

India's E-Waste Rules and Their Impact on E-Waste Management Practices

A Case Study

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Summary

India, like many other developed and developing countries, has adopted an extended producer responsibility (EPR) approach for electronic waste (e-waste) management under its E-waste (Management and Handling) Rules, 2011. Under these rules, producers have been made responsible for setting up collection centers of e-waste and financing and organizing a system for environmentally sound management of e-waste. In this article, we use the implementation of these rules in Ahmedabad in western India as a case study to conduct a critical analysis of the implementation of India's Rules. Interviews of main stakeholder groups, including a sample of regulated commercial establishments, regulatory agencies enforcing the Rules, informal actors involved in waste collection and handling, as well as publicly available information on the implementation constitute data for our case study. Our results indicate that while there has been an increase in the formal waste processing capacity after the implementation of the Rules, only 5% to 15% of the total waste generated is likely channeled through formal processing facilities. While the EPR regulation forced the producers to take action on a few relatively inexpensive aspects of the Rules, the collection and recycling system has not been made convenient for the consumers to deposit e-waste in formal collection and recycling centers. Based on our findings, we argue that Indian EPR regulation should go beyond simple take-back mandates and consider implementing other policy instruments such as a deposit-refund system. An important implication for developing countries is the need for careful attention to instrument choice and design within EPR regulations.

Introduction

Extended producer responsibility (EPR) has been a widely used policy approach for waste management across the world (see Ongondo et al. 2011; Herat and Agamuthu 2012). Particularly in the context of electronic waste (e-waste), many countries, including several developing countries, have either

adopted or are planning to adopt EPR as a policy framework. India's E-waste (Management & Handling) Rules, 2011 ("Rules" from hereon), which came into force in May 2012, use EPR as the underlying framework. Previous research argues that in developing countries, factors such as large informal sector in waste processing, illegal import of e-waste, and weak regulatory capacity make it difficult to implement EPR (e.g., Akenji et al.

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2011; Manomaivibool and Vassanadumrongdee 2011). In this context, it is important to understand the implementation of India's e-waste Rules and the impact of the Rules on e-waste management practices. Although the Rules have been in force since 2012, there is little research on the implementation (the exception being Toxics Link [2014]).

This paper is an exploratory study on the implementation of e-waste Rules in Ahmedabad, one of the fastest growing cities in India. Given that India has no baseline data on even e-waste generation quantities, any quantitative assessment of the Rules on outcomes, such as collection or recycling rates, is difficult. We thus focus on exploring if and how the Rules are impacting the e-waste management practices. Using qualitative research methods, we answer this question by examining how three central stakeholders in the implementation process—producers of electric and electronic equipment (EEE), bulk consumers,¹ and the regulatory agency in charge of enforcing the Rules—are responding to the obligations assigned to them under the Rules.

The paper is organized as follows. In the next section, we review the literature on EPR in developing countries, including the concept of EPR, in the context of e-waste. The following sections describe the India's e-waste Rules of 2011, the methodology we followed for the study, and the findings. We then discuss our findings to draw implications for EPR in India as well as other developing countries.

Literature Review: Extended Producer Responsibility in Developing Countries

Extended Producer Responsibility Framework

The disposal of EEE products after their useful life has negative externalities in terms of impact on human health and the environment (Manomaivibool 2009; Pradhan and Kumar 2014). Extending the responsibility of the management of this waste is a way to force the producers to internalize these product externalities (Sachs 2006). In the traditional model, where the responsibility lies with the local municipalities, the management of waste is usually financed by taxpayer money, although some countries instituted a fee on waste generators. By making the producers responsible for waste management, EPR shifts the burden to the producers and away from the local agencies.

An EPR approach also has the potential to provide incentives to the producers to incorporate waste disposal costs at the design stage (OECD 2006a). Because it costs the producers to safely dispose (including collection and recycling) products after their useful life, it can make economic sense to reduce these costs by incorporating the environmental issues at the design stage. For example, creating products with less toxic materials reduces the cost of processing the toxic products after their useful life. These two aspects—ensuring the internalization of product externalities and incentives for environment-friendly product design—are often cited as the two most important reasons for adopting EPR for e-waste (OECD 2006a).

Extended Producer Responsibility Design and Implementation in Developing Countries

Europe's Waste Electrical and Electronic Equipment (WEEE) Directive, which was passed in 2003, is one of the first legislations that used EPR as the framework for e-waste management. The 2003 WEEE Directive required producers to set up collection centers, either individually or collectively, to take back used electronic devices from consumers. The take-back mandate was accompanied by collection (4 kilograms [kg] per inhabitant per year from private households) and recovery rate targets. A revised Directive, which modified among other things the collection rate targets, became effective in 2014. Other developed economies such as Japan and some states in the United States have also instituted some form of EPR regulation to manage e-waste (e.g., Ogushi and Kandlikar 2007; Kahhat et al. 2008; Hickle 2014; Reagan 2015).

After Europe's WEEE directive, a few developing Asian countries have formulated their own EPR regulations. China legislated EPR through The Regulation on Management of the Recycling and Disposal of Waste Electrical and Electronic Equipment, which became effective from 1 January 2011 (Wang et al. 2013). Under this regulation, which is applicable to five products (televisions, refrigerators, washing machines, air conditioners, and computers), producers, including importers, must contribute to a fund on the basis of units of product sold (Chung and Zhang 2011; Wang et al. 2013). This fund is used to subsidize formally licensed recyclers, who are expected to meet certain treatment standards for e-waste. The law also specifies responsibilities for a few other stakeholders—retailers and service companies, refurbishment companies, and e-waste collection companies.

