A FRAMEWORK FOR UNDERSTANDING BRAND SWITCHING AND FORWARD BUYING BEHAVIORS IN A DUOPOLY MARKET

Yung Jae Lee, Graduate Business Programs, Saint Mary's College of California, PO Box 4230, Moraga, CA 94575, USA, 925 631 4610, ylee@stmarys-ca.edu

ABSTRACT

This paper proposes an analytical framework to evaluate the effect of implementing the Hi-Lo price policy for a manufacturer in a duopoly. In addition to retailer's stocking up behavior under the price dependent demand assumption, the framework also incorporates forward buying and brand switching behavior of consumers. Through extensive optimization simulation, we show that severe forward buying behavior of the consumers could lead to substantial decrease in both the retailer's and the manufacturer's profits due to demand decrease in subsequent periods. We also find that severe brand switching, with relatively low price sensitivity and a high retailer's holding costs, creates the most favorable situation for the manufacturer to adopt a Hi-Lo policy.

INTRODUCTION

An important reason for the manufacturer's adoption of the Hi-Lo policy is the intense price competition among the manufacturers. Although the manufacturers may not be sure about the short-term and long-term implications of such policy, they often are pressured to counteract the competition. Price competition among manufacturers brings about consumers' brand switching and forward buying behavior, important aspects of consumer reactions to price promotions reported in marketing literature (Gupta (1988) and Walters (1991)).

To provide a more accurate description of the sales dynamics observed in consumer non-durable market, this paper incorporates all three relevant consumer behaviors: price sensitivity, brand switching, and forward buying. We also include the retailer's stocking up behavior in our analysis. After presenting the framework with a retailer demand function that captures all three factors, we carry out extensive simulation study to fully understand the effect of the manufacturer initiated EDLPP and Hi-Lo policies.

THE FRAMEWORK

To simplify the analysis in understanding the implications of the short-term price competition among the manufacturers, we consider a duopoly situation with a common retailer. In this structure, the common retailer purchases from both of the manufacturers. The manufacturers determine their own pricing and production decisions given the retailer's purchasing behavior and the competitor's pricing schedule. To model the channel structure, we present two mathematical programming models for both the retailer and the manufacturer. The rationale for choosing the mathematical programming approach is because it may better represent the discrete nature of the decision situation with which the retailer and the manufacturers faced in making pricing, ordering, and production scheduling decisions. For example, the manufacturer may plan its production on weekly basis. The mathematical programming approach also allows the manufacturers and the retailer to choose the different price levels for different periods.

Before we present the optimization model for the retailer, we first discuss the retailer's demand function. Even though linear duopoly demand function (McGuire and Staelin (1983), Jeuland and Shugan (1988), and Choi (1991)) is popular because of its simplicity, it is expected that there is a certain degree of nonlinearity in demand for many real problem settings. In particular, the desired effect in common brand switching behavior for consumer non-durable product is a weak sales response for a relatively small price differential and a strong sales response for a large price differential where the price differential is defined as the excess of all other brands over brand i. As proposed by Simon (1979), we present the dynamic sales response model in the following form.

$$D_{i,t} = A_{i,t} + B_{i,t} + C_{i,t}, \tag{1}$$

where $A_{i,t}$ = absolute price effect term for brand *i* at time *t*,
$B_{i,t}$ = cross price elasticity effect for brand *i* at time *t*,
$C_{i,t}$ = forward buying effect for brand *i* at time *t*.

The term $A_{i,t}$ represents the relationship between sales quantity and the price level. We assume a linear relationship of the form

$$A_{i,t} = a + bp_{i,t} \tag{2}$$

where $p_{i,t}$ is the price of the brand *i* at time *t* and *a* represents the base demand and the parameter *b* satisfies the condition $b < 0$. The term $B_{i,t}$ represents the effect of the price differential between brand *i* and the other competing brands on sales of brand *i* at time *t*. To model this brand switching behavior, we propose the following model:

$$B_{i,t} = \delta \sinh(\gamma \Delta p_{i,t}), \tag{3}$$

where

$$\Delta p_{i,t} = \frac{\bar{p}_{i,t} - p_{i,t}}{\bar{p}_{i,t}}, \tag{4}$$

$$\bar{p}_{j,t} = \sum_{\substack{j=1 \\ j \neq i}}^{n} \frac{m_{j,t} p_{j,t}}{1 - m_{j,t}}, \tag{5}$$

$$\sinh(x) = \frac{e^{x} - e^{-x}}{2}. \tag{6}$$

The term $C_{i,t}$ represents forward buying effect. As observed in the market, many consumers purchase more than what they could consume during a short-term price promotion. This behavior leads to inventory buildup, resulting in lower sales in subsequent periods. If the consumers stocked up the certain product last week due to the heavy promotion, a new promotion on the same product or competing brand might not result in large demand increase this week. To model this behavior in a simplistic way, we assume

$$C_{i,t} = -e(D_{i,t-1} + D_{j,t-1}) \tag{7}$$

where *e* is the coefficient for forward buying effect for the competing brands. Combining (2), (3), and (7), the retailer demand function can be expressed as

$$D_{i,t} = a + bp_{i,t} + \delta \sinh(\gamma \Delta p_{i,t}) - e(D_{i,t-1} + D_{j,t-1}) . \quad (8)$$

