**Single period inventory system with shelf space dependent demand: Implications on Inventory Policy and design of coordination mechanisms**


## Abstract

It has been well recognized by practitioners and academicians alike that shelf space is retailer's costliest and limited resource. In modern times, initiatives like Continuous Replenishment Program (CRP), Vendor Managed Inventory(VMI) and frequent real time replenishment results in very little or no back room inventory, which tightly couples the shelf space with inventory and ordering decisions. Also, with tremendous growth of retail industry in recent years and retailer's power to influence demand by creating visibility for the products by increasing shelf space for the product or through store specific promotions, the need for effective mechanisms for shelf space and inventory management has also increased. Literature in marketing, retailing and operations has long since recognized the demand stimulating impact of inventory on shelves. Operations management literature incorporates shelf space dependent demand in both Inventory models as well as in supply chain coordination. However, except for two papers by Gerchak and Wang (1994) and Balakrishnan et al. (2008), almost all the literature considers the shelf space dependent demand to be deterministic. As a result, the impact of demand uncertainty on inventory policy and design of supply chain coordinating mechanisms is not well understood. In this dissertation, we address this gap in inventory and supply chain coordination literature and consider a single period inventory system with stochastic and shelf space dependent demand with shortage penalty and analyze the impact of shelf space dependent demand on inventory policy as well as on design of coordination mechanisms. We consider a multiplicative demand model popular in the literature. The model consists of two terms: a base random variable with a known probability distribution and a deterministic function of initial inventory. In the first part of the dissertation, we develop an inventory model for this system and derive structural results complemented by computational studies to understand the inventory policy. We show that the optimal ordering quantity in this type of supply chain depends on both the distribution of the random demand as well as the functional form of the deterministic part of the demand. We also show that ignoring influence of shelf inventory on demand results in significant loss of profits. In second part of the dissertation, we study the implications of inventory's influence on demand for design of coordination mechanisms. In this part, we consider a supply-chain with one manufacturer selling a single product to a single retailer when the retailer faces a single period inventory system with stochastic and shelf space dependent demand with shortage penalty. We assume that both players are risk neutral and there is complete information symmetry in the system.

We explore four contracts for this system: The wholesale price contract, buy-back contract, revenue sharing contract and holding cost subsidy contract. We present structural results for supply chain coordinating contract parameters for these contracts complemented with results of computational studies. We show that multiple contracts can be used to coordinate this supply chain with arbitrary division of profits between the players and also that for this type of supply chain, the contract structure remains the same as that for the simple news-vendor supply chain but the supply chain coordinating contract parameters are dependent on the distribution of the random part of the demand as well as the functional form of the deterministic part of the demand.