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Environmental impact of voluntary extended producer responsibility: The case of carpet recycling

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ABSTRACT

The extended producer responsibility (EPR) has become a focal strategy for improving the efficient use of resources and reducing the environmental burden. Carpet recycling is a case of the market-based EPR approach implemented in the United States. Historically, public and private sectors have reached an agreement on building a voluntary carpet recycling system by initiating business-driven recycling programs that fit the individual strategies of firms. This institutional context has promoted diversified recycling systems across the U.S including the vertically integrated or out-sourced recycling systems. The study strives to understand how the economic and environmental impact would differ according to responsible firm's strategies under the principle of voluntary extended producer responsibility. Specifically, we evaluate the life-cycle impact of carpet recycling systems through environmental input-output modeling at a regional scale. The simulation compares the life-cycle impacts between a vertically-integrated recycling system of production of reclaimed nylon 6 fiber and an out-sourced recycling system of production of recycled carpet padding. The result demonstrates the benefits of energy savings and greenhouse gas emissions significantly differ according to recycling systems. A large portion of environmental benefits is attributed to the energy savings in the process of reclaiming nylon 6 of the vertically integrated system.

1. Introduction

A focal strategy that industries have adopted to improve their efficient use of resources is extended producer responsibility (EPR). This approach reduces the environmental burden by imposing financial and physical responsibility on manufacturers to recycle their products. Under EPR, the cost of managing end-of-life products is internalized, encouraging manufacturers to establish take-back systems in terms of logistics, recycling technology and finance. The system of EPR has increasingly been adopted in the U.S., Europe, and several Asian countries, each with a unique institutional form from mandate to voluntary effort. For example, during the last two decades, more than 70 EPR laws have been enacted in the U.S. (Nash and Bosso, 2013). Furthermore, the principle of EPR is voluntarily adopted in private firms as a part of their strategic environmental and supply-chain management. The environmental performance of such environmentally proactive firms often exceeds mandatory compliance (Sharfman et al., 2004). Although several studies have assessed the life-cycle impact of EPR mandates in the case of electronic waste recycling under U.S state legislations (Leigh et al., 2012), EPR systems for lamp in the Nordic countries (Richter and Koppejan, 2016), and an illustrative case of used tires with producer's fee (Rodrigues et al., 2016), a proactive role of responsible firms and impact of firm's strategic choices under the voluntary EPR has not been fully understood.

The study strives to contribute to empirical research about EPR by examining how the economic and environmental impact would differ according to responsible firm's strategies in the case of carpet recycling in the U.S. Carpet has desirable features for recycling in terms of volume, material properties, and technical feasibility since it is bulky and consists of mostly synthetic fiber. Through multi-year negotiations, public and private sectors have agreed to initiate a voluntary recycling program based on the strategies of individual firms.[1] This institutional context has fostered the establishment of diversified market-driven recycling systems across the U.S. Responsible firms have developed their own recycling systems with unique choices of technology, recycled products, and organizational types. Upon this context, the study evaluates the life-cycle economic and environmental impacts through taking into account several features of market-driven EPR policies. First, the impact assessment model categorizes recycling systems by organizational forms of responsible firms. A responsible firm may

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[1] The implementation of carpet recycling is based on voluntary agreements, except in the state of California, which initiated the California Carpet Stewardship Program, an EPR recycling program with collection of an advance fee.

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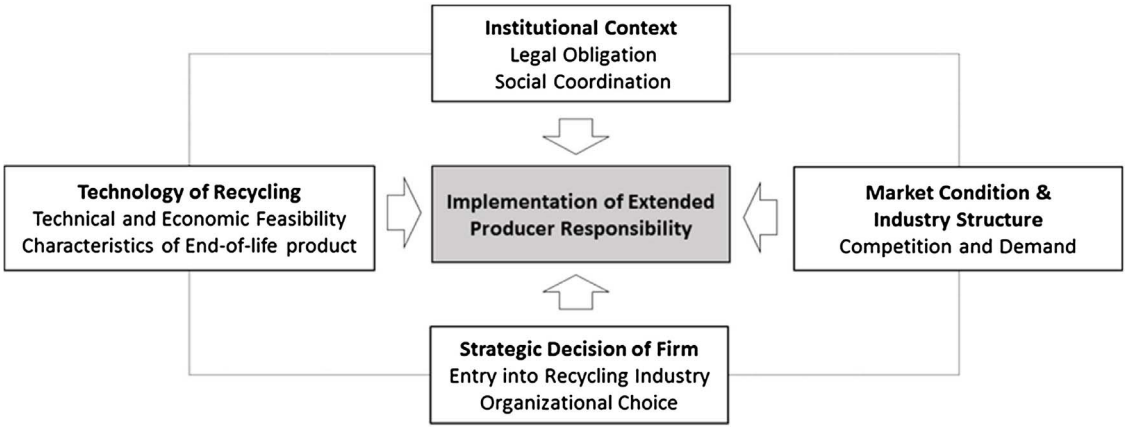

