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Tying product reuse into tying arrangements to achieve competitive advantage and environmental improvement

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A R T I C L E I N F O

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A B S T R A C T

Established understandings of ecological systems highlight patterns of simplified material composition and production systems matched to efficiently cycle natural materials. Applied to industrial systems, significant opportunity is revealed to emulate this ecological perspective in pursuit of greater industrial efficiency. By capturing and preserving the value of embodied energy and operational function in today's complex products through forms of product reuse, firms can leverage these insights to create efficient business models and operational systems that support a more circular industrial economy. In this article, we introduce a systems perspective approach that combines economic and environmental assessment methods to explore how firms can gain competitive advantage by implementing circular product reuse, leveraging business strategy and Circular Economy policy laws. Using the consumer printing sector as a case study, we explore this possibility in the specific context of the structure-conduct-performance approach for tied markets (SCP-TM), demonstrating how by remanufacturing their own products, the original manufacturer (OM) may leverage extended producer responsibility (EPR) durable product take-back legislation (individual producer scheme) to maintain profitability, while providing environmental improvement in both printer and cartridge markets. We also illustrate how a durable product take-back requirement implemented as a collective scheme in the printer market, may result in decreased economic welfare in the tied inkjet cartridge market; a result of which policy makers may not be aware without considering the SCP-TM approach.

1. Introduction

Conceptually, the circular economy has emerged as a framework for guiding contemporary economies towards economic patterns of production and consumption that focus on efficiency in an effort to support longevity without unsustainable depletion (MacArthur, 2013). This notion has evolved primarily from the fields of ecological economics, environmental economics and industrial ecology (Ghisellini et al., 2016), which employ systems thinking to understand industrial systems through a lens of ecological relationships, in order to spur innovation through emulation of natural systems (Levine, 2003). In this realm, natural systems are viewed as models from which to benchmark and guide the design and development of industrial systems. Specifically, natural phenomena that regulate material and energy flows to sustain life in an evolutionary, yet stable manner – where residues of one process are welcome inputs to another – is a complex masterpiece of efficiency from which much insight can be drawn. In this pursuit, recent investigations of industrial strategy contend that this type of innate, yet deliberate efficiency may be practically achieved through industrial models that champion appropriate use, reuse and exchange of resources. Indeed, Hawken et al. (1999) advocates the redesign of industrial systems for reuse of materials in continuous closed cycles as occurs in ecological systems.

While the potential for transformative progress is clear, products in industrial systems composed of diverse and exotic substances (e.g. polymers and alloys) are not, and often cannot be, as readily recycled (or reused) as materials with limited compositions found in ecological systems. Complexity is, in many cases, designed and accepted by society in pursuit of functional and material performance enhancements, but often requires high levels of energy input and is in most ways a stark departure from the functional simplicity of ecological systems. However, with this difference, comes both an opportunity and a responsibility of industrial systems to efficiently recapture and preserve the embodied energy and function of complex products, both in the interest of economic advantage and environmental quality. Various aspects present in industry can influence the viability of product reuse. In an industry where products are typically leased to customers, manufacturers retain product ownership and have control over its product's

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end-of-life fate. If the product can undergo some processing (e.g. repair, remanufacturing, refurbishment, testing) and then be leased for an additional term, the manufacturer may be able to reduce its costs, preserve the embodied energy of product components, and reduce both waste and virgin production (Sundin and Lindahl, 2008). Maslennikova and Foley (2000) observe that Xerox continues to utilize a modular design strategy for most of its products that allows the firm to collect and profitably remanufacture products. Xerox was able to convert a potential disposal cost associated with 160,000 Xerox machines recovered from customers in Europe (in 1997) into a net savings of $80 million by reprocessing these machines (Maslennikova and Foley, 2000). Providing that a reused product is desired by consumers in the marketplace, the manufacturer's ability to secure its product after a consumer use cycle is a key ingredient to a successful product reuse recipe. Geyer et al. (2007) note that Kodak's single-use camera core was designed to endure six consumer use cycles. Since Kodak was able to effectively recover spent single-use cameras, remanufacturing proved to be more profitable than new production while providing environmental benefits. Other factors that must be considered by a firm interested in a product reuse strategy include market structure, consumer willingness-to-pay for a remanufactured product, management's perception that remanufactured product sales will cannibalize sales of new products, environmentally-motivated regulation, and the manufacturer's ability to cost effectively collect, process and sell remanufactured products relative to that of independent remanufacturers. Ovchinnikov et al. (2014) investigate a cellular service provider that is able to offer remanufactured devices in its product + service bundle and find that it was profitable in all cases considered, and in 73% of the cases there was a decrease in energy use, resulting in a positive absolute environmental effect.

