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# Consumer returns in a decentralized supply chain

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ABSTRACT

Consumer returns tend to be ignored when managers make ordering and pricing decisions. How does accounting for this growing factor affect ordering quantities, profits and supply chain coordination? We model and analyze both a wholesale-price contract and a buy-back contract between a manufacturer and retailer facing stochastic demand and an exogenously given retail price. The results of extensive computational testing are counterintuitive: (1) higher profits and better coordination are achieved when buyer and vendor acting in a decentralized fashion do not consider any information about consumer returns; (2) retailer, manufacturer and supply chain profits increase as the retailer faces a larger share of the total logistics costs associated with consumer returns.



## 1. Introduction

In an effort to attract buyers in a highly competitive marketplace, consumer return policies have been drastically relaxed in the last decade. Most mass merchandisers offer full refunds within 15–90 days of purchase; no questions asked. As a result, return rates from consumers to manufacturers or retailers are high, often in the range of 6–11% for mass merchandisers (Gentry, 1999). For electronic retailers, they are reported to be between 11% and 20% (Lawton, 2008); for mail order companies and e-tailers, they can be as high as 35% (Gentry, 1999). Mostard and Teunter (2006) study the case of a mail order company where the return rates are generally around 35–40% and can be as high as 75%. Interestingly, experimental research on remote purchases shows that more lenient return policies lead to higher quality perceptions, even after physical evaluation of the product, and a reduction in the consumer's search for competing alternatives and the deliberation time in both the order and keep-or-return decisions, without a significant increase in the volume of returns (Wood, 2001).

Retailers expected to receive almost $220 billion in returns in 2008, the largest amount in record (Joseph Larocca, National Retail Federation, NPR's Marketplace 11/13/08). Previous reports show that the value of products returned in the United States exceeds $100 billion per year (Stock et al., 2002). Just in the electronics industry, around $13.8 billion was spent in 2007 to repackage, re-stock and re-sell returned products (Lawton, 2008). Processing returns is estimated to cost 2–3 times more than their outbound shipment, and to amount to $30–$35 per return for items purchased on the internet (Stock et al., 2006). Managing consumer returns effectively thus becomes essential to business profits. This is one of the goals of the growing field of Reverse Logistics (Rogers and Tibben-Lembke, 1999; see Fleischmann et al., 1997 and Dekker et al., 2004, for reviews of quantitative research on Reverse Logistics). In practice, however, consumer returns are often handled on an ad hoc basis (Stock et al., 2006), or by third party logistics providers (Hindo, 2007) since the operations involved suppose a major departure from the core manufacturing and forward logistics activities of the firms. As a result, they are typically not included in the forward supply chain planning activities.

In retail industries, a returned item is handled differently depending on the type and condition of the product, and the relationship between the retailer and the manufacturer/vendor. If the item is in good condition, with no apparent damage, it will often go back to the shelf. However, if the manufacturer desires to keep strict quality control and high standards, the item will not return to the retail shelf until the manufacturer inspects the product. This may be a necessary step for products with high risk of liability, such as welding equipment; HP and Bosch follow this policy (Ferguson et al., 2006). In general, the returned product may follow different paths depending on multiple factors, such as shipping cost, risk of obsolescence, profit margins, etc. A determinant factor is which player has more power along the supply chain. Large retailers normally transfer part or even all of the costs associated with the returned item to the manufacturer/vendor. In some cases, the item physically returns back to the manufacturer, who incurs most of the logistics costs associated with the return. In other cases, the item is not physically returned to the manufacturer; instead, the following two practices are commonplace: (1) the retailer decides what to do with the returned

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product and reports the cost incurred to the manufacturer, (2) the manufacturer gives the retailer a certain amount of return allowance credit and guidelines to properly dispose of the product (Corbett and Savaskan, 2001). According to our conversations with industry analysts, most vendors in the retail sector are willing to offer between 2% and 5% of the annual sales to the retailer as damage compensation in order not to lose good will. For this case where the retailer is fully in charge of the disposition of the returned product, Ruiz-Benitez and Muriel (2010b) model a return allowance credit[1] contract and find that the supplier is better off offering a discounted wholesale price on the entire order quantity rather than a credit allowance proportional to the units sold. In the current paper, we focus on the vendor–buyer relationship in the former case, where returns go back to the manufacturer for repair, quality inspection, or simply for resale to liquidators and outlet stores (which typically purchase the product at only 10–20% of their original value). As a result, vendor and buyer share the costs associated with returns.

