few subnational governments impose bans and/or charges, the rate is about 350 per year. In Thailand, which has no bag restrictions, the rate is almost 3,000 per year.[29]

44. Policies designed to reduce plastic bag use vary widely. Per bag charges range from as little as US$0.015 in parts of Indonesia to as much as US$1.00 in Brownsville, Texas. Charges are often combined with bans on bags of less than a minimum thickness (e.g., 20-50 microns), and bans without charges are also common. Not all bag charges are taxes: Frequently—as in China—bag laws require retailers to charge consumers a minimum amount for bags, but not to remit the revenues to the public treasury. Revenues that are remitted may be earmarked for environmental cleanup funds, which can lead to governance issues, particularly in developing countries. Enforcement also varies both across and within countries: For example, Mexico's 2010 plastic bag law remains largely unenforced, while China's 2008 law is mainly enforced in urban areas.

45. International experience shows that charging even a negligible fee for plastic bags can dramatically reduce their consumption (Table 6). In the listed countries, imposing a very small bag fee—the average fee was equal to 0.3 percent of national daily per capita consumption—reduced bag use by an average of two thirds. Because prior to imposition of charges bags are

[28] The rate including multiple use bags is approximately 90 per year. Ireland and Luxembourg have the lowest overall plastic bag use rates in the EU of approximately 20 bags per year.

[29] The Thai government has asked consumers to voluntarily reduce bag use and is considering introducing a tax.

given out for free (or actually, for a very tiny hidden price bundled into the retail margin), an arc elasticity of demand is estimated. Arc elasticities ranged from 24 to 47, with an average value of 34.

Table 6. Global Impact of Plastic Bag Charges

Country	Year	Bag Charge	Ratio to national average daily consumption	Change in bags consumed	Arc Elasticity	Source
		National currency	*Percentage*	*Percentage*		
Denmark	1994	0.50	0.19	-66	-33	Andresen (1994), He (2010)
Ireland	2002	0.15	0.35	-94	-47	Convery et al. (2007)
South Africa	2003	0.17	0.36	-48	-24	Hasson et al. (2007)
Botswana	2007	0.26	0.68	-50	-25	Dikgang and Visser (2012)
China	2008	0.09	0.36	-49	-24.5	He (2010)
Wales	2011	0.05	0.10	-81	-40.5	Thomas et al. (2016)
Portugal	2015	0.10	0.32	-74	-37	Martinho and others (2017)
England	2015	0.05	0.10	-83	-41.5	UK Department for Environment, Food and Rural Affairs (2018)
Average			0.31	-68.1	-34.1	

46. The extreme sensitivity of bag consumption to introduction of bag charges suggests that they impact consumer behavior well beyond the typical income and substitution effects of a marginal price increase. Imposing an explicit charge on a previously free good raises consumer awareness of the environmental costs of single-use plastic bags, triggering a voluntary additional reduction in bag use. However, the strength of this signaling effect may wear off over time. Dikgang and others (2012) posit that some of the sharp reduction in bag use that followed South Africa's introduction of bag charges was due to consumer resistance to paying for a good that they previously received "for free"; once this shock wore off, however, the deterrent effect of the bag charge diminished. It may thus be necessary to increase bag charges over time to maintain their deterrent effect, and this dynamic has in fact been observed in numerous European countries.

47. **Deposit-refund (D-R) schemes**, which have been widely used for beverage containers in particular, are ADFs offering refund for goods (or packaging) returned for recycling. In contrast to an ADF, which increases goods price unequivocally, a D-R raises prices only for consumers who do not recycle. D-Rs therefore deter consumption less and encourage recycling more than ADFs, making them a generally lower-cost and more effective strategy (Palmer and others, 1997; Acuff and Kaffine, 2013). Unlike unit-based disposal pricing (see below), deposit-refund schemes also do not encourage illegal dumping. Palmer and Walls (1997) show that the optimal D-R rate is the marginal social cost of solid waste disposal. Walls (2011) details the successful application of deposit-refund schemes for a variety of products—bottles, batteries, tires, motor oil, and electronic goods--in the U.S. and Canada.

