

## **Dynamics of Closed Loop Supply Chains**

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### **Abstract**

We investigate the dynamics of a closed loop supply chain (CLSC) consisting of a manufacturer and a remanufacturer. The market demands and the product returns are stochastic and are correlated with each other. The used products are converted into “as-good-as-new” products and used, together with new products, to satisfy the market demand. The remanufacturing process takes time and is subject to a random yield. Remanufactured products are pushed into the manufacturer’s inventory. It is assumed that the manufacturer exploits the order-up-to policy to determine its brand-new production quantity. We compute the benefit of the manufacturer obtaining advance notice of the product return quantities from the remanufacturer and demonstrate that the lead times, random yields and parameters describing the returns play a significant role. The interesting and counter-intuitive result is that increasing the lead time at the remanufacturer can increase the benefit. It is also shown that Bullwhip is generated even if both the demand and the return processes are a white noise process. Analytical results suggest that there is a fundamental underlying trade-off in a CLSC, which could be a barrier against the spread of CLSC.

### **Keywords**

Closed loop supply chain, order-up-to policy, advance notice, lead time, random yield

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### **Biography**

**Takamichi Hosoda** is a Professor of Operations Management in Graduate School of International Management at Aoyama Gakuin University, Tokyo, Japan. He earned Msc from Massachusetts Institute of Technology and PhD from Cardiff University. He has more than 10 years of supply chain consultant experience. His research interests include: supply chain management, inventory management and newsvendor models.

**Stephen M. Disney** is a Professor of Operations Management and Head of the Logistics and Operations Management Section of Cardiff Business School, Cardiff University where he lectures Operations Management and Supply Chain Modeling. Professor Disney’s current research interests involve the application of control theory and statistical techniques to operations management and supply chain scenarios in order to investigate their dynamic and

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