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The impact of trade credit on optimal quantity

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Abstract

In this research, we consider the consequence of trade credit on optimal quantity. The annualized cost which is the uniform net present value over infinite time is derived and the optimal quantity and optimal time are obtained. This work is a modification of the model formulated by Chand and Ward (1987). The computation and graphical illustration based on the data collected from Lift Above Poverty Organisation (LAPO) show that the optimal quantity is time varying with a linear trend. This means that as the delay time increases the optimal quantity increases. It also implies that the optimal quantity is an increasing function of delay time.

Keywords: Consequence; Trade credit; Annualized cost; Optimal quantity; Net present value

1. Introduction

Trade credit is the purchasing of items without instantaneous payment due to offer of credit period. All future cash flows are estimated and discounted to give their present values (PVs). The net present value (NPV) is the sum of all future cash flows both incoming and outgoing. In the discounted cash flows (DCF) approach, the computation of the net present value (NPV) considers cash flows and discount rate as input and the price as output. The widely used method of discounting is the continuous discounting which values future cash flows based on what will be currently invested at a given rate of return to yield the cash flow in future. In continuous discounting, the discount factor $(1 + r)^{-t}$ becomes e^{-rt}. (See Section 2.1 for the proof.)

Chand and Ward [1] considered the effect of trade credit on inventory financing cost and concluded that trade credit reduces inventory financing cost. Chung [2] considered four cases under trade credit and obtained the present value PV(Q) of cash flows for the first cycle. Chung and Liao [3] considered the problem of determining the economic order quantity for exponentially deteriorating items under permissible delay determined the retailer's optimal price and order size simultaneously under the condition of order-size dependent delay in payments. They assumed that the length of the retailer's order size and the demand rate is a function of the selling price. Chung and Huang [4] discussed an economic order quantity system consisting of time-varying demand and deteriorating items with conditions of permissible delay in payment. It emphasizes that the demand is time varying with a linear trend, also items deteriorate

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at varying rate of deterioration and a delay in payment is permissible. Ozokeraha and Ekoko [5] worked on discounted cash flows for a deterministic inventory model. They concluded that the total inventory cost per unit time at different discounted rates is seasonal which means that certain discounted rates that could lead to high inventory cost can be easily detected and avoided. Ozokeraha and Ekoko [6] also considered one level trade credit with discounting and compared its present value with that of the basic EOQ model using LAPO as case study. The results obtained gave much insight for better performance of LAPO as regards knowing the quantity for which one model could be preferred to the other.

2. Methodology

2.1. Proof of $(1+r)^{-t} = e^{-rt}$

There is need to show that the discount factor $(1+r)^{-t} = e^{-rt}$.

Proof. Let

$$r = \frac{x}{t} \Rightarrow x = rt. \tag{1}$$

Now,

$$(1+r)^{-t} = \left(1+\frac{x}{t}\right)^{-t} = 1 + (-t)\left(\frac{x}{t}\right) + \frac{(-t)[-(t+1)]}{2!}\left(\frac{x}{t}\right)^2 + \frac{(-t)[-(t+1)][-(t+2)]}{3!}\left(\frac{x}{t}\right)^3 + \frac{(-t)[-(t+1)][-(t+2)][-(t+3)]}{4!}\left(\frac{x}{t}\right)^4 - \cdots. \tag{2}$$

Taking the limit of both sides we have that

$$\underset{t\to\infty}{Lt}(1+r)^{-t} = \underset{t\to\infty}{Lt}\left(1+\frac{x}{t}\right)^{-t} = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \frac{x^4}{4!} - \cdots = e^{-x}. \tag{3}$$

But $x = rt$.

Therefore,

$$e^{-x} = e^{-rt}. \tag{4}$$

This shows that $(1+r)^{-t} = e^{-rt}$.

2.2. Proposed algorithm

The following notations will be used in this subsection

Notations

K = Setup cost.
D = Demand rate.
H = Holding cost per item per unit time.
C = Purchasing cost.
r = Interest rate.
t = Delay time permitted in paying for the goods after the receipt by the retailer.
T = Cycle time.
Q^* = Optimal quantity.
T^* = Optimal time.
$NPV(T)$ = Net present value of all future costs.
$ANN(T)$ = Annualized cost.

Assumptions. (i) No backlogging or shortages are permitted.
(ii) The vendor permits some delay in payment for the goods after the receipt by the retailer.
(iii) Rate of return earned on funds equals the cost of funds.