48. Though theoretically efficient, D-Rs can in practice have high administrative and compliance costs. Consumers incur some cost of storing and returning used items, which must at least be compensated by the deposit in order to ensure compliance. As incomes increase, higher deposit rates become necessary to compensate consumers for their time and effort, particularly if there are alternative methods of recycling, such as curbside pickup.[30] Depending on program design, retailers, distributors and producers may also incur costs of administering the program, which can be offset by their receiving some fraction of the deposit amounts. Unclaimed deposits may revert to the state (or recycling authority) or to participating businesses.

49. Deposit-refund schemes be a very useful method of reducing waste and encourage recycling in developing countries, and their incidence could moreover be highly progressive. By establishing a minimum monetary value for covered goods, D-R schemes could boost urban employment, invigorate existing informal recycling activities, and help ensure an income stream for scavengers. Unclaimed deposits from consumers whose compliance value exceeds the deposit amount can be appropriated to fund the D-R system and other recycling activities. The United Nations Development Program supports D-R schemes as an effective method of combatting ocean plastic pollution and has funded feasibility studies for their introduction in small island developing states (SIDS) of the Pacific (Mar Dieye, 2018). Somewhat surprisingly, few developing countries outside of that region have moved to introduce D-R schemes. One exception is Zimbabwe, where Kaseke (2005) finds a high elasticity of recycling response with respect to the deposit-refund scheme for bottles in particular.

Production/Import Level

50. As previously noted, ADFs can be levied at the production or importation stage rather than the retail stage, which makes for greater administrative simplicity. Like retail ADFs, production-level ADFs pass through into consumer prices, reducing consumption of more pollutive goods; they are however less likely be separately itemized on the receipt and are therefore less salient to consumers. A major concern regarding ADFs levied at the production level is their effect on the competitiveness of exports. As a source-based tax, ADFs raise the relative price of goods at the production stage, even if consumption (and disposal) take place in another jurisdiction. Importers will therefore favor goods produced in jurisdictions that do not levy ADFs. Rebate of ADFs on exports is therefore appropriate, at the cost of increased administrative complexity.

51. ADFs have become quite common throughout Europe on goods with high environmental disposal costs and/or high recycling value, including batteries, electronics and appliances, packaging including food and beverage containers, tires and vehicles. An early review of

[30] The rise of curbside recycling in the U.S. has led to pressure to repeal "bottle bills" in some U.S. states, and Delaware scrapped its law in 2011. Deposit rates of $0.05-0.10 have stagnated over decades, diminishing the real incentive for consumers to participate, while the spread of curbside recycling offers a "free" alternative. However, bottles collected through D-R programs are generally cleaner and more likely to be reused or recycled than bottles processed via curbside recycling. D-R programs have historically been unpopular with beverage producers, distributors and retailers, who are sometimes undercompensated for their participation. In recent years, however, increased interest in sustainability has led some producers to support bottle bills to ensure an adequate flow of recyclable inputs.

European ADFs highlights their main challenges as policy instruments aimed at correcting the underpricing of waste generation: ADFs tend to be introduced at very low levels with numerous exemptions due to concerns about impairing competitiveness and employment (Ecotec, 2001). Lack of international coordination and/or export exemption exacerbates these pressures. Korea and some Canadian and U.S. subnational governments also apply ADFs selectively, with occasional use in emerging market countries including China, India, Russia and South Africa.

52. The OECD Policy Instruments for the Environment (PINE) database provides a detailed description of many national and subnational ADFs, including base, rates, and revenues. Tax rates for some of the most common items subject to ADFs—plastic packaging, batteries, tires and appliances—are summarized in Figures 12-15. These figures show the tremendous variability in ADF rates not only across but also within countries, either due to rate differences among subnational jurisdictions or to rate variation applied to different goods within the same category. Tax base descriptions also include numerous exemptions, most commonly for exports but also for particular uses—e.g., tires for public service vehicles or plastic packaging for medical goods. Further research into the determinants of ADF rates, such as local disposal costs and political values, would help develop rate-setting norms and delineate best practices.

