EPR AND POLICY INSTRUMENTS FOR E-WASTE MANAGEMENT: A REVIEW AND LESSONS FOR INDIA'S NEW E-WASTE REGULATIONS

R.M.R. TURAGA* AND K. BHASKAR**

** Indian Institute of Management Ahmedabad, Ahmedabad, India*
*** XLRI – Xavier School of Management, Jamshedpur, India*

SUMMARY: Extended producer responsibility (EPR), in which the producers are made responsible for the end-of-life disposal of EEE, is a widely used approach to manage e-waste, both in developed as well as developing countries. Within the EPR framework, a range of policy instruments such as mandatory take back, recycling rate targets, and deposit-refund systems are adopted by various countries to ensure environmentally safe disposal of e-waste. India's E-waste (Management and Handling) Rules, 2011, which came into effect in May 2012, use EPR framework for e-waste management, which is currently dominated by informal markets. In an amendment to these regulations in October 2016, the Indian government has introduced new policy instrument in which the producers have to meet certain e-waste collection targets and implement a deposit-refund system. In this paper, we extensively review the theoretical literature on policy instruments within the EPR framework to first show that the simple mandatory take back provision does not provide incentives to either the producers or the consumers and then analyse the incentive effects of alternative policy instruments compatible with EPR framework. We then draw on the empirical literature on implementation of various policy instruments in developing countries to draw implications for EPR policy design and implementation in India.

1. INTRODUCTION

Extended producer responsibility (EPR) is a policy framework in which the responsibility of the end-of-life management of consumer products is assigned to producers. India adopted EPR framework to regulate e-waste in its E-waste (Management and Handling) Rules, 2011, which became effective in May 2012. The 2011 Rules use mandatory take-back as the policy instrument within the EPR approach. The Indian Ministry of Environment and Forests (MoEF) has amended the 2011 Rules; the new Rules have become effective in October 2016. Among other important changes, the amended Rules set collection targets for the producers and require them to set up a deposit-refund system. In this context, this paper reviews the theoretical research on policy instruments available for EPR and empirical research on the experience of EPR policy instruments in other countries to draw implications for EPR policy design and implementation in India.

2. E-WASTE SCENARIO IN INDIA

India still does not have an official estimate of the quantity of e-waste that the country generates. Several estimates exist - one of most the recent estimates suggest that India may have generated close to 1.5 million tons of e-waste in 2015 (Bhaskar and Turaga, forthcoming). Being one of the fastest growing markets for some electronic equipment such as mobile phones, the e-waste quantities are only expected to grow further at a rapid rate. An important attribute of e-waste management in India, like in many other developing countries, is that more than 90% of the e-waste processing takes place in the informal sector.

The 2011 e-waste Rules were the first set of regulations implemented by India to address the e-waste problem. The take-back system of the the 2011 Rules requires producers to set up collection centres, either individually or collectively, to channel the waste for recycling and safe disposal. The producers, dismantlers, and recyclers are all mandated to register with the state environmental regulators - the state pollution control boards (SPCBs) - and receive authorizations to operate. The initial evaluation of the impact of the 2011 Rules suggest that the response from producers has been inadequate although the number of registered e-waste processing units have risen significantly since the introduction of the Rules (Bhaskar and Turaga, forthcoming).

The Indian government amended the 2011 Rules in pursuit of making them more effective and the new amended Rules have become effective since October 2016. The new Rules, in addition to mandatory take-back requirement, specify collection targets as a percentage of sales of electronic equipment, with the targets becoming stricter over time. In addition to the targets, the Rules also require the producers to set up deposit-refund system for electronic equipment. In this context of these new policy instruments introduced into India's EPR framework, this paper's objective is to review the theoretical and empirical literature on policy instruments within EPR and then draw implications for potential effectiveness of the new instruments introduced in India's e-waste management regulation.

3 THEORETICAL INSIGHTS ON POLICY INSTRUMENTS WITHIN EPR

Several types of policy instruments – regulatory, economic, and informational – are compatible with EPR approach (OECD, 2006). Theoretical research on EPR policy instruments has been of interest in two streams of research: environmental economics and more recently operations management. In this section, we review these two streams of literature.