We consider a two-echelon supply chain with a single manufacturer and a single retailer that faces stochastic demand and a certain percentage of consumer returns of a single product in a single period. The manufacturer sets a wholesale price for the product and may also set a buy-back price at which she will buy the product left at the retailer at the end of the selling season. We will refer to the return of unsold product from retailer to manufacturer at the end of the season as buy-back to avoid confusion with the central issue of consumer returns, which make their way back to the manufacturer via the retailer throughout the season. The retailer determines the order quantity at the start of the season, having no additional replenishment opportunity. Consumers return a fraction of the sold units to the retailer, who in turn sends them back to the manufacturer. These consumer returns do not make their way back to the supply stream during the sales period under consideration; they may be sold in an e-marketplace (as in Choi et al., 2004), and/or to off-price retailers or offshore buyers that reach a different market segment. Logistics costs related to consumer returns are incurred at both the retailer and manufacturer sites. Typically, a small percentage of this cost, corresponding to the handling of such returns, is incurred by the retailer. Meanwhile, the manufacturer faces the larger share of the cost, including transportation, inspection and remanufacturing or disposal of the product.

Our objective is to assess the impact that consumer returns have on the wholesale price, the order quantity, and the coordination of the decentralized supply chain[2]; that is, does supply chain coordination improve by considering the additional information of consumer returns occurring at the retailer? For that purpose, we compare two decision policies: one in which consumer returns are considered prior to the calculation of the optimal decision variables, and a second one in which those consumer returns are ignored in the planning process but later observed with the corresponding impact on profits. This latter situation is common in practice as described by the study done by Bernon and Cullen (2007) on the management of product returns by UK high street retailers. As one can expect, the lower expected profit margin per unit and higher costs associated with consumer returns lead to lower ordering quantities. Regarding the coordination of the supply chain, however, the results obtained are counterintuitive: In general, higher profits and better coordination can be achieved when the players acting in a decentralized fashion do not consider any information about consumer returns as they make their pricing and ordering decisions. In extensive computational testing, this result holds true throughout, except in cases where profit margins are very low—close to the break even point.

The principal contributions of this paper are: (1) determining how consumer returns impact the decision making process of the retailer and the manufacturer, and the resulting order quantities and transfer prices; (2) showing that the consideration of consumer returns information in the decision making process under a wholesale contract is in most cases detrimental to the coordination of the decentralized supply chain, and to both manufacturer and retailer, and identifying the conditions under which this happens; (3) finding that, under a wholesale contract which considers returns, the supply chain tends to be better coordinated when the retailer bears the major share of the logistics cost associated with consumer returns [although the manufacturer indirectly ends up paying for it by offering a lower transfer price]; and (4) proving that buy-back contracts fully coordinate the supply chain when consumer returns are present and properly considered in the decision making process.

The remainder of the paper is organized as follows. In Section 2, we review the existent literature and put our work in perspective. Section 3 introduces the model and assumptions. In Section 4, we analyze the centralized system where the supply chain is operated by a central planner and thus fully coordinated. When vendor and buyer act independently to maximize their own profits, we investigate the effect that consumer returns have on the coordination of the supply chain, first under no incentive schemes, analytically in Section 5 and computationally in Section 7.1, and then through buy-back contracts, analytically in Section 6 and computationally in Section 7.2. An extensive computational study, summarized in Section 7 and detailed in the Appendix, includes sensitivity analysis with respect to the coefficient of variation of demand, the profit margins, the rate of consumer returns and the associated logistics costs, and shows the robustness of our results. Finally, Section 8 summarizes our findings and points out future research directions.

Along this paper, we will adopt the convention, as in Cachon (2003), that the upstream firm, in this case the manufacturer, is female and the accepting firm, in this case the retailer, is male. The proofs of analytical results are detailed in the Appendix, as well as a full description of the computational study and results.

## 2. Literature review

Supply chains require the collaboration of independent players who seek to maximize their own profits. The presence of returns adds one more dimension to the relation between vendor and buyer and underscores the need for coordination. Some incentives to coordinate,[3] or at least improve, the supply chain can be offered through contracts. Supply chain contracts have become a growing field of study, in which special attention has been paid to whether or not the contract can coordinate the system. Extensive reviews on supply chain contracts and coordination literature can be found in Lariviere (1999), Tsay et al. (1999) and Cachon (2003). Furthermore, Corbett and Savaskan (2001) review the state-of-the-art in supply chain contracts and coordination, and examine how the lessons learned change in the presence of a reverse supply chain.

Buy-back contracts as a tool to achieve supply chain coordination have been studied by several authors. The seminal work of Pasternack (1985) shows that neither a policy that does not allow for buy-backs nor one that allows for unlimited buy-back at full credit could be optimal. It also demonstrates that a policy that

[1] Similar to a sales rebate, see Taylor (2002) and Wong et al. (2009).

[2] Because of misaligned objectives of the different parties in the supply chain, the total chain profit is typically lower than that in a vertically integrated setting, resulting in what we refer to as the coordination gap.

[3] We say that supply chain coordination is achieved when the total profit of the supply chain is equal to that in a vertically integrated setting.

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