

# Optimal production planning with capacity reservation and convex capacity costs

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## ABSTRACT

In this paper, we develop an analytical model for a multi-period production planning problem with dual supply sources of production capacity, where the supply price of one source (i.e., the spot market) is random and the supply capacity of the other source (i.e., the contract supplier) is limited. The purchasing cost of reserved capacity is assumed to be a convex function, rather than a linear function. We solve this problem by first characterizing the structure of the optimal production policy by employing a stochastic dynamic programming approach, and then determining the optimal capacity reservation level by applying a single-variable optimization method. For any given level of capacity reservation, the optimal periodic production policy is a quantity-dependent base stock policy with a threshold of production quantity that increases with the spot price. With this structure of the optimal production policy, the expected total discounted cost function is shown to be convex in the capacity reservation level. These results are also extended to the infinite-horizon case. A numerical study is conducted to examine the impacts of spot market characteristics on the optimal capacity reservation level and the corresponding optimal total cost.

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