Figure 12. ADF Rates – Plastic Packaging

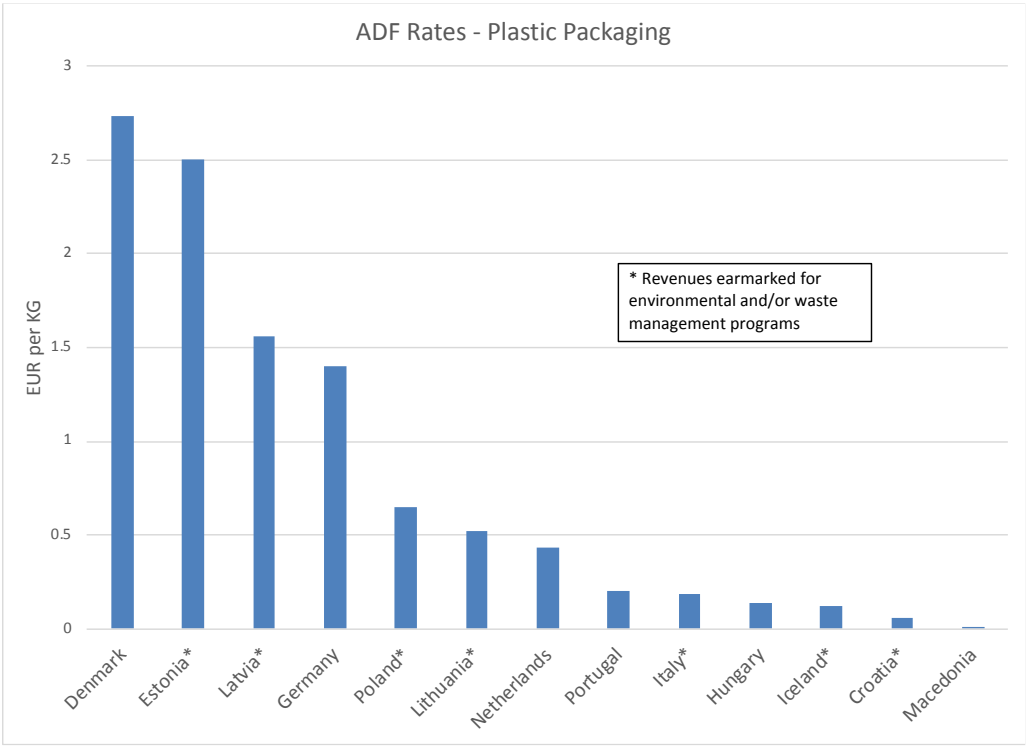


Figure 13. ADF Rates - Batteries