3.1 EPR Instruments in Environmental Economics

Most theoretical models in environmental economics that evaluate EPR instruments use a framework in which producers, in perfectly competitive markets, maximize profits by choosing material inputs to production and levels of output; consumers choose how much to consume, recycle, and dispose of while maximizing their utility, subject to a budget constraint (Walls, 2006). The models then evaluate the economic efficiency and cost-effectiveness of various instruments. A few models also incorporate recyclers, along with producers and consumers, as the other players in the waste disposal markets (Cacott & Walls, 2005).

In general, economists prefer Pigouvian taxes to internalize externalities; in the case of e-waste, the externalities are negative externalities of electronic product consumption and disposal. A tax charged to the consumer at the rate equal to the marginal cost of waste disposal would lead to an economically efficient outcome. In the case of solid waste, however, the general result is that charging the users for waste disposal leads to illegal dumping, sometimes referred to as "moonlight dumping" (e.g., Runkel, 2003). This makes the Pigovian tax infeasible because of extremely high monitoring and enforcement costs of preventing illegal dumping by

consumers. This is the context in which a number of alternative economic instruments to Pigouvian tax are suggested and the theoretical models explore the efficiency properties of these alternatives. In EPR context, a particular aspect of interest in this literature has also been the ability of policy instruments to create Design for Environment (DfE) incentives to producers.

In the following sections, we discuss three instruments that are commonly studied, including one of the most common EPR instrument: the mandatory take-back.

3.1.1 Take-back Requirements

Mandatory take-back requirements place the physical responsibility of collecting the electronic products after the end of their useful life on producers of electronic equipment. Take-back mandates typically allow producers to either set up their own collection and recycling systems or form a collective system, commonly known as Producer Responsibility Organization (PRO). The PRO is a separate entity, which sets up the e-waste management system, and charges the producers for the collection of their waste.

In theory, a PRO charging the producers for the collection of waste is similar to an upstream tax on the producers (Palmer & Walls, 1999). Depending on the price elasticities of demand for various products, a part of the additional cost of paying the PRO is passed on to the consumers and is reflected in the product prices. The increase in product prices, in turn, reduces the demand for the product, thus reducing the volume of waste. This reduction in output produced by the PRO fees is what the economists call “the output effect.” It matters whether the PRO charges the producer on per unit basis or on the basis of weight; charging on the basis of weight generates incentives for producers to move towards a light-weight design of products, reducing the material use.

From an economic perspective, a simple mandatory take-back does not create incentives for consumers to deposit the waste in collection centres, especially when they are not paid for returning their products. It is cheaper for the consumers to illegally dump the waste than to deposit it at designated collection centres. Even on the producer side, in a simple take-back mandate, the lower the quantity of waste that the consumers deposit to the PROs, the lower will be the cost to the producers. In this sense, a simple take-back does not generate enough incentives for either the consumer or the producer to “close the loop.” This is one of the reasons why most take-back mandates are accompanied by either collection targets or recycling rate targets or both. The European Union’s Waste Electrical and Electronic Equipment (WEEE) Directive, for example, has an annual collection target of 4 kg of e-waste per capita and specifies recycling rate standards for a large number of electronic products. Producers not meeting these targets can be penalized. These additional regulatory mandates create incentives for the producers to induce the consumers to deposit their waste to the PRO. While take-back requirements accompanied by recycling rate standards are better than simple take-back, they are still not as economically efficient as some of the other instruments available, such as an “upstream combination tax/subsidy (UCTS)” discussed below (Palmer and Walls, 1999).

