Omega 54 (2015) 134–146

Contents lists available at ScienceDirect

Omega

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

The comparison between trade-in and leasing of a product with technology innovations ☆

Kate J. Li [a,*], Susan H. Xu [b,†]

[a] Department of Information Systems and Operations Management, Sawyer Business School, Suffolk University, Boston, MA 02108, USA
[b] Department of Supply Chain and Information Systems, Smeal College of Business, The Pennsylvania State University, University Park, PA 16802, USA

ARTICLE INFO

Article history:
Received 12 June 2014
Accepted 31 January 2015
Available online 9 February 2015

Keywords:
Trade-in
Leasing
Durable goods
Product reuse
Stationary equilibrium

ABSTRACT

Companies can adopt trade-in and/or leasing to shorten consumers' upgrade cycle and gain control over secondary markets. In this paper, we consider a monopolistic manufacturer who offers a technology product to a market consisting of heterogeneous consumers. We focus on an exogenous, stochastic innovation process that determines the availability of new technology and consequently, residual value of the current product. We derive the optimal pricing strategy of trade-in and leasing, respectively, examine its impact on the manufacturer's expected profit, and compare the performance of the two strategies. Trade-in protects the manufacturer against residual value risk and allows the flexibility of offering the option at different innovation states separately. Leasing, on the other hand, provides the manufacturer an opportunity to circumvent low new product prices and thus increases expected profit when product reuse profitability is high. The interplay between the two forces, product reuse profitability and new product price, determines the preference between trade-in and leasing. Our findings provide monopolistic manufacturers guidance on how to optimally employ the trade-in and leasing strategies.

1. Introduction

Trade-in and leasing are two widely adopted strategies by individual consumers and companies in a variety of industries. Consumers regularly trade in automobiles, electronics, power tools, video games, golf clubs, etc. towards the purchase of new products. In the business-to-business (B2B) markets, many companies trade in large-scale communication devices, CT scanners, photocopies, computers, etc. when they replace their current equipment. On the leasing side, equipment leasing has a long history and has been adopted by companies around the world [41]. It accounts for about $827 billion of business each year in the United States, and will continue to be a dynamic and growing business [11]. It has been used by companies of different sizes to acquire a broad range of assets, such as aircraft, automobiles, IT, medical, manufacturing and construction equipment. According to ELFA, 72 percent of U.S. companies lease some or all of their equipment. In recent years, in spite of the challenges posed by a slow economy, low interest rates and falling equipment prices, IT leasing remains a viable and vibrant industry [39]. Leasing has also been widely used in business-to-consumer (B2C) markets, mainly for acquiring automobiles and technology products. For example, new car leasing basically did not exist in the early 1980s, but experienced steady growth in the 1980s and 1990s with reaching a peak in around 2000 [20]. Recently battery leasing has been introduced by automobile manufacturers and power suppliers in order to reduce the purchase cost of electronic vehicles [24].

Manufacturers are increasingly offering trade-ins and leasing, and using the returned products for remanufacturing, recycling, and other types of product reuse. Xerox is one of the best-known examples. Its remanufacturing facility is based partly on returns from trade-ins and off-lease products, which has generated cost savings of several hundred million dollars each year [14]. Interface Inc., a carpet manufacturer, provides Evergreen Lease with the goal of reducing the environmental impact of its operations and describing it as a "new workable business model for sustainable development" [29]. Other examples include IBM, HP, Herman Miller, Bosch, and Eletrolux [33].

With the ever-increasing rate of technology innovation and product replacement, trade-in and leasing play a crucial role in helping companies to stay competitive, increase consumer satisfaction by providing more flexible acquisition methods, and be environmentally responsible. The examples above show that companies have been implementing trade-in and/or leasing, in combination with outright selling. Trade-in and leasing enable companies to achieve two basic goals. First, the two strategies can be used to incentivize consumers to upgrade to products featuring newly introduced technology or simply to replace used products

☆This manuscript was processed by Associate Editor Wang.

* Corresponding author. Tel.: +1 6175571586.
† Deceased.
E-mail addresses: kjli@suffolk.edu (K.J. Li), shx@psu.edu (S.H. Xu).

http://dx.doi.org/10.1016/j.omega.2015.01.018
0305-0483/

with brand-new ones. Second, since trade-in and off-lease products are returned to the companies, they can gain better control over product reuse and secondary market activities in order to achieve higher profit, fight counterfeits, and engage in sustainable operations.

In this paper, we intend to study the implementation of trade-in and leasing under stochastic technology innovation, examine their impact on consumer behavior and firm profitability, and compare the two strategies under different pricing and product reuse scenarios. Specifically, we consider a setting where a monopolistic manufacturer offers a technology product to a heterogeneous consumer population who differ in their willingness-to-pay (WTP) for the product. The technology product is designed to last for two periods functionally, i.e., after it has been used for two periods, it fully depreciates functionally and has no residual value remained. We assume that there is an exogenous, stochastic innovation process governing the availability of the next-generation technology. Whenever a new technology becomes available, the manufacturer introduces a new product featuring the latest technology to the market and stops offering new products featuring the previous-generation technology. A product thus is subject to two types of value decay: functional depreciation (FD), caused by wear and tear, and technological obsolescence (TO) caused by technological innovation. Trade-in and leasing can be offered by the manufacturer to encourage consumers to replace products suffering FD and/or TO to brand-new products featuring the latest technology.