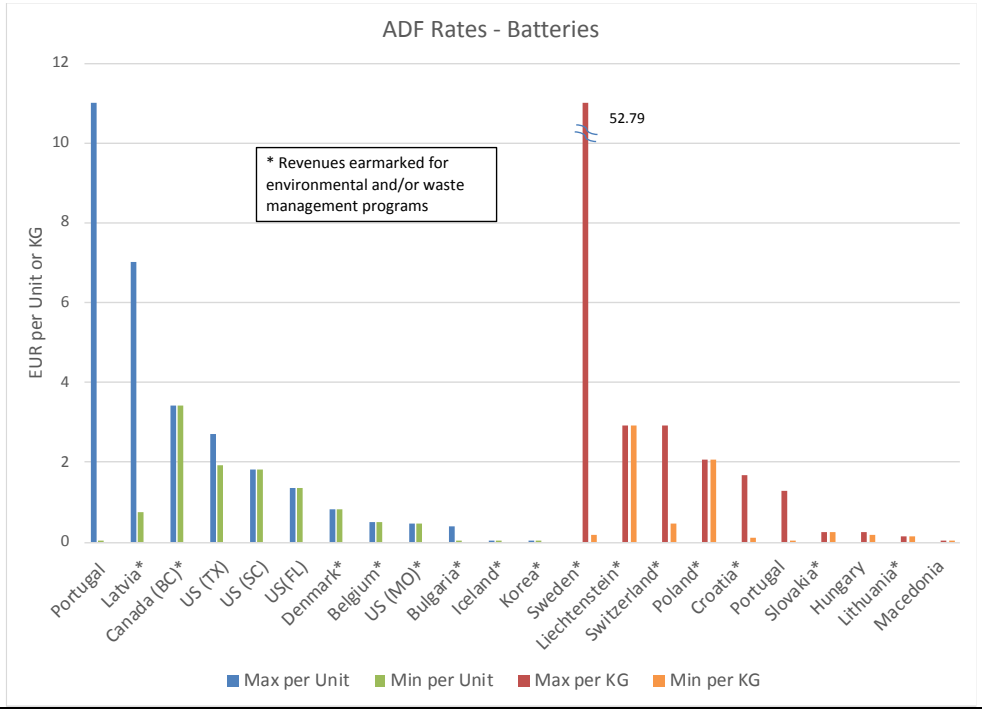


Figure 14. ADF Rates - Tires

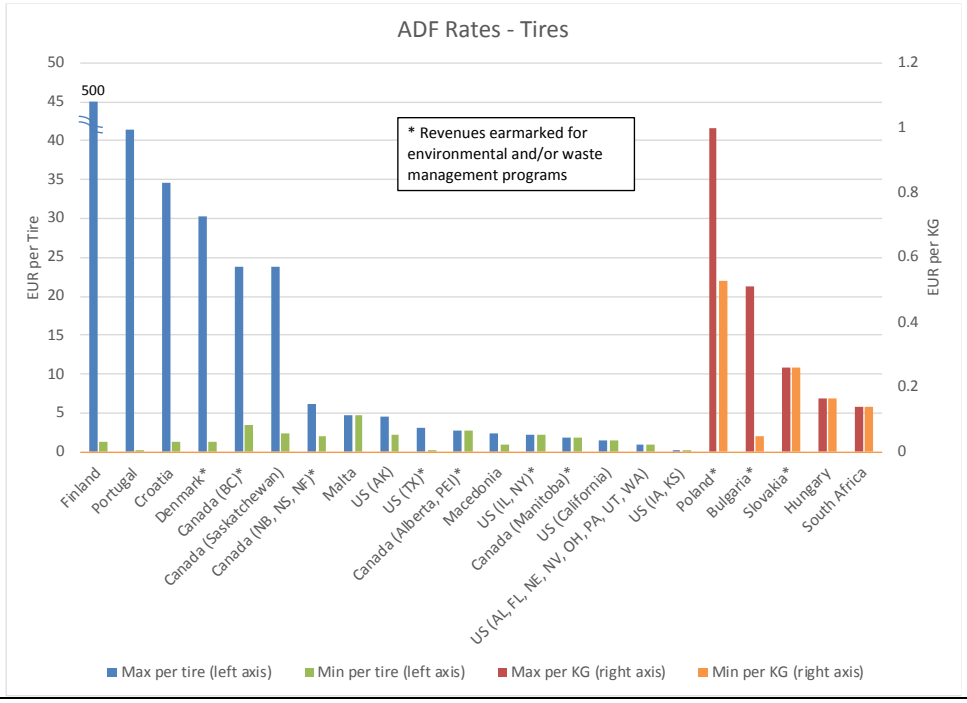
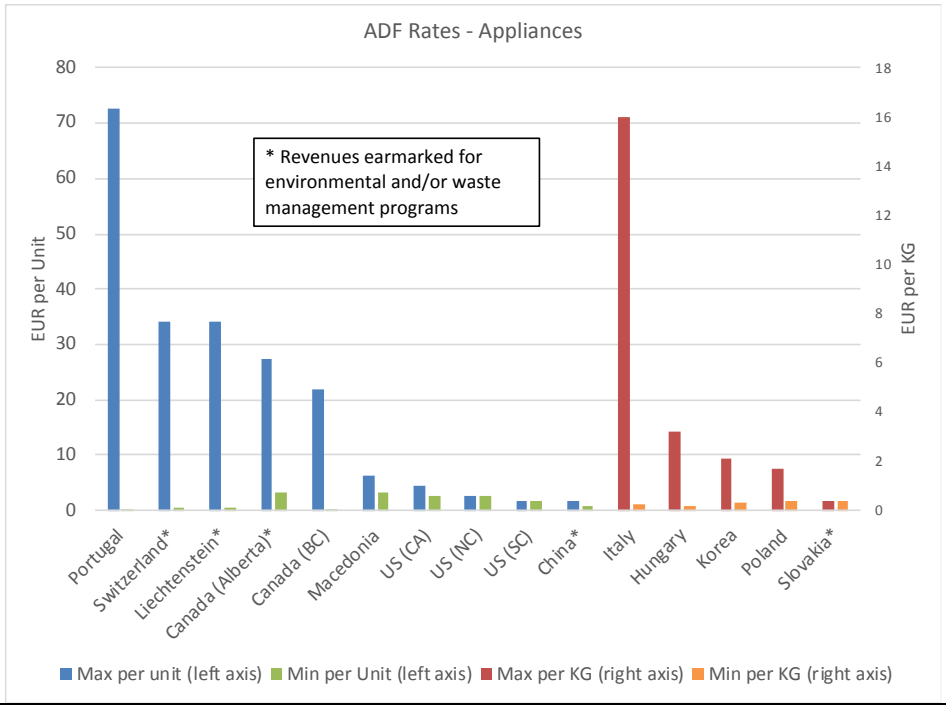


