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Competition and Compliance in circular supply chain: A game theoretic model of OEMs, Remanufacturers and Regulators

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Abstract

Remanufacturing is a process of restoring used products to the same condition as new products. It has become a important practice in advancing circular economy by retrieving the remaining useful value and reducing material and energy consumption. The strategic significance of remanufacturing is increasing as firms and regulators strive to balance environmental performance with economic competitiveness. This study develops an exhaustive game-theoretic framework to analyze the strategic interactions among OEM, an independent remanufacturer, and a regulator within the context of Extended Producer Responsibility (EPR). Based on the literature on durable goods and remanufacturing markets, we model a three-stage game in which the Regulator, acting as Stackelberg leader, sets policy instruments, including collection targets, recycling standards, and potential credit mechanisms. The OEM and the remanufacturer then engage in simultaneous competition. Consumer heterogeneity and durability considerations yield a system of linear inverse demands that affect both the primary and secondary market prices. The equilibrium characterization signifies the threshold conditions on remanufacturing costs that governs full, partial or no remanufacturing choices. By considering both remanufacturing strategy and regulatory design, this study contributes to the theoretical understanding of the producer-remanufacturer competition under environmental policy and offers guidelines for implementing EPR schemes that align remanufacturing incentives with environmental objectives.

Keywords
Remanufacturing, Stackelberg Model, Extended Producer Responsibility, Durable Goods.

Biography
Kaustov Chakraborty is an Assistant Professor at the Indian Institute of Management Sambalpur, India. He has 8 years of teaching experience in the operations and supply chain domain. He earned his PhD from the Department of Management Studies, IIT (ISM) Dhanbad in Operations and Supply Chain Management and M. Tech in Industrial Engineering and Management from West Bengal University of Technology. He is deeply passionate about research and believes in interdisciplinary research collaborations. His teaching interests include Supply Chain Modelling, Operations Management, Warehouse Management, Sustainable Operations and Operations Research. He has published papers in various peer-reviewed journals including Annals of Operations Research, International Journal of Production Research, Journal of Business and Industrial Marketing, Enterprise Information System, Journal of Cleaner Production, Benchmarking: An international journal, and International Journal of Logistics and System Management. He has presented research papers in various prestigious international conferences, including POMS, EUROMA, EURO. Apart from his research interest, he also serves as an ad-hoc reviewer of many peer-reviewed journals, including CIE, JBIM, JCLP, ANOR, and many more.