The Retailer Model

Decision Variables:

$D_{i,t} =$ retailer's demand for brand *i* at time *t*;

$p_{i,t} =$ retailer's selling price for brand *i* at time *t*;

$q_{i,t} =$ retailer's purchase quantity for brand *i* at time *t*;

$I_{i,t} =$ retailer's inventory level for brand *i* at time *t*;

Parameters:

$c_i =$ regular purchasing cost for brand *i*;

$c_{i,t} =$ purchasing costs for brand *i* at time *t*;

$h =$ retailer's inventory holding costs, expressed as a percentage of the regular purchasing cost;

$IO_i =$ beginning inventory for brand *I*;

$ub =$ upper bound for selling price;

$a =$ constant for base demand;

$b =$ price sensitivity coefficient;

$c_1 =$ brand switching coefficient for magnitude;

$c_2 =$ brand switching coefficient for shape.

The retailer's optimization model can be formulated as the following nonlinear programming problem:

$$\textbf{MAX} \sum_i \sum_t [p_{i,t} D_{i,t} - c_{i,t} q_{i,t} - c_i h I_{i,t}] \quad (9)$$

subject to:

$$D_{i,t} = a + bp_{i,t} + \delta \sinh(\gamma \Delta p_{i,t}) - e(D_{i,t-1} + D_{j,t-1}) .$$

$$I_{i,t+1} = I_{i,t} - D_{i,t} + q_{i,t} \quad (10)$$

$$I_{i,0} = IO_i \quad (11)$$

$$0 \le p_{i,t} \le ub , \ D_{i,t} \ge 0 , \ q_{i,t} \ge 0 , \ I_{i,t} \ge 0 \qquad \forall_{i,t} \quad (12)$$

The Manufacturer Model

The manufacturer model can be formulated as the following linear programming problem and the notations for the manufacturer optimization model are:

Decision Variables:

$Q_t =$ production quantity at time *t*

$I_{m,t} =$ inventory level at time *t*

Parameters:

$\lambda_t =$ manufacturer's demand at time *t*

$\mu =$ unit time production capacity

$p_{m,t} =$ manufacturer's selling price at time *t*

c_m = unit production cost
h_m = manufacturer's inventory holding costs, expressed as a percentage of c_m
IO_m = initial inventory level

$$\textbf{MAX} \qquad \sum_t [\lambda_t p_{m,t} - c_m Q_t - c_m h_m I_{m,t}] \tag{13}$$

subject to:

$$I_{m,t} = I_{m,t-1} - \lambda_t + Q_t \tag{14}$$

$$I_0 = IO_m \tag{15}$$

$$0 \le Q_t \le \mu \,,\; I_{m,t} \ge 0 \qquad\qquad \forall_t \tag{16}$$

SUMMARY OF THE INSIGHTS

First of all, we have found that the Hi-Lo policy is optimal for a manufacturer only when (i) the competing manufacturer deploys a relatively large temporary price discount, (ii) the price sensitivity is at a low level, and (iii) the brand switching coefficient is at a high level. However, if the both manufacturers are flexible enough to change their pricing policies, their equilibrium pricing policy will be an EDLPP policy. When the competing manufacturer deploys a large temporary price discount and the price sensitivity is at a low level, the high retailer holding cost case provides higher manufacturer's profit. When the retailer's holding cost is high, the retailer cannot stock up a high level of inventory and therefore Manufacturer 2's Hi-Lo policy will be less damaging to Manufacturer 1. When the competing manufacturer (Manufacturer 2) deploys a large temporary price discount, the higher price sensitivity will benefit the manufacturer. We have also observed that the higher price sensitivity forces the retailer to reduce the selling price to the consumers. Lower retailer's selling price will always benefit the manufacturer because of the increased sales volume. The retailer suffers from decreased profit when the price sensitivity coefficient is at a higher level since the demand increase was not big enough to compensate for the decreased profit margin of the retailer. The profits of both the retailer and the manufacturer decrease as the forward buying coefficient increases. Increased forward buying coefficient implies the higher percentage of the current demand quantity will be consumed later by the consumers, reducing the demand for the next period. Therefore, the profits for both the retailer and the manufacturer will strictly decrease in forward buying coefficient.

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