Figure 15. ADF Rates – Appliances



53. Another common feature of ADF regimes highlighted in Figures 8-11 is frequent earmarking of their revenues for waste management, recycling or other environmental purposes. Although revenue earmarking is generally considered suboptimal as it may prevent public revenues from being applied to their highest-value use, earmarking of environmental revenues may be necessary to sustain environmental protection programs through economic downturns and changes of government. Brett and Keen (2000), for example, model environmental earmarking as a means by which green politicians can insulate environmental programs from potential future changes in government.

54. For developing countries, source-based ADFs are attractive insofar as the small number of collection points make them relatively easy to administer. Countries that import a large share of their consumer goods can collect most ADFs at customs, plus perhaps at a small number of manufacturers. The environmental cost of managing the waste stream from imports, which are particularly high for island countries, could potentially be used as a basis for rationalizing tariff structures, which currently reflect a variety of economic and political influences. In order not to harm trade competitiveness, manufacturers should be charged ADFs only for output sold into the domestic market, and ADFs charged on imported inputs should be rebated for exported products. However, production waste should be charged for where it is disposed of (likely in the producing country).

55. Palmer and others (1997) suggest that deposit-refund schemes be imposed at the producer level in order to achieve greater administrative simplicity. Under producer-level D-R, producers (or importers) charge retailers an ADF, part or all of which recycling consolidators reclaim from the producer when returning used goods and/or packaging. Operation of a deposit-refund scheme at the producer level thus assumes the existence of household- or retail-

level recycling mechanism, such as the curbside pickup systems prevailing in many developed countries. Where such mechanisms do not exist, D-R schemes are more effective at the retail level in order to ensure the return of used goods or packaging.