3.1.2 Advance disposal fee (ADF) or advance recycling fee (ARF)

ADF or ARF is an economic instrument that is often studied in the theoretical literature and also often used in practice. The fee is collected at the point of sale of a product and may be charged either directly to the consumer (as a visible fee or otherwise) or charged to the producer and incorporated into the price of the product. The revenues generated from the fees are typically used to cover the costs of disposal or recycling. Theoretically, this instrument, like the charge paid by the producers to the PRO, results in “output effect,” reducing the waste quantities because of the higher prices, and in turn, lower demand for the product. It does not,

however, produce “input substitution effect” because there are no recycling incentives (Palmer & Walls, 1999) that incentivize the producers to substitute virgin input material with recycled inputs. The theoretical properties of this instrument also vary depending on how the revenues are used. Using the revenues to provide subsidy on the basis of per unit of product recycled or per unit weight of material recycled is more efficient than using the revenues to cover the costs of recycling (Walls, 2006).

3.1.3 Deposit refund and UCTS

Theoretically, deposit refund is considered a two-part instrument with the economic efficiency properties of a Pigouvian tax (e.g., Fullerton & Wolverton, 1999). The deposit is paid upfront by the consumer at the time of the sale of the product and a refund (usually the same amount as deposit) is paid at the time of returning the product, after its useful life. The deposit should ideally be set equal to the marginal cost of disposal and most studies model the refund as being equivalent to the deposit.

A number of theoretical and empirical studies show the deposit refund to be the most cost-effective instrument in the context of solid waste management (e.g., Sigman, 1995; Palmer & Walls, 1997; Palmer, Sigman, & Walls, 1997; Fullerton & Wolverton, 1999; Lavee, 2010; Brouillat & Oltra, 2012). The optimality of the instrument comes from the output effect – the deposit acts as a tax on the product, reducing the demand for the product and hence reduction in waste – and the input substitution effect wherein the refund (equivalent to a subsidy) encourages substitution of recycled input materials for virgin inputs. The most popular deposit refund policy is on recyclable containers, generally referred to as bottle bills policy. These bottle bill systems are administered by the producers and retailers and a drawback of this form of deposit refund system is that it often involves high administrative and transaction costs in implementation (Walls, 2003).

In the context of EPR, a favoured instrument for economists has been a particular form of deposit refund system, the UCTS. The upstream tax is paid by the producers on the basis of product weight and passed on to the consumers through the product price. The recycling subsidy, unlike the refund in the bottle bills programme, is paid to the collectors and recyclers, thus reducing the administrative costs. This subsidy, however, gets passed on to the consumers by the recyclers. The advantage of UCTS over the standard deposit refund system is in terms of transaction costs – there are much fewer players (i.e., producers and collectors/recyclers as opposed to retailers and consumers) involved in the UCTS system.

In theory, UCTS is also considered superior to other instruments with regards to DfE incentives. The model of Calcott and Walls (2000) compares a disposal fee instrument with a deposit-refund and show that in absence of a perfectly working recycling markets (where signals of consumer preference for recyclable products are perfectly transmitted to producers), an ADF type instrument does not generate DfE whereas a “second-best” deposit-refund type system in which a tax is imposed on producers’ output and the recyclers receive an equivalent subsidy.

3.2 EPR Instruments from Operations Perspective

Theoretical modeling of EPR instruments has been of recent interest from an Operations perspective (Atasu and Van Wassenhove, 2012). Studies in this stream of research also evaluate various EPR instruments, both from the objective of a social planner (policy makers) as well as producers, who are made responsible within an EPR framework.

Atasu, Van Wassenhove, and Sarvary (2009) models the take-back mandate with collection and recycling rate targets within an EPR framework. Their model assumes a world in which a

social planner (government) sets the collection target and recycling rate target to maximize the social welfare, the producer chooses how much to produce to maximize the profit (given the government set targets for collection and recycling), and the consumer buys the product to the extent that the market price is below the willingness to pay. An important component of the social planner's welfare function is the external costs of waste disposal to the environment. Among other things, the modeling exercise draws some important implications for optimal (i.e., social welfare maximizing) collection and recycling rate targets within a broader EPR approach; the optimal targets are positively related to: (i) environmental impact of the products, (ii) value of recyclables, and (iii) consumer willingness to pay to reduce environmental impact. In addition, the model suggests that the optimal targets could be higher in markets where the competition is high.

