Omega 41 (2013) 574–585

Contents lists available at SciVerse ScienceDirect

Omega

journal homepage: www.elsevier.com/locate/omega

The compatibility of durable goods with contingent generic consumables

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ARTICLE INFO

Article history:
Received 7 November 2011
Accepted 13 July 2012
Processed by B. Lev
Available online 22 August 2012

Keywords:
Durable goods
Contingent consumables
Compatibility
Strategic consumers
Remanufacturing

ABSTRACT

Many durable products provide value only when used together with contingent services or consumable components, e.g. light fixtures (bulbs), printers (ink), electronics (batteries). Consumers need only have access to the contingent consumable components to continue to derive service from a durable. In fact, many firms rely primarily upon the revenues generated from the contingent services or consumables as the primary source of profitability, e.g. giving away the razors to make money on the blades. Such firms often invest considerable effort into making sure that consumers of their durables are held captive to their own branded consumables by impeding their access to generically available consumables. They do so by designing their products in such a way that they are not readily compatible with the generic consumables. We consider the implications of competition from third-party manufacturers that can provide generic consumables and the manufacturer's production decisions of a durable good under such contingencies. This allows us to draw managerial insights about how a firm should decide on his product compatibility and production quantity when the generic contingent consumables enter the market.

1. Introduction

Many products are sold in a bundle that includes a durable good and a contingent consumable, such as printers and ink, electronic products and batteries, automobiles and warranty services. However, in order for a consumer to continue to derive value from the durable, she must continue to buy the contingent[1] consumable. This interdependence between the durable good and the consumable creates a stream of revenues for the durable good manufacturer over the life of a durable. Further, the stream of revenues and profits from the consumables can often far exceed that from the initial sale of the durable.

The printer and ink supply industry provides a good example. In 2004 Hewlett-Packard (HP) derived 73% of its profits from its printer division, but more than 50% of the profits in the printer division came from the sales of ink and toner supplies [5]. Naturally, the profitability of the ink supply business has not gone unnoticed, and it has attracted many fast-growing startups, such as Cartridge World. Although HP did not take any initiative to interfere with consumers' ability to use generic ink cartridges in its printers, it instead focused on maintaining a perceived gap in quality between its ink and that of other manufacturers. While consumers accepted HP cartridge as a higher quality option, Cartridge World earned its market share with its low prices and convenient locations [4].

Consider another example from the electronic products industry. When Apple first introduced its iPod, the product was not designed to be opened up in order to replace the battery. For most consumers, the life of their iPod was thereby limited to the life of its battery. Subsequently, in response to environmental issues as well as the entry of third-party firms offering iPod battery replacements, Apple set up its own battery replacement program. Further, Apple has not interfered with the compatibility between the iPod and alternative battery kits, and even promoted these alternatives on its website as a more affordable option.

In other durable goods industries, e.g. heavy equipment, automobiles, etc., the maintenance and repair services that are required to keep a durable product in good working order represent contingent consumables. Some third-party manufacturers are highly engaged in remanufacturing services for major brands like Ford, Xerox and Caterpillar [17]. Nevertheless, some original manufacturers prevent third-party service providers from gaining access to their consumers by requiring large investments in expensive diagnostic equipment, or by withholding technical specifications or specialized replacement parts as is common in the automobile industry. The car manufacturers prevented independent service shops from gaining access to the tools and information needed to diagnose and repair problems, and forced customers to certified dealers [21].

The decision to have third party manufacturing firms is critical because the manufacturer, on one hand, loses revenues from the consumable sales and has an economic motive to reduce competition, including the ability to deter entry of the third party firms

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[1] As described in [29] contingency between two products is a special case of complementarity that occurs when neither product can be used in the absence of the other.

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http://dx.doi.org/10.1016/j.omega.2012.07.004

with a proprietary product design. On the other hand, the sales of the product are dependent on the availability of consumables and service because consumers consider the total utility of a durable over its lifetime. These durable cores which have a long lifetime relative to the consumables maintain potential value for the consumer, either for their market resale value or their ability to provide additional usefulness with another period of use. Then, the central question the manufacturer seems to face is, "*When does the benefit of third party consumable manufacturers outweigh losses from competition*?"

Consequently, the primary goal of this paper is to provide the monopolist manufacturer with guidelines for the compatibility decision between the durable goods and contingent consumables, and to avoid price competition and costly litigation. We develop a model for a monopolist manufacturer of a durable product that requires a contingent consumable for continued use. We first consider the implications of linking a durable to a contingent consumable in an environment in which the manufacturer is a monopolist in both markets. We then consider the existence of a competitive industry that supplies a generic consumable that is an alternative to the branded one provided by the durable goods manufacturer. We focus on the consumable quality-to-cost ratio of the generic consumable manufacturers to explain how the manufacturer who has monopoly power in the durable product market can produce under such contingencies. This allows us to identify the implications of competition from generic consumable manufacturers and draw managerial insights about how a firm should decide on the compatibility of its durable good with a rival generic consumable industry.