Preliminary analysis of China's EPR regulation has identified a few potential problems, including (1) inadequate specification of financial incentives for take-back by wholesalers and retailers, (2) lack of penalties for retailers and manufacturers for violating the provisions of the law, and (3) inadequate provisions for preventing recycling and treatment in informal sector (Chung and Zhang 2011; Tong and Yan 2013; Reagan 2015).

South Korea has had some form of e-waste regulation since 1992, under its broader umbrella of waste management regulations. Mandatory EPR came into effect around 2003 (Yoon and Jang 2006) in which ten types of electronic products were regulated, with mandates for product-wise recycling obligation rates (as percentage by weight of the sales volume in the preceding year) for producers. The law specifies monetary penalties between 115% and 130% of the standard recycling cost for the missing volumes. Impact-wise, South Korea's EPR program proved to be more effective than the preceding deposit refund system. The recycling rate targets were met comfortably by the producers; however, the overall collection rates of e-waste remained well below those of the more developed European countries (Manomaivibool and Hong 2014). Also, the EPR regulation could not effectively control recycling activities in "junk shops" or the informal sector and the quantity of "hidden flows" continued to grow (Manomaivibool and Hong 2014).

Table 1 Estimates of e-waste generation quantities for India

Estimation year	E-waste quantity (million tonnes/year)	Comments	Source
2004	0.146	Based on market penetration; includes computers, televisions, washing machines, and refrigerators	International Resource Group Systems South Asia Report as quoted in Toxics Link (2011)
2005	0.15	Based on obsolescence rate and installed base assumptions	CPCB (2008)
2007	0.383	Includes computers, mobiles, televisions, and imports	GTZ-MAIT (2007)
	0.66	Based on GTZ-MAIT (2007), but includes large household appliances and others	Greenpeace (2008a)
	0.439	Compiled from multiple sources of data; includes computers, printers, mobile phones, televisions, refrigerators	UNEP (2009)
2011	0.97	Projections based on GTZ-MAIT (2007)	Greenpeace (2008a)
2012	0.8	Based on obsolescence rate and installed base	CPCB (2008)
2014	1.19	Uses 0.8 million tonne in 2012 as the base; projections up to 2019 based on a cumulative annual growth rate of 27% between 2008 and 2012 and 21% between 2014 and 2019	Frost & Sullivan (2015)
	1.64	Based on the assumption of 1.3 kg per capita e-waste generation rate	Balde and colleagues (2015)
2015	1.4	Same as reported above for 2014	Frost & Sullivan (2015)

Note: kg = kilograms.

Thailand formulated a form of EPR regulation under its National Integrated Strategy for the Management of Waste Electrical and Electronic Equipment (Manomaivibool and Vassanadumrongdee 2011). This regulation requires producers to pay a fixed up-front product fee with the revenues from the fee used to fund a buy-back program that pays a subsidy to the consumers who return their end-of-life (EoL) electronic products to collection centers. Research on this program's potential effectiveness suggests that while it has the ability to induce consumers to return their products to the formal recycling systems, the subsidy may not be enough to prevent the waste from flowing into the existing informal recycling sector (Manomaivibool and Vassanadumrongdee 2012). Malaysia and Sri Lanka are the other developing Asian countries that are likely to adopt EPR as the primary approach to e-waste management (see Mallawarachchi and Karunasena 2012; Agamuthu and Victor 2011). Vietnam is another developing Asian country that has instituted EPR for e-waste management recently (Tran and Salhofer 2016).

Among the other emerging economies, Brazil does not have a specific e-waste regulation; however, e-waste is one of the categories of waste regulated under its solid waste laws. These laws require mandatory take-back by producers. Lack of operationalization of the take-back requirements and poor enforcement of these laws make them ineffective in improving the collection

and recycling of e-waste in Brazil (Quariguasi Frota Neto and van Wassenhove 2013).

To summarize, many developing Asian countries, including India, have adopted or are planning to adopt some form of EPR regulation over the past 5 years. Very little is known, however, about the actual impact of these regulations on e-waste quantities, flows, and management practices. Scholars argue that (1) the difficulty in identifying producers, (2) illegal imports of e-waste, (3) the existence of a large informal sector, and (4) weak regulatory capacity pose major challenges to EPR regulations in developing countries (e.g., Manomaivibool 2009; Kojima et al. 2009; Skinner et al. 2010; Akenji et al. 2011). Our study contributes to this literature on understanding the effectiveness of EPR regulations for e-waste management in developing countries through an exploratory analysis of India's EPR regulations.

India's E-Waste Status

India is one of the fastest growing markets for electronics in the world. Some projections predict a fivefold increase in e-waste from old computers and 18-fold increase from mobile phones between 2007 and 2020 (UNEP 2009). India, however, never conducted an inventory of e-waste and no official estimates of e-waste generation quantities are available. Estimates

are available from other sources (see table 1), but refer to different years and vary for the same year because of the varying assumptions and variation in the number of electronic items included in the estimation. Based on these estimates, it is likely that India generated approximately 1.5 million metric tonnes in 2015.

Like many other developing countries, most e-waste is collected and recycled in the informal sector (e.g., Wath et al. 2011; Rajya Sabha 2011); according to some estimates, this amounts to close to 95% of generated e-waste (e.g., GTZ-MAIT 2007). The hazardous nature of e-waste and the unscientific practices employed by the semiskilled and unskilled workers in the informal sector pose serious risk to human health and the environment (e.g., Bandyopadhyay 2008; Manomaivibool 2009; Bandyopadhyay 2010; Pradhan and Kumar 2014).