Ozdemir, Denizel, and Guide (2012) investigates an EPR policy instrument in which the producer is required to collect and recover a certain percentage of product sales and has to pay a disposal fee on each product not recovered up to the mandated level. The producer in this model chooses the sales quantity, recovery amount, and product recoverability level to maximize profits. The model also examines the impact of the initial funds that the producers are willing to allocate for recovery. The analytical solution for the model suggests that the optimal collection targets and disposal fee is a function of relative magnitudes of recovery costs and savings (value generated by recovery) and whether opportunities are available for product redesign that improves recoverability. This indicates that the targets and disposal fee should be product-specific. The model also finds that even if recovery is cost-effective, if the firms lack enough capital to set up the recovery facilities, the recovery rates will be suboptimal. The study recommends that governments may consider providing subsidies to firms that cannot allocate enough capital but operate in industries where recovery is economically viable.

Akyıldırım (2015) compares two alternatives models for producers to comply with a collection and recycling target rate regulation: collective compliance scheme and an individual deposit-refund system (DRS). In the compliance scheme, the producers come together to set up a compliance scheme in which the collection and recycling is outsourced to licensed private parties recognized by the government. The producers' objective in this model is to minimize the fee paid to the licensed collection centers while the licensed firms choose the bid amount to maximize their profits. In the DRS model, the producer charge a deposit at the time of purchase on the consumer and refund the deposit when the consumer returns the product. This model uses retailers as intermediaries - they receive the returned product from the consumers and pay the refund - and receive a fee from the producers for their services. The objective of the producers in this model is to minimize the net costs, calculated as net of deposit revenues, refunds paid to the consumers, service fee paid to the retailers, and the revenue loss due to reduced sales.

The two models are compared on two parameters: (i) cost to the producers and (ii) return rates of used products. With respect to costs, the deposit-refund imposes, on an average, lower costs on producers, especially when the value of the recyclable material from the returned products is high. The collective compliance scheme does slightly better in terms of return rates although there is a convergence between the two schemes when the recyclable materials have high value. The main policy implication of this modeling is that high recycling rate targets, when combined with products with low value for recyclables, make DRS less attractive for producers relative to a collective compliance scheme.

Taking both streams of literature together, theoretically, some form of deposit-refund does seem to be an attractive cost-effective instrument. However, the theoretical literature in general also points out to issues such the value of recyclables from returned products as some of the important parameters that determine the cost-effectiveness of the instrument. Also, the theoretical environmental economics literature often ignores the administrative costs and the

transaction costs involved in implementing the economic incentives based regulations but those costs could be important in determining the feasibility and cost-effectiveness of alternate policies (Shinkuma, 2003; Sachs, 2006).

In addition, it is not obvious that the policies that might work in developed countries could work equally effectively in developing countries (Tong, Lifset, & Lindhqvist, 2005). In the context of e-waste, one of the major differences between developed and developing countries such as India is the presence of a strong informal recycling markets for e-waste processing in developing countries. In the next section, we review the experience of implementation of EPR in a few developing countries to understand the practical issues involved in employing various instruments.

4. EPR: A REVIEW OF EMPIRICAL RESEARCH IN DEVELOPING COUNTRIES

The implementation of the WEEE directive made Europe one of the first countries to adopt EPR for e-waste management. Many countries, including Japan, China, Thailand, South Korea, and India subsequently adopted EPR. The exact design of the EPR approach varies considerably across different countries.

Japan clearly specifies the roles of various stakeholders in its EPR regulation, Home Appliance Recycling Law (HARL). The retailers are responsible for collection, the producers are responsible for recycling the collected waste, and consumers pay a fee to partially cover the costs of recycling and transportation. The experience with HARL indicates that although recovery rates exceeded the targets and the recycling rates (approximately 50%) have improved since the introduction of the EPR legislation, requiring the consumer to pay for waste disposal led to illegal dumping, as predicted in theoretical literature (Ogushi & Kandlikar, 2007).