The remainder of the study is organized as follows: in the next section we review the literature. Section 3 details our model. We analyze the optimal strategies for the incompatible consumable market and the consumable market with generic consumables in Section 4. In Section 5 we discuss the optimal compatibility and production decisions for the manufacturer, and numerically analyze our findings in Section 6. The final section provides managerial insights and concludes the study. Throughout the study, we adopt the convention of using masculine pronoun to refer to the original manufacturer and feminine pronoun to refer to the consumer.

2. Literature review

There are several distinct literatures to which our work relates. There exists a large literature that addresses the conditions under which a firm can benefit from compatibility with a rival. As discussed in Katz and Shapiro [23], compatibility can be an important issue either in settings in which there are direct network effects, that allow consumers to benefit from being able to interact with other consumers of compatible products, or in settings in which products consist of sets of compatible components, e.g. video gaming hardware and software, and increasing compatibility increases the choices available to consumers [7]. Our work is more closely related to compatibility among components of product systems. Matutes and Regibeau [28] and Economides [13] consider a setting in which competing firms offer products that are systems of two component types, and each firm offers exactly one flavor of each of the component types. They demonstrate that compatibility among the two firm components can be beneficial by allowing differentiated consumers to better match their preferences. Although we also focus on a product that requires two compatible components, we include a time dimension in which one of the components is durable, i.e. lasts for more than one period, while the other is not.

Our work also draws upon the literature on durable goods that studies the interaction of durable goods with leased, used or complementary products. This line of research focuses on the use of a leasing and/or selling strategy for competitive interactions [11,12,3] and complementary interactions [33,2,6]. Related to our work, Bhaskaran and Gilbert [2] show how the availability of complements can stimulate demand for the durable good and discuss how a durable goods manufacturer can manage this demand. In our research, since the technological life of the durable good is long relative to the physical durability of the consumable, consumers need a consumable to prolong their use of the durable good. Therefore, consumers in our research possess the durable good, but can only use it by purchasing a consumable, similar to leasing. We further consider competition in the consumables market and the impact of third-party manufacturers who may cannibalize the consumable sales as well as generate value for the product. In a similar setting to ours, Gilbert and Jonnalagedda [16] show that the durable goods manufacturer who cannot commit to shutting down production of her durable after the first period, due to the role that the continued sale of durables plays in mitigating the holdup problem with respect to consumers, may be better off without consumables market. However, they do not consider any value of a used durable for consumers, e.g. their market resale value. We extend their analysis to a situation in which consumers evaluate any future value of the durable cores in their purchasing decisions and examine to what extent the presence of generic consumables influences the value of a brand new durable good.

The problem that we study is related to reverse and closed loop supply chains for durable goods [30,31,36]. It is, in particular, related to the one considered in the literature on remanufacturing. Implicitly, a remanufacturable product involves a durable core as well as one or more consumable components that wear out sooner than the durable core and are critical to the operation of the product. In this respect, remanufacturing has some similarity to the setting that we study. Although much of the work in remanufacturing has focused on logistical issues, there are several papers that address the competition between the original manufacturer and remanufacturers, which is similar to the competition between the firms to provide the service or consumable component in our setting. Majumder and Groenevelt [26] show how a rival remanufacturer can erode the profits of a monopolist manufacturer and discuss how the manufacturer can deter the remanufacturer from entering. This work was extended by Ferrer and Swaminathan [15], who focus on the effect of remanufacturability on the pricing strategies of a monopolist original manufacturer with and without competition from a remanufacturer, and by Ferguson and Toktay [14], who focus on strategies for deterring the entry of a remanufacturer. Debo et al. [9] endogenizes the manufacturer's remanufacturability decision and shows how the joint pricing-remanufacturability decision is affected by a rival remanufacturer. This work was extended in the context of a diffusion of technology model, but ignoring the possibility of competition [10].

In all these papers, it is assumed that the durable cores are disposed of by consumers who consume them with either new or remanufactured units, and it is up to either the original manufacturer or a remanufacturer to collect the cores and convert them into marketable products. Relatively little attention has been paid to the potential for these durable cores to have value to consumers, either for their market resale value or their ability to provide additional usefulness. With notable exceptions of Guide et al. [19], Ray et al. [32] and Atasu et al. [1] little attention has been paid to the potential for these durable cores to have value to consumers. However, neither of these papers allows for consumers' willingness to pay to be influenced by their rational expectations of the future value of their durable core.