The e-waste Rules introduced in 2011 is a response to the growing problem of e-waste management.² Prior to the introduction of the 2011 Rules, e-waste was included in Schedule IV of the Hazardous Waste (Management, Handling, & Transboundary Movement) Rules, 2008 (MoEF 2010), making it mandatory for recyclers handling e-waste to legally register with the Central Pollution Control Board (CPCB).³ According to the data obtained from the CPCB through our personal communication, in 2010, there were 23 e-waste recycling/reprocessing units registered throughout the country under the Schedule IV of the Hazardous Waste Rules. As a prelude to the 2011 Rules, CPCB also released “Guidelines for Environmentally Sound Management of E-waste” in 2008 (CPCB 2008), which provided information on recycling and treatment options for e-waste management.

E-Waste (Management & Handling) Rules, 2011

The Rules apply to every producer, consumer, or bulk consumer involved in the manufacture, sale, purchase, and processing of EEE or components, including collection centers, dismantlers, and recyclers of e-waste. The Rules, however, are not applicable to micro and small enterprises and batteries.

The Rules define extended producer responsibility as “the responsibility of any producer of electrical or electronic equipment, for their products beyond manufacturing, until the environmentally sound management of their end-of-life products” (MoEF 2011, 28). The producers are made responsible for collection of e-waste generated either during the manufacturing process or from the EoL use of the product by consumers. The producers are also made responsible for setting up collection centers and financing and organizing a system for environmentally sound management of e-waste.⁴ The Rules, however, give producers the choice of either preparing such a system on their own or by joining a collective scheme involving other producers.

The Rules also contain specific responsibilities for collection centers, dismantlers, and recyclers involved in e-waste management. All these entities are required to register with the SPCBs of the states in which they operate and ensure proper handling and disposal of e-waste. In addition, these entities are required

to maintain records of e-waste handled and file returns with the SPCBs. The rules also contain a suggested timeline beyond which e-waste cannot be stored by producers, collection centers, dismantlers, or recyclers. For both household and bulk consumers, the Rules require channeling of waste to registered facilities. The bulk consumer should also maintain records of the e-waste generated in a specific format. Finally, the urban local bodies (ULBs) are given the responsibility of safe disposal of orphaned e-waste, defined as unbranded e-waste.

Following the promulgation of the Rules, the CPCB developed implementation guidelines (CPCB n.d.) for various actors regulated under the Rules, including producers, collection centers, dismantlers, recyclers, SPCBs, and ULBs. In our study, we focus on three central actors: the producers of EEE, who are made responsible for EoL management of their products, the bulk consumers, who generate close to three quarters of the total e-waste generated in India (Manomaivibool 2009), and the SPCB, which is the main agency responsible for the enforcement of the Rules.

Methodology

Data Collection

We collected most of our data in Ahmedabad, which is the fifth largest city in India in terms of population (around 6 million) and the largest city in the state of Gujarat in western India. It is also the commercial capital of Gujarat (the administrative capital Gandhinagar is 20 kilometers [km] from Ahmedabad) with a land area of 464 square km and boasts of several chemical, pharmaceuticals, dyes and paints, electronic appliances and equipment, and machine component industries.

We adopted different strategies for collecting data on our three stakeholders. With regards to producers, we first identified the top five producers of EEE in each of the three categories: mobile phones, computers, and household appliances. We ended up with a list of 22 producers, some producers being common across product categories (see table 2 for details). We initially collected data from publicly available information on the websites of producers (see table S1 of the supporting information available on the Journal’s website for the details on the nature of data we collected from the websites). In order to verify the extent to which the producers implement what they promise on their websites, we have sent questionnaires for more information on their practices in response to the Rules. In spite of two reminders, we did not receive a single response from the producers to our questionnaires. In addition, we called the collection/recycling phone numbers provided on the websites, posing as customers wishing to deposit their products.

For bulk consumers, we conducted face-to-face interviews with representatives of banks, educational institutions (both colleges and schools included), private sector firms (industries from Vatva industrial area in Ahmedabad), and government and semigovernment firms. In the case of regulatory agencies, our data consist of two interviews with the officials of the Gujarat Pollution Control Board (GPCB): one is an informal

Table 2 Top electrical and electronic equipment producers in terms of market share

Category	Products	Top five brands	Market share of top five brands
Mobile phones	Mobile phones and accessories	Samsung, Nokia, Micromax, Karbonn, Lava	59%
Personal computers	Laptops, desktops, tablets	HP, Lenovo, Dell, Acer, HCL	71%
Household appliances	Washing machines	LG, Samsung, Videocon, Whirlpool	75%
	Televisions	LG, Samsung, Videocon, Sony, Panasonic	90%
	Air conditioners	Bluestar, Voltas, LG, Godrej	50%
	Refrigerators	LG, Samsung, Videocon, Godrej, Whirlpool	86.5%
	Vacuum Cleaners	Eureka Forbes, Panasonic, LG, Gryphon, Philips	95%

Source: Compiled by the authors from a variety of sources, including news reports and market research databases such as Market Line and Emerging Markets Information System.

Note: The market share numbers are for the year 2013.

unstructured conversation with a lower-level official involved in the implementation of the Rules and the other with the person in-charge of the implementation of e-waste Rules in the Head Office of the GPCB in the capital city of Gandhinagar. We also interviewed one official from the CPCB involved in the development and implementation of the Rules nationally.

To supplement these data, we conducted face-to-face interviews with three scrap dealers⁵ in Ahmedabad (there is no estimate of the total number of such scrap dealers in the city) and telephonic interviews (as well as questionnaire surveys) with all the seven dismantling/recycling units registered in Gujarat. In addition to the interviews and data from producer websites, we have collected extensive information on the Rules and their implementation from a variety of publicly available sources—nonprofits, government agencies, international organizations, and industry associations. Table S2 of the supporting information on the Web provides more details on the data collection methodology.

