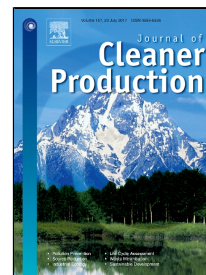


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## Two-stage Remanufacturing Decision Makings Considering Product Life Cycle and Consumer Perception

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### Abstract

Remanufacturing is widely considered a solution to environmental pollution and resource shortage but its progression is influenced by Original Equipment Manufacturers (OEMs), remanufacturers, consumers and public policy makers. This research studies the optimal price and production quantity of new and remanufactured products with a two-stage model under both scenarios under which the remanufacturing is conducted by the OEM or by the third-party remanufacturer (TPR). A non-cooperative game model is used at the second stage when the TPR conducts remanufacturing. The models consider both the impact of the product life cycle through the market growth factor at the second stage and the influence of consumers' perceived value of new and remanufactured products, which depends on the identity of the remanufacturer. Both theoretical and numerical analyses show that both the life cycle phase and consumers' perception have an impact on the OEM's decision whether to allow the TPR in the remanufacturing business. The results also reveal that the market may not be efficient for maximizing the environmental sustainability and societal equity. Governments may need to interfere with the market in order to promote the TPR manufacturing, especially when the product is at the mature or declining phases of its life cycle.

**Key Words:** Remanufacturing, Consumer Perception, Product Life Cycle, Third-Party Remanufacturing, Pricing

### 1. Introduction and Literature Review

As a solution to environmental pollution and resource shortage, remanufacturing has recently attracted a lot of attention from governments, enterprises, and consumers. Remanufacturing is the process of replacing, repairing or reprocessing parts of a used product to bring it to like-new condition. Through the reuse of parts and materials, remanufacturing can save a company 40%–65% in manufacturing costs (Ginsburg, 2001), reduce the waste, and therefore significantly realize environmental benefits and support low carbon economy. During the life cycles of personal computers and mobile phones, remanufacturing is considered a very

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