The EPR legislation in South Korea followed a not-so-successful voluntary producer-driven deposit refund system. The EPR system uses a mandatory take-back, with a flexibility to choose either individual collection or PRO, with clear targets on recycling rates for regulated industries. Violation of the recycling rate targets can invite penalties up to 130% of standard recycling costs. The PRO model turned out to be the predominant choice for the producers to meet their obligations under the EPR law. In Korea’s EPR, the consumer also pays a volume-based fee at the time of disposal. Evaluation of South Korea’s EPR indicates that the obligatory recycling rates induced clear increase in the amount of e-waste recycled, exceeding the regulatory targets for many years (Manomaivibool & Hong, 2014). It is not clear, however, if the collection rates are adversely affected because of the volume-based fee system charged to the consumers.

The EPR mechanism in Thailand includes an upfront charge on the product, the proceeds from which go to a central fund. The local government use the revenues from this upfront charge to set up collection centres and buy back the end-of-life equipment from the consumers and part of the revenues are used to cover for operational and administrative expenses. (Manomaivibool & Vassanadumrongdee, 2011). The buy back system where the local government pays to the consumers for depositing their waste is expected to be important because of the strong informal market in Thailand. Lack of financial incentives for returning the waste to formal collection centres may lead to more and more waste ending up in informal sector collection and recycling centres.

It is important to recognize that there are several differences between an OECD and non-OECD contexts which have been considered important for the design and implementation of EPR regulation. Unlike the developed countries, developing countries in general have a large informal sector, existing with or without the formal sector, dealing with different streams of waste, including e-waste (Manomaivibool & Vassanadumrongdee, 2011; Yang et al., 2008). In

addition, there are other factors such as rapidly expanding markets for different categories of electronic products and consumer appliances, considerable difference in ownership of such products between different types of users, large presence of repair and service shops which outnumber the producer-authorized repair and service shops (and charge less comparatively), and limited financial and administrative capacity of local governments to manage waste disposal (Manomaivibool & Vassanadumrongdee, 2011). Owing mainly to these factors, it has been suggested that EPR programs need special mechanisms to encourage formalization of waste management and to discourage non-compliance in a non-OECD context (Hotta et al, 2009; Kojima et al., 2009; Manomaivibool, 2009). Kojima et al., (2009) argue for the need of authorized recyclers in developing countries to get subsidy to be able to compete with informal sector.

5. CONCLUSIONS AND IMPLICATIONS FOR INDIA'S E-WASTE REGULATIONS

We can draw at least three main implications for India's e-waste Rules based on our review of the extant literature on EPR instrument design and implementation. First, from the perspective of policy instrument design, one can argue that the simple take-back requirement in the current Rules is unlikely to generate enough incentives, either to the consumers or the producers, for improving the collection and recycling rates of e-waste. This might, to some extent, explain the initial reports that the implementation of the e-waste Rules has been unsatisfactory (e.g., Toxics Link, 2012; Bhaskar & Turaga, 2015).

Second, the experience in other developing countries suggest that the difference in contexts, and the presence of strong informal markets for recycling, result in poor incentives for consumers to bring their waste into formal channels (i.e., authorized collection and recycling centres) without a monetary incentive. With no producer offering any monetary or other incentives to deposit waste in authorized collection centres (Bhaskar & Turaga, 2015), it is unlikely that there will be improvement in collection rates under the current Rules.

Third, the draft amendments to the 2011 Rules require producers to operate a deposit refund system. Based on our review, this could be a good policy initiative, since deposit-refund appears to be the preferred instrument, at least in theory. Also, a recent empirical study (Dwivedi & Mittal, 2013) on the willingness of Indian consumers to recycle e-waste finds that the consumers are averse to paying an advance fee for recycling e-waste. It indicates that the ARF might not find favour with the Indian consumer and the study argues that deposit refund system is a better option. It is important, however, to analyse the administrative costs and the transaction costs of various forms of deposit refund systems. The Rules appear to suggest that the deposit refund system will be set up and run by the producers. Our review shows that a producer run deposit refund, similar to bottle bills programmes, could have serious administrative and transaction costs. The UCTS, which is administered by the government, with an upstream tax on the producers and the downstream recycling subsidy to the collectors and recyclers could be a better option.

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