56. Producer-level ADFs are often an important component of extended producer responsibility (ERP), a regulatory regime that imposes a legal liability on manufacturers to reclaim their goods and/or packaging after use. Under EPR, imposition of the recycling responsibility on producers and importers increases their costs, which they pass along to consumers through higher prices, abating consumer demand. Producers then use the higher unit income to either recycle the goods themselves or, as is often the case, to compensate an intermediary to fulfill this function.[31] In this respect, EPR functions like an ADF or producer-level D-R scheme, reducing source demand and encouraging recycling. However, EPR has some distinct advantages over those regimes: With EPR the government does not need to determine the appropriate excise tax level, so EPR is less information-intensive than ADFs. And perhaps even more importantly, ERP incentivizes manufacturers to design their products to reduce waste and maximize recycling and reuse. Also, to the extent that ERP does not apply to exports, it should not impact competitiveness. Applying ERP to importers should ensure that it does not favor imports over domestically produced goods.

57. ERP has the greatest potential in larger developing countries with significant manufacturing for domestic consumption. South Africa has included a significant ERP component in its National Waste Management Strategy (Republic of South Africa, 2016). In the first phase, manufacturers in the paper and packaging, electrical and electronic, and lighting industries were required to submit comprehensive waste minimization and management plans in 2018.[32] Manufacturers may either subscribe to the government waste management plan or define their own plan, which may include the establishment of non-profit organizations to manage the industry waste cycle. Plans are required to include detailed data on waste volumes, management costs, environmental impact, and job creation. Plans are also required to define methods of raising public awareness of industry waste streams and involvement of historically disadvantaged individuals and communities.

58. A **virgin material tax (VMT)**, as the name suggests, is an excise on virgin (but not recycled) raw materials. VMTs lower the relative cost of recycled inputs, stimulating producer demand for recycled materials and consumer demand for goods with higher recycled content (Miedema, 1983; Conrad, 1999). Increased demand for recycled inputs can make recycling programs, which frequently operate at a loss, more cost-effective. However, Dinan (1993) demonstrates that either deposit-refund schemes (i.e., a waste charge combined with a recycling subsidy) or unit-based disposal pricing are more efficient than a VMT at encouraging recycling, because a VMT only encourages use of recycled inputs in goods that also use virgin materials.

[31] For example, under Germany's pioneering "Green Dot" program, manufacturers can discharge their obligations under Germany's 1991 Packaging Ordinance, by paying a private company (Duales System Deutschland, or DSD) to collect and recycle their packaging. Manufacturers paying into this system mark their packaging with a "Green Dot" logo to indicate that can be recycled in the DSD bin/bag system. This system has since been adopted by 19 other European companies, each of with its own consolidator enterprise.

[32] Republic of South Africa (2017).

However, VMTs (or resource royalties) are appropriate instruments for internalizing the environmental costs of extracting of virgin materials (Dinan, 1993; Kinnaman, 2006).

IV. Conclusions and Areas for Further Research

59. Pressured by the rising environmental costs of solid waste, countries are seeking better means of reducing its generation and financing its processing. Minimizing waste and maximizing recycling offer several economic benefits in addition to a cleaner environment, including more secure material supplies, greater productive efficiency, and greener employment (European Commission, 2015). Fiscal instruments, together with appropriate regulations, can play an important role in both generating resources for proper waste management and modifying producer and consumer behavior to reduce waste. While the full product cycle may generate multiple externalities, this analysis focuses on those produced by waste disposal, assuming that carbon and virgin material taxes are available to address externalities from fossil fuel consumption and natural resource extraction, respectively.

60. Developing countries face several fiscal policy priorities for waste management. First, waste management programs are often underfunded and/or are charged for in a manner that obscures their cost to consumers. Waste management is often paid for out of general revenues, so consumers do not perceive its price. Even when households pay an explicit garbage collection fee, it often does not cover the full cost of disposal, let alone waste-related environmental externalities. Further, because fees are usually unrelated to the amount of trash disposed of (that is, the marginal cost of disposal is zero), households face no disincentive for waste generation. For all these reasons, consumer awareness of waste management costs and externalities tends to be poor.

