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Theory and Methodology

On the stability region for multi-level inventory problems *

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Abstract: This paper focuses on analysing the multi-stage assembly system with cost function, which is widely used in the literature. We shall point out that the set of cost inputs having the same optimal production plan is a convex cone. In addition, the structure of an optimal solution is analysed to reveal the stability region.

Keywords: Production planning

1. Introduction

The dynamic lot-size model is one of the best known standard models in OR/MS, and the procedures for solving the problem have received considerable attention in the literature. In addition to the optimal dynamic programming and branch-and-bound algorithms, numerous heuristics have also been developed for both single- and multi-level problems. However, relatively little effort has been made to investigate the stability of a schedule. The stability region of a schedule means the set of cost inputs having the same production plan for a given demand series.

This question is of interest for both theory and practice. It would be useful for the practitioner to know the range of cost parameters over which the optimal production is not altered. Characterizing the shape of the stability region is the theoretical question of interest.

The single-level lot-sizing stability problem was analysed by Richter (1987). Using constant set-up and holding costs and the assumption that the cost inputs belonging to the stability region have the same production plan for every problem with period t, $t = 1, 2, \ldots, T$, where T is the length of the planning horizon, he gave the explicit form of the stability region. He also pointed out that the stability region is a convex cone. Omitting the need of these strong assumptions, we show that this convex cone property can be extended to more general multi-level problems with certain cost functions. Analysing the structure of an optimal schedule, we also show that this production plan can be expressed by a regeneration matrix. The advantage of this production-quantity-independent plan definition is that this could open the way to a discussion on the impact of the changes in demand.

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