ELSEVIER
European Journal of Operational Research 125 (2000) 588–601
EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
www.elsevier.com/locate/dsw

Theory and Methodology

The effects of inflation and time-value of money on an economic order quantity model with a random product life cycle

Ilkyeong Moon *, Suyeon Lee

Department of Industrial Engineering, Pusan National University, Pusan 609-735, South Korea

Received 1 November 1997; accepted 1 February 1999

Abstract

For several decades, the Economic Order Quantity (EOQ) model and its variations have received much attention from researchers. Recently, there has been an investigation into an EOQ model incorporating a random product life cycle and the concept of time-value of money. This paper extends the previous research in several areas. First, we investigate the impact of inflation on the choice of replenishment quantities. Second, the unit cost, which has been inadvertently omitted in the previous research, is included in the objective function to properly model the problem. Third, we consider the normal distribution as a product life cycle in addition to the exponential distribution. Fourth, we develop a simulation model which can be used for any probability distribution. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Inventory; Inflation; Time-value of money

1. Introduction

The Economic Order Quantity (EOQ) model initiated by Harris [13] has been extended many ways to improve the practicality of the model. See, for example, [3,4], etc. One of the important extensions is to properly recognize the time-value of money in determining the optimal order quantity. Trippi and Lewin [21] have adopted the Discounted Cash-Flows (DCF) approach for the analysis of the basic EOQ model. Kim et al. [14] extend Trippi and Lewin's work by applying the DCF approach to various inventory systems. Chung [5] has studied the DCF approach for the analysis of the basic EOQ model in the presence of the trade credit. Recently, Haneveld and Teunter [11] apply the DCF approach to the basic EOQ model with a Poisson demand process.

* Corresponding author. Tel.: +82-51-510-2451; fax: +82-51-512-7603.
E-mail address: ikmoon@hyowon.cc.pusan.ac.kr (I. Moon).

PII: S 0 3 7 7 - 2 2 1 7 (9 9) 0 0 2 7 0 - 2

Gurnani [9] has applied the DCF approach to the finite planning horizon EOQ model in which the planning horizon is a given constant. Gurnani [10] has claimed that an infinite planning horizon does not exist in real life, and a finite horizon inventory model (accounting for the time-value of money) is theoretically superior and of greater practical utility. Chung and Kim [7] prove that Gurnani's [9] model is essentially identical to an infinite planning horizon model since the planning horizon is assumed to be a given constant. As pointed out by Gurnani [9], an infinite planning horizon occurs rarely because costs are likely to vary disproportionately and product specifications and design are prone to change, abandonment or substitution by another product due to rapid technological development. This phenomenon can be observed frequently in high-technology product markets. Chung and Kim [7] have also suggested that the assumption of an infinite planning horizon is not realistic, and called for a new model which relaxes this assumption. Moon and Yun [16] answered this request by developing a finite planning horizon EOQ model where the planning horizon is a random variable following an exponential distribution. The unit cost, which does not affect the replenishment quantity (or cycle length) in the infinite planning horizon model, was not included in their model. However, the unit cost does affect the replenishment quantity in the finite planning horizon model, as will be demonstrated later.

One of the assumptions in most derivations of the inventory model has been a negligible level of inflation. Unfortunately, many countries have recently been confronted with fluctuating inflation rates that often have been far from negligible [20]. Silver et al. [20] investigate the impact of inflation on the choice of replenishment quantities in the basic EOQ model. There have been several studies which consider various inflationary situations. Bose et al. [2] have investigated an EOQ model for deteriorating items with linear time-dependent demand rate and shortages under inflation. Hariga and Ben-Daya [12] have developed time-varying lot-sizing models with linear trend in demand, taking into account the effects of inflation and time value of money.

The objectives of this study are fourfold. Firstly, we include the unit cost, which has been inadvertently omitted in [16], in the model to properly derive the optimal order quantity. Secondly, the impact of inflation on the choice of order quantities is investigated. Thirdly, we consider the normal distribution as a product life cycle in addition to the exponential distribution. Fourthly, a simulation model is developed to be used for any probability distribution.

In Section 2 we introduce the notation and mathematically formulate the problem. Analytical results for both exponential and normal distributions are developed. In Section 3, we perform some computational results to show the cost savings compared with the solution of Moon and Yun [16]. A simulation model which can be used for any probability distribution is presented in Section 4 to complement the analytical work. The paper concludes with Section 5 which includes some possible research problems.

2. Analytical modeling

The following notation will be used:

Q	the order quantity
T	the cycle length
p	the product life cycle (random variable)
$f(p)$	the probability density function of p
D	the demand rate per year
S	the ordering cost per order
c	the unit cost
h	the inventory carrying cost per unit per year ($\equiv ic$ where i is the inventory carrying charge rate)