ABSTRACT

Increasing competition and globalization has led to increase in product varieties as well as uncertainties associated with product demand. Capacity planning under uncertainty assumes complexity as one has to deal with the trade-off between the cost of investment in excess capacity and the opportunity loss for not meeting the demand due to capacity constraint. Under price postponement or production postponement strategy, the capacity decisions have to be taken before the actual demand is known. The manufacturer is allowed to decide on price or production level after the demand is realized. Under production postponement, the possibility of producing more than the demand does not arise. Similarly by price postponement, the firm can have control on the demanded quantity by adjusting the price. While postponement strategies in general allow the manufacturer to avoid or hedge against demand uncertainty, another important dynamics that comes into play in the context of production postponement is the economies of Dedicated versus Product Flexible plant. This dissertation explores the following three major issues and provides managerial insights in the context of strategic capacity planning problem: (a) benefits of production and price postponement, (b) economies of flexible versus dedicated plant and (c) benefits of limited product flexibility.

Capacity planning problems have been modeled by many researchers as a single period two-stage stochastic program. These studies have considered various postponement strategies as well as flexibility and have addressed issues on characterization of optimal strategy and establishment of dominant conditions. While these studies have contributed significantly to the current literature in capacity planning, the major limitation has been their inability to come out with solutions for optimal capacity level in different scenarios of capacity planning problems. In this dissertation an effort has been made to fill up this gap. Single period stochastic programming models have been developed by initially considering different postponement strategies under multivariate normal distribution in demand, and Simulated Data Based Optimization procedure has been applied for solution. Flexibility has been incorporated in the above framework and the resulting models have been solved under various conditions. Finally the above has been extended to a two-period model with a view to devise strategies to respond to seasonality in demand.

In the first part of this dissertation, classical Newsboy framework has been extended to incorporate price postponement and product flexibility besides production postponement in the context of capacity planning. While Meighem and Dada (1999) and other studies have developed similar models, the contributions of this dissertation include (a) incorporating correlation between the product demand explicitly in the models, (b) understanding the effect of different postponement strategies on substitute/ complementary products, (c) providing a surrogate measure of flexibility, and (d) obtaining the value of information with a view to help in deciding on the choice among various strategies. Some important findings include, (a) flexibility has no benefit if there

is no production postponement, and (b) price postponement acts as a better hedge against uncertainty compared to production postponement.

In the next part of this dissertation the concept of Limited Flexibility has been addressed, which may be seen as a generalization of the work done by Jordan and Graves (1995). Unlike the abovementioned study, a comparative analysis among Dedicated, Limited and Total Flexibility has been undertaken in this dissertation by considering capacities of the plants as decision variables. The model has also been extended with a view to obtain optimal product-plant combination under capacity decision. The resulting non linear mixed binary programming model has been transformed into a linear form. In the final part of this dissertation, the single period models have been extended to capture two-period dynamics, in terms of inventory and backordering decision. It has been shown that, (a) in a two-period setting, flexible plant may generate more profit compared to dedicated plant, even with no postponement strategy, and (b) if the price is low and backorder cost is high, the commitment to backorder may reduce manufacturer's profit.

This dissertation has been carried out to study the effects of various postponement and flexibility strategies on capacity planning under demand uncertainty. Stochastic programming models for the strategies have been developed and solved, which helps to contribute to several managerial insights for strategic capacity planning in general. It may be expected that both academia and industry would benefit from this study.