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Choosing the right exchange-old-for-new programs for durable goods with a rollover

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ABSTRACT

By offering to trade-in one unit of old product at a discounted price while selling new products, "exchange-old-for-new" (EON) programs have been considered efficient ways of expanding market for durable goods. Starting from the choice behavior of customers, this paper studies optimal pricing and remanufacturing decisions for firms that adopt the EON program. Specifically, considering a supply chain that consists of one manufacturer and one retailer, we investigate two business models: (i) in the manufacturer-initiated scenario, the manufacturer launches an EON program and owns all the old items that are returned; he remanufactures all (or a portion) of the old items and sells them to a secondary market. (ii) In the retailer-initiated scenario, any old items that are returned belong to the retailer; she remanufactures the old items and sells them to the secondary market. An in-depth comparison between the optimal decisions in the two models is conducted in this paper. We show it is possible that a firm may be even more profitable from being a "free-rider", instead of offering an EON program by himself/herself. Based on a centralized supply chain as a benchmark, an exchange-discount-sharing contract is proposed to coordinate the supply chain and to improve the overall welfare of customers. Numerical experiments are conducted to show the profit impact for the supply chain members, which uncover some interesting managerial insights for the proper adoption of the most efficient EON programs.

1. Introduction

It has been challenging for firms involved in the production and distribution of durable products (such as furniture, household electrical appliances, computers, etc.) to continuously expand the market in a competitive environment. This is because, unlike consumer goods, a durable product can usually be used for a rather long period of time, whereas advances in technology accelerate the development of new products. Therefore, marketing a new generation of durable products has become increasingly difficult, especially when the market is highly saturated. For example, given that a customer already owns an old but fully functional air-conditioner, he/she would be reluctant to buy a newly-launched high-frequency model that is more energy-efficient, if he/she must resell the old one at a markedly low residual value or discard it even by paying a disposal cost. To stimulate the sales volume of new products, various forms of "exchange-old-for-new" (or simply "old-for-new", abbreviated as EON) programs have been widely adopted, in which manufacturers or retailers offer a trade-in rebate to customers seeking replacements to hasten their purchase decisions (Ray, Boyaci, & Aras, 2005). A typical example is Apples iPhone trade-in program, which was rolled out in August 2013 to increase the uptake of the iPhone 5 (Burrows, 2013; Fiegerman, 2013). After the bolstered sales in the U.S, Apple also extended the trade-in program for iPhones to China in association with the Foxconn Technology Group in March 2015 (Culpan & Higgins, 2015).

In an EON program such as the one offered by Apple, the credit received by customers can, generally, be only used toward the purchase of a new product (Fiegerman, 2013). As a result, a direct benefit of this program is to support the sales of new products in more-developed markets such as the U.S. or Japan (Walsh, 2013). For example, it was estimated that about half the people buying iPhones in the U.S. during the final quarter of 2014 traded in their older phones (Culpan & Higgins, 2015). In fact, the EON program represents a win-win solution for customers and firms. On the one hand, it provides an additional option for customers that already possess old items. By receiving a credit and paying a discounted price, replacement customers can "upgrade" their product without worrying about their obsolete generation of product. As a result, it increases the purchasing frequency (Van Ackere & Reyniers, 1995).

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On the other hand, while expanding the market of new products by launching an EON program, a firm can generate additional revenue from the returned old items by refurbishing and selling them to less-developed countries or regions. This provides an opportunity to boost a firm's secondary market (Graham & Molina, 2013). Even if the returned old items do not have any monetary value, they can be disassembled in an environmentally friendly manner, and the recyclable components and materials can be sold to other firms at a reasonable price.

Recognizing its benefits, an increasing number of companies have adopted various forms of EON program to stimulate demand. For example, a few years before the iPhone trade-in program, Apple has initiated a "Reuse and Recycling program" (see http://www.apple.com/recycling/), which allows a customer to bring his/her old iPod to an Apple retail store and get 10% off a new one (Boehret, 2012). The major Chinese smart phone manufacturers, including Huawei, Xiaomi, Letv, Lenovo, and Qiku, all have rolled out their EON programs in recent years.[1] It is worth mentioning that, besides the aforementioned manufacturers, an increasing number of retailers are adopting their EON programs as well. For example, kindle owners can trade in their old models and receive credit for a new one, or anything else that Amazon sells (Sorrel, 2011). One of the largest online retailers in China, *JD.com*, offers a EON program for a variety of household electrical appliances.[2] Note that the EON program of the retailer will benefit the upper-stream manufacturer as well because it induces more new product sales. The effectiveness of EON programs has been promising: as reported in China Daily, from September 1, 2009 to December 31, 2011, China's household appliance replacement policy, which has been proposed by The Ministry of Commerce, "drove sales of 342 billion yuan, around 22% of the expenditure in the sector as a whole during the period (Liu, 2012)."