Interview Methodology

All the interviews with various stakeholders are conducted using semistructured questionnaires. Our interviews with bulk consumers and scrap dealers largely focused on understanding their awareness of the e-waste Rules and their past and current e-waste management practices. The authors of the study were assisted by a team of three trained interviewers. None of the interviews was recorded because of the general reluctance of the interviewees. The interviewers took notes, which are used as the basis for data analysis.

Data Analysis

We analyze our data to generate evidence for our central question: if and how the three stakeholders of interest (i.e., producers, bulk consumers, and regulator) are responding to the provisions of the e-waste Rules in Ahmedabad? We follow the

general principles of data analysis for case study research (Yin 2013). The first set of themes that we identify is the mandated responsibilities assigned to each of the three stakeholders. We use the Rules as the source of data to interpret the mandated responsibilities. The second set of themes we use is the actual response of the stakeholders to their mandates. We organize the data that we collected from multiple sources to analyze the actual response to mandates. We then analyze the gaps, if any, between the mandated responsibilities and the actual response to draw broader implications for the implementation of e-waste Rules in India. Wherever possible, we use data triangulation in which we verify the claims made by some stakeholders using data generated from other stakeholders.

Findings

We begin this section with the findings on the impact of Rules on the collection and recycling infrastructure. We organize the rest of the discussion around our three key stakeholders of interest, with a focus on understanding the practices that are attributable to the implementation of e-waste Rules.

Impact on Overall E-Waste Collection and Recycling

Prior to the 2011 Rules, recycling units processing e-waste were required to register with the CPCB under the Hazardous Waste Rules, 2008. Data obtained from the CPCB⁶ indicate that as of September 2010, 23 recycling/reprocessing units across the country were granted registration under the Hazardous Waste Rules. Gujarat had one registered unit—Jhagadia Copper Limited, with a 12,000 metric tonne/annum capacity to process shredded printed circuit boards and mother boards. Gujarat currently has seven registered units and Jhagadia Copper Limited is not among them. This unit was closed down around 2012. Table S3 of the supporting information on the Web presents details on the likely year of establishment of the seven registered units, the Rules under which these units

Table 3 Trend of registered e-waste recycling units in India

	September 2010	November 2014	September 2015
No. of registered units	23	138	148
Total capacity (metric ton/year)	89,177	394,154	455,058

Source: Compiled by authors based on data obtained from the Central Pollution Control Board.⁶

Note: E-waste (Management and Handling) Rules, 2011 were notified in May 2011 and became effective in May 2012. All the 23 units registered in 2010 continue to operate in 2014 and 2015, except for three.

are established, the dates on which the units registered with pollution control board to process e-waste, and the nature of e-waste processing for which they received authorization.

Four units were registered under the Hazardous Waste Management (HWM) Rules in January 2012, which is before the e-waste Rules became effective (i.e., May 2012), but after the Rules were notified (i.e., May 2011). The remaining three have been established after the e-waste Rules became effective and are registered under the e-waste Rules. Our analysis thus suggests that in Gujarat, 40% of the currently available formal (registered) e-waste processing capacity (in addition to the capacity to process 160,000 printer cartridges per year) has been added after the e-waste Rules became effective. We cannot be certain that the rest of the capacity came into existence in response to the e-waste Rules.

At the national level, 148 dismantler/recycler units with a total e-waste processing capacity of 455,059 metric tonnes/annum are registered as on September 2015 (see table 3 for the trend in the number of registered units). Our analysis shows that 20 out of the 23 dismantlers/recyclers operating in 2010 are part of this list of 148. This means that 128 dismantlers/recyclers have registered after 2010. We do not, however, have details of the exact date of establishment of these 128 registered dismantlers/recyclers nor details on whether all these

units are registered under the E-waste Rules. As we have seen in the case of Gujarat, it is likely that some of these units may have been registered under HWM Rules, 2008. Overall, it is clear though that since the notification of the e-waste Rules, there has been a substantial increase in the number of registered e-waste processing units.

We have conducted further analysis of the amount of waste that is being channeled through formal e-waste processing facilities (table 4). Assuming that the country generated 1.5 million metric tonnes of e-waste (based on estimates in table 1) in 2015, we estimated the percentage of e-waste that might be handled through registered facilities under three different capacity utilization assumptions: full utilization, 50% utilization, and 20% utilization. As table 4 shows, even under the most optimistic scenario of full capacity utilization, formal facilities would process around 30% of the total e-waste generated. Our interviews with dismantling/recycling units in Gujarat and officials in the regulatory agencies indicate that the capacity utilization is quite low and is likely in the range of 20% to 50%. If this assumption is correct, then approximately 6% to 15% of the waste is channeled through formal e-waste processors.

Impact on Producer Practices

We assess the producers with respect to their broad responsibilities mandated under the Rules (see table S1 of the supporting information on the Web for the details on our producer analysis and table 5 for a summary). One question we attempt to address, wherever possible, is the extent to which the observed e-waste practices of the producers are potentially attributable to the implementation of the Rules.

Information Provision

Most producers (more than 70%) explicitly mention the Rules and their commitment to comply with the Rules. Even among the six producers who do not explicitly mention the Rules, four of them provide information on collection and recycling. This suggests that there is at least a general awareness of the existence of the Rules among most producers. Only

Table 4 Estimation of e-waste diverted to formal recycling units

Assumption about capacity utilization in the formal sector	Total E-waste generation in 2015 (tonnes/year) ^a	Waste processed through registered recyclers (as on September 2015)	
		Waste (tonnes/year)	Percent waste (%)
	1,500,000		
100%		455,058	30
50%		227,529	15
20%		91,011.6	6

Source: Calculated by authors based on the available estimates.

