Comments on Two Models for Operating Two-Warehouse Inventory Systems with Deteriorating Items and Inflationary Effects

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ABSTRACT

This paper deals with the two-warehouse partial backlogging inventory problems under inflation for a deteriorating product with a constant demand rate over an infinite horizon. In contrast to the traditional model in which each replenishment cycle starts with an instant replenishment and ends with shortages, an alternative model is proposed in recent literature in which each cycle starts with shortages. It is proven to be less expensive to operate than the traditional model in terms of the present value of the cost per unit time. The present paper points out that the criteria of minimizing the cost per unit time is unreasonable when the inflationary effect is taken into consideration, and instead, the criteria of minimizing the present value of the total cost over the whole infinite planning horizon should be used. The objective functions of these two models are changed and proved that the model with shortages at the start of the cycle is less expensive to operate than the traditional model in terms of the present value of the total cost, but the optimal solutions of the models minimizing the cost per unit time indicate significantly higher total costs.

Keywords: Deterioration, Inflation, Inventory, Partial Backlogging, Two-Warehouse

INTRODUCTION

The inventory problem for deteriorating items with deterministic demand rates has been studied extensively in the literature. Nahmias (1982), and Goyal and Giri (2001) provided excellent reviews for research works in this field before 1980s and 2000s respectively. The problem attracts growing interests from researchers thereafter (Dye et al., 2007a & 2007b; Shah et al., 2009; Teng et al., 2002). In contrast to the studies that assume an organization owns only
a single warehouse with unlimited capacity, the last decade sees an explosive number of studies focusing on two warehouses, i.e., an owned warehouse (OW) with limited capacity and a rented warehouse (RW) which is assumed to be available with abundant capacity. An early discussion on the effect of two warehouses can be traced back to Hartely (1976), and recently the two-warehouse inventory models have been considered by many other researchers (Chung et al., 2009; Dey et al., 2007b, 2008; Gayen & Pal, 2009; Hsieh et al., 2008; Lee & Hsu, 2009; Niu & Xie, 2008; Rong et al., 2008; Wee et al., 2005; Yang, 2004, 2006; Zhou, 2003; Zhou & Yang, 2005).

In traditional inventory models, it is generally assumed that each replenishment cycle starts with an instant replenishment and ends with shortages. In a recent paper, Yang (2004) considered the two-warehouse inventory problem for deteriorating items with shortages under inflation, and proposed an alternative model in which each cycle begins with shortages and ends without shortages. Under some assumptions, he proved that the model with shortages at the start of the cycle is less expensive to operate than the traditional models under the objective of minimizing the cost per unit time. More recently, Yang (2006) extended the completely backlogging model to incorporate partial backlogging.

Among all literature on inventory management, the models provided by Yang (2004, 2006) are the only models where each cycle begins with shortages and ends without shortages. These models are unique in literature and the practical managers might have a special interest in them if they are really less expensive to operate than traditional models. However, careful examinations of these models reveal that there are some serious shortcomings in the objective functions used in these models. First, the objective function to be minimized in these models is the present value of the cost per unit time. When the inflationary effect is taken into consideration and the planning horizon is infinite, the objective function to be minimized should be the present value of the total cost over the whole planning horizon (Dye et al., 2007a; Hsieh et al., 2008; Kim & Philippatos, 1986). Second, these models ignore the purchasing cost in the objective function, just as the models without the inflationary effect usually do since the purchasing cost is a constant. But when the inflationary effect exists and the shortages are partially or completely backlogged, the total purchasing cost is not a constant and thus should be taken into consideration explicitly (Teng et al., 2002; Wee et al., 2005). Finally, the present value of opportunity cost due to lost sales is evaluated at the time when the next replenishment occurs in Yang (2004, 2006). However, when the inflationary effect is considered, this cost should be evaluated just at the time when the actual lost sales occur. Owing to these shortcomings, these models and the resulting optimal replenishment cycles derived from them are suspicious. In fact, the optimal replenishment schedule obtained in Theorem 1 of the paper by Yang (2006) is only a local minimum solution, and the global minimum solution does not exist for the models (the present value of the cost per unit time converges to zero when the replenishment cycle goes to infinity). In order to avoid misleading the practical managers, it is important to correct these models and conduct a fair comparison of these models with the traditional models.

In this paper, we reformulate and compare the two models in Yang (2006) under the objective of minimizing the present value of the total cost over the whole planning horizon. In the next two sections, the above-mentioned shortcomings in Yang (2006) will be discussed in details, and the modified models with the objective of minimizing the present value of the total cost over the whole planning horizon will be developed to overcome these shortcomings. Then we characterize the optimal solutions for the modified models, and draw a conclusion that the model with shortages at the start of the cycle
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