In the trade-in model, the manufacturer may offer trade-in credit to buy back consumers' on-hand products, which can be applied towards the purchase new products. Meanwhile, consumers who have a one-period-old product on hand decide whether to take advantage of the trade-in offer or to keep their product for one more period until it fully depreciates functionally. If a consumer chooses to trade in when innovation does not occur, he essentially replaces a used, one-period-old product suffering only FD by a brand-new product with the same technology. This decision is made based on his own willingness-to-pay and the trade-in credit provided by the manufacturer. Since such used products are still technologically current, the manufacturer sells them in the marketplace to consumers with lower willingness-to-pay. If a consumer chooses to trade in when innovation occurs, the consumer is able to upgrade to the new technology immediately after it becomes available. In essence, the consumer can enjoy a brand-new product featuring the latest technology instead of a used product suffering both FD and TO. However, because now these trade-in products are used and obsolete, it is usually not to the best economic interest of the manufacturer to resell them given her costs of inspection, remanufacturing, and remarketing; instead, the manufacturer is better off disassembling, reusing or recycling materials, or donating these products to charity.

Evidence in practice supports the manufacturer's different disposing methods of trade-in products at different innovation states. Apple has a “Reuse and Recycling Program”[1]. Currently, the Reuse Program accepts iPhones as old as iPhone 4 and gives customers gift cards based on model number, capacity, and condition of the device. But for older models (including iPhone, iPhone 3G, and iPhone 3GS), customers can only participate in the Recycling Program which does not provide any monetary compensation, but simply recycles for free for customers. Besides Apple, other companies, such as Cannon, Best Buy, and Costco, offer programs operated in a similar way. A trade-in value search conducted in October 2014 using Best Buy's online trade-in calculator shows that the trade-in values of iPhone 3G, iPhone 3GS, iPhone 4, iPhone 4s, iPhone 5, and iPhone 5s (all with 16 GB memory) are: $0, $5, $60, $110, $201, and $300, respectively.[2] In the B2B markets, asset recovery services are a popular offering from HP Financial Services (HPFS) that take back HP and non-HP equipment from a wide range of industrial customers. HPFS took in roughly one million units in 2006 [7]. Remarketing older assets is a key part of HPFS's business; however, if a piece of equipment is too old (severe technology obsolescence), or in such a bad shape that it no longer has any useful life left (severe functional depreciation), HPFS will mine the equipment for any useful parts and then manage the disposition of the remainder in accordance with applicable environmental regulations. These B2B- and B2C-market examples demonstrate that when the resell value of trade-in products is higher than the associated costs, companies sell refurbished and/or used products in the market; otherwise, they dispose these products by reusing or recycling materials or donating to charity.

Note that though operated in the same way, trade-ins offered when innovation occurs and when innovation does not occur serve different purposes to the manufacturer and the consumers. When innovation occurs, the manufacturer uses trade-in to buy back technologically obsolete, used products in order to accelerate new technology adoption; when innovation does not occur, the manufacturer uses trade-in to buy back technologically current, used products and sells them alongside new products featuring the same technology. As such, the manufacturer essentially serves as an intermediary to facilitate the transaction between consumers who want to replace their functionally depreciated, one-period-old products with brand-new ones and consumers who demand used products. The manufacturer decides trade-in credits in anticipation of consumer choice to maximize her expected profit; while consumers choose consumption strategy based on their own willingness-to-pay and trade-in credits offered by the manufacturer in order to maximize their own utility. From the manufacturer's perspective, prices are her enabler to induce consumer behavior that results in her maximum expected profit. Since we are interested in analyzing the long-run behavior of the manufacturer and the consumers, we characterize the optimal stationary prices.

The leasing model is set up in a similar way where consumers may be offered the option of leasing a new product. All leases are designed to last for one period and it is assumed that no call option is embedded. If a consumer leases a new product, he returns the off-lease product to the manufacturer after one period when the lease ends and assumes no further responsibility. Same as in the trade-in model, the manufacturer sells off-lease products in the marketplace when innovation does not occur, and disposes them outside the primary marketplace otherwise. The manufacturer decides lease prices, given which the consumers choose their consumption strategy to maximize their own utility.

The trade-in and leasing models are solved separately and their results are compared. We find that the manufacturer's trade-in decision is affected by two factors, namely new product price and product reuse profitability. When new product price is low, a relatively low trade-in credit is enough to get consumers interested. Therefore, the manufacturer can increase her profit by encouraging more frequent product replacement and upgrade through trade-in. Product reuse profitability is the value that the manufacturer can recover from traded-in products. The higher this is, the more likely that the manufacturer offers trade-in. An important characteristic of the trade-in model is the manufacturer's flexibility to make separate decisions of offering trade-in when innovation occurs and when it does not. This is because consumers participating in trade-in return their used product when they purchase a new one, and the manufacturer can dispose these used products promptly under observed innovation condition. Therefore, for example, if selling used products to lower-valuation consumers is lucrative, but recycling materials is not, the manufacturer can choose to offer trade-in only when innovation does not occur.

[1] See www.apple.com/recycling/gift-card/for details

[2] See www.bestbuy.com/site/Electronics-Promotions/Online-Trade-Infor details