Note: Capacity utilization represents the amount of waste that is actually processed by the registered recycling units relative to their total available capacity.

^a Assumed based on the available estimates of total e-waste generation in the country.

Table 5 Summary of findings on producer compliance with e-waste rules

<i>Producer responsibility</i>	<i>No. of sample firms complying (percentage)</i>
Mention the rules on website	16 (72)
Information on e-waste hazards on website	22 (100)
Information on collection centers on website	
Third-party tie-ups for collection	13 (59)
Own stores	2 (9)
No specific information except phone number to call for collection of waste	5 (23)
No information	2 (9)
Response to phone calls for collection ^a	
No response/phone not working	8 (36)
Must exchange with a new product	2 (9)
Connected to third party	5 (23)
No information on recycling	2 (9)
Referred to local service center	3 (14)
Only e-mail contact	2 (9)
Producer authorization in at least one state	16 ^b (72)
Total number of firms sampled	22

^aBased on calls to phone numbers available on producer websites for e-waste collection information.

^bBased on authorization data from only three states—Delhi, Maharashtra, and Karnataka.

two producers provide no information on anything related to e-waste.

Although the details vary, almost all the producers provide information on the hazardous nature of e-waste and the consequences of mixing e-waste with municipal solid waste. This is part of the awareness generation mandates of the Rules. Clearly, the Rules had an impact on this aspect. According to a study conducted by Greenpeace in 2008, none of the 20 producers⁷ that their study evaluated had provided any information on the hazardous nature of e-waste (Greenpeace 2008b). Although we have no data on exactly when this information is uploaded on the manufacturer websites (post-2008), it is still reasonable to infer that the mandates under the Rules had some influence in the manufacturers' decision to provide this information. Providing information on websites though is relatively cheap, and we cannot infer anything from our data on the other

mechanisms (publications, advertisements, and posters are the other modes of communication that the Rules suggest) through which producers create awareness on e-waste.

Collection and Recycling Practices

All the firms in our sample, except for two, provide some level of information on how to deposit their products after the end of useful life (table 5). A majority of our sample firms (close to 60%) claim to have tied up with a third-party provider for collection and recycling. All the third-party firms tied up with the producers in our sample are registered with some state pollution control board in the country, but none with the GPCB. Approximately one quarter of our sample firms provide just a phone number or some other basic guidance on how to drop off e-waste. Only one brand (LG) claims to provide monetary incentive for depositing the equipment after its use. A third-party firm registered with LG picks up the waste and pays the consumer after assessing its value.

Has there been any influence of the Rules on the producers' take-back practices? Referring to the Greenpeace study again, close to half of the electronic manufacturers had no take-back policy in 2008 (Greenpeace 2008b). Among those with take-back policy mentioned on the website, only three manufacturers had a functioning take-back system. A comparison between Greenpeace study and our study shows that five producers, who had no take-back policy in 2008, have a take-back policy now. Clearly, there is some evidence that the Rules may have influenced the collection and recycling practices of the producers, at least in our sample of producers.

Our phone calls posing as customers provided interesting insights on the actual practices (as opposed to what they promise on their websites) (table 5). Only in two cases, we received any concrete response that explains how to deposit the waste. In these two cases, the phone got connected to a third-party recycler,⁸ who gave information on the location where the waste can be dropped. In the rest of the cases, from the information provided, it would be quite difficult for a consumer to understand how the waste can be deposited at an authorized collection/recycling center. In the case of eight producers, there is no response on the phone in spite of multiple attempts, and in another two cases, the respondent had no idea about collection or recycling of e-waste.

Overall, our analysis suggests that while the Rules might have incentivized the producers to engage in some e-waste management practices that they would not have engaged in otherwise, the implementation on the ground has been less than satisfactory.

Compliance with Authorization Requirements

Rule 9 of the Rules requires that producers obtain an authorization from the SPCB "concerned as the case maybe" (MoEF 2011, 32), meaning that the authorization should be obtained from an appropriate SPCB. The implementation guidelines (CPCB n.d.) related to the Rules are then supposed to define the appropriate SPCB from which the producers should obtain the authorization. About three quarters of our sample

Table 6 Summary of findings on e-waste disposal practices of select bulk consumers in Ahmedabad

Banks
<ul style="list-style-type: none"> • Auction to e-waste vendors • Exchange contracts with equipment dealers • Sell to informal e-waste dealers • Store waste
Industries and educational institutions
<ul style="list-style-type: none"> • “Gift” old equipment to employees • Sell to scrap dealers • Exchange for new products with discounts from dealers
Government agencies
<ul style="list-style-type: none"> • Sell to empaneled recyclers registered with state pollution control board under a fixed-rate contract

producers have registrations in at least one of the three states—Maharashtra, Karnataka, and Delhi—but none in Gujarat, although all the producers sell their products in Gujarat. This is surprising given that most producers explicitly mention the Rules on their websites. The answer, however, lies in the detail regarding the SPCB that has the jurisdiction over the producers.

According to the guidelines on the implementation of the Rules (CPCB n.d.), the concerned SPCB from which the producers must obtain authorization is the SPCB of the state in which the producers’ manufacturing facilities and corporate head offices are located.⁹ None of the producers in our sample has their corporate offices located in Gujarat (see table S1 of the supporting information on the Web for the details). This explains why most of our sample firms have authorizations from these three states and not from Gujarat.¹⁰ The implication is that although most producers sell their products throughout the country, the regulatory control entirely lies within the SPCB of the state in which the producers have their manufacturing operations and/or corporate head offices. In addition, the guidelines on implementation also suggest that the producers make their authorization information available on their websites. The producers’ websites, however, have not provided any details on the authorizations that they might have obtained from the SPCBs, and we did not receive any response for our questionnaire sent to all the 22 producers.