The effectiveness of EPR policy instruments is a fairly young topic in the literature since EPR policy concepts were introduced in 1991 with the German Green Dot scheme. Fleckinger and Glachant (2010) show that EPR product take-back is not sufficient to ensure an efficient producer response. When waste management is competitive, individual take-back acts like a Pigouvian tax and always yields a higher welfare than a perfectly collusive collective take-back scheme using a producer responsibility organization (PRO). But if waste management is not competitive, an individual take-back scheme will perform worse than the perfectly collusive collective scheme. Atasu et al. (2009) focus on the effects of take-back legislation of existing policies such as the mass based Waste Electrical and Electronic Equipment (WEEE) Directive of the European Commission. They find that the WEEE directive is not efficient from an economical or ecological perspective and argue for a directive with focused targets for different product categories that consider: a) EOL treatment cost, b) environmental impact, c) consumer willingness-to-pay for a decrease in environmental impact, and d) competition intensity for a specific product market. They also point out that the WEEE Directive favors recycling over reuse and the collective take-back scheme does not incentivize an individual firm to improve its product's environmental quality as would be the case under an individual take-back scheme. We suggest readers interested in remanufacturing strategy under EPR to a recent article by Özdemir et al. (2012) that investigates the firm's optimal remanufacturing strategy under an individual EPR take-back requirement, and review articles by Esenduran et al. (2012), Atasu and Wassenhove (2011) and Atasu and Van Wassenhove (2010).

The evolution of complex industrial systems and their similarly complex products, is not entirely incompatible with ecological systems, but can benefit in many ways from the circular economy approach to design and operation. To this end, a review of circular economy literature by Ghisellini et al. (2016) suggests that actions need to be addressed at the micro, meso and macro levels in a coordinated fashion to affect change with producers, consumers, and governments alike. This paper looks to address this research gap by providing a framework for analysis that considers the actions and reactions of these actors for the consumer printing sector. Specifically, we consider what will happen in this sector when government mandates extended producer responsibility laws that would be applicable for the printer (i.e. the durable good). But since the prevailing business model in this sector is product tying, our framework suggests we need to consider the tied cartridge market as well. In this article, we introduce a systems perspective approach which combines economic and environmental assessment methods to show that a firm can gain competitive advantage through implementing product reuse (with specific focus on remanufacturing) by leveraging business strategy and Circular Economy policy. Our particular interest pertains to a product tying (or tie-in) sales strategy that connects two product (or service) markets. In order to apply our approach, it is necessary to consider both the tying product market and the tied product market. We accomplish this by using a modified version of the structure-conduct-performance (SCP) approach used in the economics of industrial organization literature (Carlton and Perloff, 2005). In applying SCP in an industrial system with two tied markets, we refer to this modified version as structure-conduct-performance-tied markets (SCP-TM) approach. SCP is used to identify and characterize interactions between actors (i.e., producers, consumers and government) in the industrial system. For an actor initiated intervention that maintains the SCP-TM model, our framework allows for economic and environmental comparison of pre and post intervention conditions. If an intervention alters the tying and/or tying product markets, our approach suggests redefinition of the tied products system structure to identify avenues that may lead to unintended economic and environmental consequences.

Our SCP-TM approach is based on the *structure-conduct-performance (SCP) approach* shown in Fig. 1 commonly used in the industrial organization economics literature. The goals of industrial organization study aim to (1) increase the understanding of how industries operate, (2) improve contribution to economic welfare, and to (3) improve government policy. Fig. 1 shows how each aspect is interrelated, and how conduct in an industry can influence government to set policies than can affect other aspects of the industry. Typically if the conduct in an industry is leading to some type of harm, whether economic, environmental, or both, government may enact some form of policy to counteract the misconduct.

The consumer printing sector serves as the backdrop to demonstrate this approach. This sector is an interesting and challenging landscape requiring consideration of both the durable product (inkjet printer) and consumable (inkjet cartridge) markets. Producers use a tie-in sales strategy where printers are offered at a low price in order to encourage consumption of high priced and highly profitable replacement ink cartridges. Product tying results in two outcomes with environmental consequences that we investigate using our systems perspective framework: (1) increased consumption of printers which are abandoned prematurely, and (2) inkjet cartridges designed and marketed to be single-use. Fig. 2 represents those elements of the SCP-TM framework investigated in this article. One key difference found in Fig. 2 is the inclusion of additional complexity by including two product markets (inkjet printers and inkjet cartridges) in the industrial system versus a single product market emphasized in the *structure-conduct-performance* approach shown in Fig. 1.

As a result of significant environmental impacts associated with commercial and consumer printing, there is a rich body of literature in this space. Bousquin et al. (2012) provides a review of life cycle assessment studies for both printers (durable good, tying product) and ink/toner cartridges (consumable good, tied product). While it is difficult to compare the results of each LCA study due to differences in goals and scope, functional units, system boundaries, and assumptions, it was clear that the actions of various actors (producers, consumer and government) could affect the environmental impacts over different aspects and phases of a product's life cycle. An example is having consumers adjust behaviors to print double-sided versus single-sided, thus reducing the environmental impact associated with paper use. Another