One of the key factors that determine the profitability of an EON program is the exchange discount (or trade-in rebate) that is offered to replacement customers. Although a high exchange discount may induce more customers to engage in the program and therefore increase the sales of new products, it may harm profitability by the so-called "demand dilution" effect. That is, a portion of customers who have intended to buy a new product may turn to exchange their on-hand old product for a new one at a discounted price. As a result, the firm may lose money from this specific transaction. A second key factor relates to how the firm generates additional revenue from the returned old items. Given the old items being perfectly usable, they can be remanufactured and sold to a secondary market in less developed countries/regions (like Apple's iPhone). Or, they can be manufactured into a totally different product; for example, a U.S. startup, Xavage Technologies, has created a phone-housing-plus-app combo (i.e., Xentry) that turns an old iPhone or Galaxy S Fascinate into a door-mounted caller-display (for more information, visit *xavagetech.com*).

Therefore, considering the choice behavior of customers and the revenues from the exchange sales and the secondary market, is an EON program always profitable? If so, how should a firm make the trade-off between the sales volume and unit revenue, and balance the revenue from selling new and returned old products, so as to maximize the profitability from the EON program? In particular, what is the impact of an EON program on other firms involved in the supply chain? Moreover, is it possible to motivate the supply chain members to act in a coordinated way so that the maximal profit potential from EON programs can be realized? In this paper, we seek to provide answers to the above questions and investigate the problem of how an EON program should be implemented in a more efficient way.

Specifically, we study a stylized supply chain that consists of one manufacturer and one retailer facing an uncertain demand. This is a common setting in the supply chain optimization and coordination literature (Cachon, 2003; Chen, 2003). The upper-stream firm sells a new generation of product through a wholesale price contract with the down-stream firm. Given that the market is becoming increasingly mature, they are considering expanding the market by adopting some form of EON program. Note that both supply chain members have incentive to adopt an EON program. Depending on the program-initiator, we consider two variants of decentralized business models in this paper: (i) in the manufacturer-initiated scenario, the manufacturer launches an EON program and owns all the old items that are returned; he remanufactures all (or a portion) of the old items and sells them to a secondary market. We consider the setting in which the collecting of old items is conducted by the retailer because the manufacturer does not have direct access to the market. (ii) In the retailer-initiated scenario, any old items that are returned are the property of the retailer; she remanufactures and sells them to the secondary market. As we will show, each supply chain member may benefit from the EON program offered by the other member. Therefore, the retailer and the manufacturer will act as a "free-rider" in the two business models, respectively. Starting from the choice behavior of customers, we will study the optimal decisions for the supply chain members under the two business models, and then provide an in-depth comparison between them. Based on a centralized supply chain as a benchmark, we will propose to adopt a collaborative EON model to coordinate the supply chain. Numerical experiments will be conducted to show the profit impact by adopting different forms of EON programs.

Our major findings include the following. (1) The comparison between the two decentralized business models shows that the supply chain member (i.e., the manufacturer or the retailer) will offer a higher exchange discount if his/her takes a higher profit margin in selling new product (Proposition 1). Consequently, the optimal exchange discount in each decentralized scenario is lower than that of the centralized system (Proposition 3). (2) Each supply chain member may prefer to wait for the other firm to launch an EON program, instead of initiating the program by himself/herself, for example, when the new product is associated with a high selling price. (3) If the manufacturer and the retailer agree to adjust their wholesale price according to a pre-specified formula [i.e., Eq. (28)], an exchange-discount-sharing contract, which is incentive compatible, can be adopted to coordinate the supply chain. In particular, the coordinated contract may help improve the welfare of customers as compared to the decentralized system. The numerical experiments show that coordination between the supply chain members could improve their overall profit rather significantly, especially when the substitution level is high, when the size of existing customer is medium, and/or when the size of the secondary market is relatively large. We hope that our research provides useful insights for firms that are considering managing demand of durable goods by choosing the right EON program.

To model the demand for durable goods has been extensively studied in the marketing literature. For example, Cripps and Meyer (1994) examine the process by which individuals make recurrent decisions about when to replace durable goods. Melnikov (2000) provide a theoretical and empirical description of consumer behavior in a dynamic market for differentiated durable goods. Gowrisankaran and Rysman (2009) specify a dynamic model of consumer preferences for new durable goods with persistently heterogeneous consumer tastes, rational expectations, and repeat purchases over time. For a more detailed overview of the representative models that study consumers' micro replacement decisions,

[1] For more detailed information regarding their trade-in policies, please visit their respective websites.

[2] For more details about JD's EON program, please visit http://jmall.jd.com/p192319.html.

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