Impact on Practices of Bulk Consumers

The general findings of our analysis on the current disposal practices of the sampled bulk consumers are described below and summarized in table 6.

Banks

All the nine banks in our sample reported being aware of their responsibility under the Rules. All of them maintain a record of e-waste generated and channeled through dismantlers and/or recyclers, as required by the Rules. In terms of e-waste management practices, most banks (five out of nine in our sample) channel their e-waste either by auctioning the e-waste to

vendors registered with the banks or through take-back agreements with the dealers of EEE, especially that of computers. In the take-back system, the banks enter into a contract with the dealer to take back the old equipment when they replace it with new equipment and offer discounts on the new products. We do not know how the dealer processes the returned electronic equipment. Other practices of banks include selling the waste to informal dealers or simply storing the waste.

What does this tell us about the influence of the e-waste Rules on e-waste practices of banks? Clearly, some banks continue to sell their waste in the informal markets, even after being aware of the Rules. On the other hand, our interviews reveal that after the introduction of the Rules, the banks that take the auction route are insisting that the vendors that bid for their e-waste obtain necessary government authorizations under the Rules to qualify for participation in the auction. This is perhaps the most significant change prompted by the Rules.

It is also interesting to note that the banks have a system of record keeping of e-waste generation even before the implementation of the Rules. This is apparently because of the requirements under the annual financial audit that banks must undergo. Under this auditing process, computer and other electronic equipment that banks purchase are considered as physical assets that banks must account for in their annual statements. In this process, the banks must maintain a record of the disposal of e-waste. Thus, it is not possible to attribute the record keeping practice of banks to the implementation of e-waste Rules.

Schools and Medium and Small Industrial Units

In the case of the other two types of bulk consumers in our sample—educational institutions and industrial units—the awareness regarding the Rules is very low. Only one educational institution out of the seven and only two industrial units out of 12 that we interviewed report any knowledge of e-waste Rules. Not surprisingly, very few of them claim to maintain (one quarter of the 12 industrial units and two out of seven schools) a record of e-waste generation required under the Rules.

Regarding their practice of disposing of waste, our interviews suggest that these entities have no established policy. The mode of disposal of e-waste ranges from “gifting” the equipment to the employees after the useful life, selling to scrap dealers, and exchanging the old products for the new products from their dealers to receive discounts on the new products.

Other Bulk Consumers

While we did not interview other groups of bulk consumers, our interviews with the GPCB officials reveal an initiative by the Gujarat state government. State government offices are defined as bulk consumers under the e-waste Rules. In December 2014, Gujarat Informatics Limited (GIL), a state agency charged with procuring computers and other EEE for state agencies, had released its policy for disposal of e-waste in accordance with the e-waste Rules. This policy provides guidelines for all the state departments and agencies on the procedures to be adopted for disposing EoL electronic equipment (Government of Gujarat 2014). It specifically requires the agencies to first

determine whether an equipment requires disposal (e.g., any computer that is more than 5 years old automatically qualifies for disposal, if the users wish to dispose it) and then dispose them through a recycler registered with the GPCB and empaneled by GIL. This could potentially be a useful model for other state agencies as well in which one state agency is made responsible for managing the e-waste generated across all the government agencies.

The final piece of evidence regarding the potential influence of e-waste Rules on the practices of bulk consumers comes from our interviews with the scrap dealers. Only one of the three scrap dealers report any knowledge of the e-waste Rules. However, two out of the three dealers noted that there has been a decline in the waste they receive through the informal channels over the past 2 years, which coincides with the implementation of the Rules. They attribute this to the (1) increasing practice of auctioning the e-waste by industrial units and government establishments and (2) longer time intervals of product replacement by industries. Although it is not possible to make any definitive statement, this evidence reinforces the findings from our interviews with banks that there is a change in practice prompted by the Rules in which the banks are increasingly channeling their waste to registered dismantlers/recyclers.

Assessment of Regulatory Response to Implementation

The GPCB has so far authorized seven e-waste collection/dismantling centers in various parts of the state (see table S3 of the supporting information on the Web). Four out of these seven are registered under HWM Rules, 2008 while the other three are registered under the e-waste Rules. In our interviews, the GPCB official insisted that e-waste is dismantled in India and recyclable material is exported to other countries for material recovery—no recycling is carried out in India by formal recyclers. Part of the explanation is that the amount of e-waste collected in the formal recycling sector is so low that it is not economically viable to set up recycling processes in India. We could not independently verify this claim. According to another lower-level GPCB official we interviewed, the authorized collection centers in Gujarat have not been able to collect enough waste because, according to him, the waste is mostly still passing through the informal channels. As part of GPCB's obligations to conduct an inventory of e-waste in Gujarat, the task has been assigned to Gujarat Environmental Management Institute, an agency of Gujarat government.

The third activity that the GPCB has initiated under the Rules is notifying various bulk consumers of their responsibilities under the provisions of the Rules. Although the copy of the letter sent to the bulk consumers was not shared with us, the officials indicated that the letter informs the bulk consumers on their responsibilities to channel their e-waste through authorized entities and provides the list of seven collectors/dismantlers that the GPCB authorized in the state.