Fig. 1. Schematic Map of the Components of Extended Producer Responsibility.

integrate or outsource a recycling function in their organization associated with different applicable recycling techniques. The model compares a vertical integrated system with the production of reclaimed nylon 6 fiber and an out-sourced system of production of recycled carpet padding. Second, the geographical dimension for waste carpet collection is incorporated in the model. The siting of recycling facility may be related to the location patterns of incumbent production facilities. We compute the environmental impact of reserves collection systems suitable to integrated and out-sourced cases. Lastly, a regional environmental input-output model is employed to estimate the life-cycle impact of carpet recycling systems at a regional scale.

The rest of the paper consists of four sections. The next section describes how U.S. carpet recycling systems have formed and institutionalized in various ways. The third section presents an augmented environmental input-output model that examines waste generation and the recycling industry. The fourth section presents a simulation of the economic and environmental impacts of carpet recycling under voluntary EPR policies. The final section summarizes the findings, and suggests directions of future research.

2. Voluntary extended producer responsibility for waste carpet recycling

This section presents a framework in which one can understand how to implement voluntary EPR policies for waste carpet. As waste carpet recycling has become institutionalized as market-based voluntary EPR, several forms of carpet recycling systems have emerged in terms of various organizational types, geographic scope, and location patterns. Such differences may have evolved from the diverse responses of responsible firms to institutional contexts, market conditions, technological feasibility, and organizational choices. The schematic map in Fig. 1 lists several influential components in the establishment of actual market-based recycling systems under EPR policy. This section reviews the institutional context in which firms initiate voluntary EPR, explores the technological frontier of waste carpet recycling, and examines feasible strategic decisions of carpet manufacturers and relevant firms engaged in voluntary carpet recycling.

2.1. Voluntary agreement for waste carpet stewardship

The driver of initiatives pertaining to market-based waste carpet recycling is voluntary agreement. Historically, product stewardship for waste carpet was initiated by a state environmental agency, the Minnesota Office of Environmental Agency. Then, several midwestern state environmental agencies and the U.S. Environmental Protection Agency formed a partnership, the Midwestern Workgroup on Carpet Recycling, for promulgating the stewardship of waste carpet (Fishbein, 2000), which the industry interpreted as a warning that it needed to become proactive in carpet recycling. Major carpet manufacturers and the industry association joined the workgroup and engaged in discussions about the establishment of a carpet recycling system and mechanisms that secure a commitment from industry to divert and recycle waste carpet. After a two-year negotiation process, representatives of industry, federal and state governmental agencies, and non-governmental organizations reached an agreement and signed the Memorandum of Understanding for Carpet Stewardship in 2002.

The main focus of the Memorandum of Understanding for Carpet Stewardship was the establishment of a voluntary effort by carpet manufacturers to take physical and financial responsibility while minimizing the role of government in carpet stewardship. According to the meeting notes of the Midwestern Workgroup on Carpet Recycling, the underlying issue was the funding mechanism that potentially determined the role of each participant and the shape of the entire recycling system. The funding mechanism consisted of two options: either imposition of a recycling fee on consumers at the point of disposal or sale or the internalization of costs by manufacturers. The first financing option was a more enforceable mechanism requiring the enactment of regulations as well as governmental administrative involvement. The second was a highly flexible option for industry highlighting the self-regulatory role of manufacturers. The workgroup took the idea of a manufacturer responsibility model and excluded direct regulation such as the landfill ban and the disposal fee.[2] As a result, the industry was granted autonomy to flexibly establish its own recycling system.

The industry and the government negotiated specific goals and a timeline of phasing out the disposal of waste carpet in landfills. To implement these actions, industry and government agencies agreed to create a third-party organization, the Carpet America Recovery Effort (CARE), funded by the industry. The task of this organization was to strengthen the collection system, to serve as an information source for technology and market development, and to measure and report quantitative progress. In 2002, their efforts led to a negotiated outcome on carpet stewardship in which the diversion goal for the first phase from 2002 to 2012 was established. The diversion rate goal was to be 10% by 2005 and 23% by 2010.

This voluntary agreement scheme for waste carpet recycling among industry, local and federal governmental agencies, and non-governmental organizations is an example of a transition in environmental regulation from a command and control approach to a participatory and consensual approach. The progress of recycling relies on the ability and the willingness of an individual carpet manufacturer and a current market system in which each firm is expected to compete to provide innovative recycling solutions and green products. However, the exclusion of mandatory provisions and enforceable mechanisms has been

[2] Source: Minnesota Pollution Control Agency (2000) accessed in October, 2007.