61. To remedy this situation, households and businesses should be confronted with the full cost of waste management, including not only collection and disposal costs, but environmental externalities as well. Where feasible, unit-based pricing schemes based on the actual weight or volume of trash disposed of create the best incentive for residents to minimize waste. However, where administrative capacity is limited and/or illegal dumping risk is high, charging on the basis of household consumption is a second-best alternative. A sales tax tailored to local disposal costs prepays for waste generation at the retail level. Alternatively, an ad valorem surcharge can be added to water or electric utility bills, which offer a proxy for household consumption. Though marginal disposal cost under this system is still zero, households at least perceive an average cost of waste management, and administration is facilitated. If property tax compliance is good and the above systems are rejected for political reasons (e.g., because they are relatively regressive), a third-best alternative is to pay for waste management through the property tax; however, the waste management fee should then at least be separately stated to inform households of its cost.

62. Imposing adequate landfill charges—both tipping fees to cover the private costs of landfill operation and landfill taxes scaled to environmental externalities—ensures that full waste disposal costs are internalized. Landfill taxes should reflect local waste externalities, which will

depend on population density, and topography, among other factors; they should also cover the cost of any increase in anti-dumping enforcement necessitated by higher landfill charges. Landfill charges paid by public and private waste haulers ultimately raise costs for consumers by increasing production costs or raising local government charges. Fully financing waste management in a manner that raises consumer awareness of its environmental costs should help build support for an increase in environmental standards. Improved solid waste regulations, such as sanitary landfilling and separation of organic materials, will reduce externalities (though raising landfill operating costs).

63. While both upstream and downstream fiscal instruments can help internalize disposal costs, downstream instruments have clear advantages. Downstream charges will typically be more visible to the consumer and thus more likely to raise their awareness of alter behavior. Consumer-level charges also do not need to be border-adjusted to avoid harming competitiveness. Nonetheless, production waste disposed of in the source country should be charged for at source, even if the product is then exported. Revenues from waste-related charges should arguably be earmarked for waste management to ensure that environmental standards are not compromised in times of fiscal stress.

64. Deposit-refund schemes (disposal tax plus recycling subsidy) can be used to ensure recycling of goods with the highest material value and/or the highest disposal externalities. This would include large consumer items such as vehicles, appliances, electronics and tires as well as batteries, metal cans, PET bottles, and paper/cardboard. Where broad-based curbside recycling programs exist, deposit-refund schemes could be applied at the producer level for ease of administration. In the absence of such programs, however, retail-level deposit reclaim is necessary to incentivize consumers to recycle; it also helps generate a revenue stream for scavengers. Where the goal is less to encourage recycling than to discourage consumption, a simple retail-level ADF may be more appropriate, as in the case of lightweight plastic bags. If high value and pollutive goods are covered by deposit-refund schemes and ADFs, then fees for waste disposal can be gauged toward the average cost of other types of waste.

65. A regulatory requirement for extended producer responsibility offers certain advantages over producer-level ADFs. Importantly, they place fewer information requirements on governments, since producers choose how to adjust their prices to reflect their expected recycling costs. Assuming that producers are not liable for reclaiming exported goods, EPR also does not require border adjustment. And internalizing recycling costs allows producers to design goods to for ease of recycling.

66. More research is needed on many aspects of waste taxation, but perhaps the two most salient areas are responsiveness of consumer behavior to ADFs and measuring the environmental externalities from waste disposal. Plastic bag taxes have received a great deal of attention, but most studies do not take a rigorous approach to estimating behavioral elasticities that would help determine effective bag tax policies. Given the proliferation of ADFs on various items—and the wide differentials among their rates and bases (see Appendix)—better studies of their effects

would be extremely useful. Similarly, in order to set ADF and waste management charges to internalize the external costs of waste disposal, the magnitude of those costs—as well as their variability in different geographic and demographic settings—must be determined.

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