In terms of enforcement for violation of provisions of the Rules, our interviews suggest a general reluctance to take enforcement actions and there are at least two reasons. First, there

is a general sense that 2 years is a relatively short time for the regulated entities to respond effectively to the Rules. For example, the officials cited the implementation of the Municipal Solid Waste Management Rules for which it took them more than 10 years to effectively enforce the Rules. The officials also repeatedly emphasized a need to “sensitize” both the producers and the consumers regarding the requirements of the Rules before enforcement actions are initiated on the offenders. Second, the sanctions for violation of Rules involve initiating a judicial process, which is a time-consuming process. Also, in the larger scheme of things within the GPCB, implementation of e-waste Rules does not appear to be a top priority, partly because of the lack of manpower. The official in-charge of e-waste Rules implementation is also responsible for the implementation of the HWM Rules, which require monitoring and enforcement of a large number of industries in the state.

Finally, the GPCB believes that the awareness of the Rules is generally low among the consumers, especially the household consumers. They view this as a big challenge in the effective implementation of the Rules. In particular, the question is how to induce the household consumers to channelize their waste through authorized channels, given that selling the waste to informal scrap dealers fetches them money.

Discussion and Implications

Extended Producer Responsibility and Formalization of E-Waste Management

A constant theme in the discussion on EPR in developing countries is the presence of a large informal sector (e.g., Manomaivibool 2009; Kojima et al. 2009; Skinner et al. 2010; Akenji et al. 2011). Given that more than 95% of e-waste was processed in the informal sector before the notification of e-waste Rules in India, one question that we must address is the impact of Rules on formalization of e-waste processing. The positive side, according to our analysis, is that within the first 3 years of implementation of e-waste Rules, there has been a considerable rise (from 23 in 2010 to 148 in 2015) in the number of registered e-waste processing units. Several major producers have also reported tying up with the registered recycling units and some types of bulk consumers may be shifting toward disposing their waste through formal channels.

Several problems remain, however. In spite of the increase in the number of registered units, our study suggests that many of these units might not be receiving adequate amounts of e-waste for processing, indicating that significant amounts of e-waste is still likely diverted toward informal channels. Our estimates reveal that somewhere between 5% and 15% of the e-waste is likely processed through formal channels; even under full utilization of the current capacity, only less than one third of the total e-waste is likely channeled through formal processing.

What does our study suggest are the likely reasons for the low utilization of formal processing units? First, the collection and recycling systems for which the producers are responsible are inadequate and it is not easy for consumers to deposit

their waste in formal collection centers. Second, our study indicates that consumers lack sufficient incentives to channel their waste to the authorized collection centers/recyclers. Our interviews with a section of bulk consumers clearly indicate that the practice of disposal to informal sector continues because of the monetary benefits. At the same time, except for one producer, none of the producers in our sample offer monetary incentives to consumers—bulk as well as individual. Research on the behavior of bulk consumers such as information and technology (IT) companies (Subramanian et al. 2012) shows that irrespective of the size of the organization, bulk consumers attach a monetary value to their e-waste. The implication is that the bulk consumers are likely unwilling to channel the e-waste to formal waste processors in the absence of financial incentives.

Finally, lack of adequate awareness among consumers might be an impediment for greater diversion of waste to formal sector. As our analysis shows, the producers provide information on their websites, which is cheap. The awareness generation, however, should go beyond websites because many bulk consumers, including industrial units, need increased awareness on their obligations under the Rules, the need for systematic management of e-waste, and the options available to them for recycling. While we have not studied the awareness among the household consumers, one would expect the awareness to be even lower among households, which is corroborated by one recent study (Kwatra et al. 2014).

Role of Producers

Our study shows that the producers, who are the central stakeholders in EPR programs, have not responded adequately to the challenges of e-waste management in India. This, in our view, points to potential problems in both the design and implementation of EPR in India's Rules. EPR programs across the world vary in their design—particularly in terms of the nature of obligations that they place on the producers. In general, mandatory take-back requirements such as those adopted by India are accompanied by targets for collection and/or recycling as in the case of Europe's WEEE directive as well as South Korea's EPR program for e-waste. Failure to achieve these targets typically invites significant monetary penalties. This creates stronger incentives for producers to set up robust collection and recycling systems than a simple take-back mandate would (Palmer and Walls 1999). India's e-waste Rules of 2011 just require simple take-back mandates with no accompanying targets of any kind. The Rules do not specify any monetary penalties for the failure of the producers to fulfil their responsibilities under the Rules.¹¹

What is the way forward for EPR in India? Our study indicates a need to go beyond simple take-back mandates. If take-back is used as the primary instrument within the EPR framework, the mandate should be accompanied by targets for collection and/or recycling. Many other policy instruments are also compatible with EPR framework (OECD 2006a). Some countries charge an advance fee on the products (either on

the consumer or the producer) at the point of purchase and use the revenues to fund collection and recycling activities, including providing subsidies to consumers. This instrument places only the financial responsibility on the producers, leaving the physical responsibility of managing the waste to governments and other actors.

Another instrument is the deposit-refund system in which a deposit is charged to the consumer at the time of the sale of the product and a refund is issued when the product is returned after its useful life. In theory, this system can create financial incentives to consumers to return the products after their useful life. A number of studies consider deposit-refund systems to be economically efficient for waste management (e.g., Palmer and Walls 1997; Lavee 2010). India's amended e-waste Rules, which became effective in October 2016, require producers to set up a deposit-refund system.

Implications for Extended Producer Responsibility in Developing Countries

The main implication of our study is that EPR policies in developing countries are unlikely to succeed in the absence of (1) careful attention to policy instruments—their choice as well as design—within the broad EPR framework, (2) political will and clarity in the enforcement of EPR, and (3) concerted efforts to generate awareness among stakeholders on e-waste management in general, and EPR in particular.

