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# Joint Pricing of New and Refurbished Items: A Comparison of Closed-Loop Supply Chain

## Models

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## Abstract

This study aims to provide a clear understanding of the interaction between forward and reverse processes in a closed-loop supply chain based on a comprehensive model, which determines the sales prices of new and refurbished items, incorporating the channel conflict issues between the first and second markets. A three-echelon supply chain consisting of a manufacturer, a seller, and a refurbisher is examined. Then, we introduce five models with different supply chain structures considering possible combinations of processes. The comparison among five models reveals that the supply chain structure can differentiate not only the sales prices of new and refurbished items but also the overall performances. Specifically, the manufacturer's integration of the selling process induces the lowest sales price of a new item, and the sales price of a refurbished item is highest when a third-party refurbisher handles the refurbished item. The first-market sales are maximized when the manufacturer directly sells the new item, while second-market sales are maximized when the seller deals with both new and refurbished items. The combination of supply chain processes also plays an important role in enhancing the profit of each supply chain player and overall supply chain.

**Keywords:** closed-loop supply chain; return; refurbishment; pricing; supply chain structure

## 1. Introduction

Sales returns have become a common consideration of the modern businesses. Given the increasing volume of product returns over the last decade, firms are giving great attention to strategic management of product returns (Petersen and Kumar, 2009; Douthit, 2012; Krikke et al., 2013). One such concern is disposition of returned items, for which there are various options,

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