As discussed extensively earlier, India's e-waste Rules, by mandating take-back by producers without any targets for collection and/or recycling, did not create enough incentives for producers to take their responsibilities seriously. On the implementation side, the unwillingness on the part of the regulatory agencies to enforce the EPR regulations and the issue of lack of clarity in regulatory enforcement that our analysis demonstrates could potentially reduce the effectiveness of the regulation by providing an excuse for producers to not comply (e.g., Quariguasi Frota Neto and van Wassenhove 2013). This is particularly pertinent in a developing country such as India because of the already weak regulatory structure with regards to enforcement of environmental regulations (e.g., Priyadarshini and Gupta 2003; Prasad 2006; OECD 2006b).

Our analysis also shows that the informal sector, which has a huge presence in developing countries, is likely to thrive even in the presence of EPR regulations unless (1) the formal systems make it easier for consumers to deposit their waste, (2) the producers and/or formal waste processors are willing to provide monetary incentives for consumers to deposit their waste at the authorized collection centers, and (3) efforts are made to improve the awareness on e-waste management. This is consistent with past research in developing countries (e.g., Yu et al. 2010).

Conclusions

We studied the response of three major stakeholders in the implementation of India's e-waste management Rules using

the case of implementation in Ahmedabad city in the western state of Gujarat. Four years since the Rules have come into effect, our analysis suggests that the awareness of the Rules is still low among the institutional consumers, the Rules do not appear to be high on the agenda of the regulators, and not all producers have clear plans in terms of the mechanisms for collection and recycling. On the positive side, a number of formal dismantling/recycling units are being set up to cater to the demands of the Rules and these formal units are partnering with some major producers to comply with the requirements of the Rules.

Our results, however, are largely based on a case study of one city and one must be cautious in making generalizations. Even within our case study, our analysis is based on a small sample of bulk consumers, producers, and regulators. In addition, our results cannot illuminate how the Rules are working on the ground in ensuring that e-waste is managed in an environmentally sound manner. For example, although the producers are partnering with registered waste processors (collection centers, dismantlers, and/or recyclers), we do not know to what extent the registered waste processors are subject to monitoring and enforcement by the regulatory agency to ensure safe handling of e-waste (see Kandhari and Sood [2010] for the controversy surrounding one of the registered recyclers). Also, the amendments brought to the 2011 EPR Rules brought in several changes, discussion of which is beyond the scope of this paper. Future research, however, should analyze the extent to which the amended Rules address the issues we raise through this study.

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Notes

1. India's e-waste management Rules differentiate between "consumer" and "bulk consumer." Bulk consumers are similar to what is referred to elsewhere as institutional, commercial, and industrial users of electronic equipment. In this paper, we use the definition specified in India's Rules, which is: "bulk consumers means bulk users of electrical and electronic equipment such as Central Government or State Government Departments, public sector undertakings, banks, educational institutions, multinational organizations, international agencies and private companies that are registered under the Factories Act, 1948 and Companies Act, 1956" (MoEF, 2011, 28).
2. India promulgated various other regulations under the Environmental Protection Act, 1986 to manage different kinds of waste streams in an environmentally sound manner. These include (1) Hazardous Waste (Management and Handling Rules), 1989; (2)

- Biomedical Waste (Management & Handling) Rules, 1998; (3) The Recycled Plastics (Manufacture and Usage) Rules, 1999; (4) The Municipal Solid Waste (Handling and Management) Rules, 2000; (5) The Batteries (Handling and Management) Rules, 2001; and (6) Plastic Waste (Management and Handling) Rules, 2011.
3. The CPCB is a statutory organization under India's Ministry of Environment Forests and Climate Change (MoEFCC). The CPCB was established in 1974 and provides technical services to the MoEFCC and advisory and technical assistance/guidance to the Government of India and state pollution control boards (SPCBs).
4. Another producer responsibility, which is not central to our study, is the reduction in the use of hazardous substances. Within 2 years of the implementation of the Rules, the EEE producers are prohibited from using certain hazardous materials, such as lead, mercury, hexavalent chromium, and polybrominated phenyls, in the manufacturing of new equipment.
5. The term *scrap dealer* appearing in the text refers to an individual who procures or purchases e-waste and sells it to recycling units and/or dismantlers. Some scrap dealers also extract materials such as copper from wires in e-waste before selling it to recycling units and/or dismantlers.
6. This information is not publicly available at this point, but we obtained it from the CPCB through personal communication. The details of all the 23 centers are available on request.
7. Thirteen producers are common between our study and Greenpeace study.
8. This recycler is the same recycler that the producer listed on their website.
9. It is important to note that the amended e-waste Rules (www.moef.gov.in/sites/default/files/EWM%20Rules%202016%20english%2023.03.2016.pdf, last accessed on 13 May 2016), which were notified in March 2016 and will come into effect in October 2016, address this issue by requiring that all producers seek authorization from the CPCB, which will forward the details of the authorization to SPCBs for monitoring.
10. This also partly explains why, as per CPCB data, of the 150 producers (including importers) that have been granted authorization so far in 11 states, more than 80% (123) are registered in these three states. Gujarat has authorized three producers (the names are available with us upon request), but none from our sample of 22 producers.
11. The Rules give the power to the SPCBs to cancel the authorization provided to the producers for violation of any provisions of the Rules.

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Supporting Information

Supporting information is linked to this article on the *JIE* website:

Supporting Information S1: This supporting information provides three supporting tables to the main article: Table S1 shows producer responses to e-waste rules, based on information on websites; table S2 gives a summary of data collection methodology; and table S3 presents the status of registered e-waste recycling units in Gujarat.