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DUAL SALES CHANNEL MANAGEMENT WITH SERVICE COMPETITION

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Abstract:

It present a strategic analysis of manufacturer-retailer interaction in a dual channel setting and an analytical model that incorporates the key trade-offs regarding the channels. we study how a manufacturer can effectively manage his direct online channel and an independent retail channel when the channels compete in providing better service to end consumers. We suggest dual channel strategies to the manufacturer by integrating a consumer channel choice model with the manufacturer and the retailer's operational decisions.The manufacturer earns a higher profit margin in the direct channel. whereas, he can share the inventory risk with the retailer in the retail channel. In the model, the strategic interaction between the manufacturer and the retailer is driven by a consumer channel choice model that considers the consumers' willingness-to-wait and product availability concerns as well as the relative convenience of shopping from the channels. The analysis illustrates how the manufacturer can use the dual channel structure to his advantage.

We characterize the manufacturer's optimal wholesale price when contracting with the retailer, and the resulting channel mix. The key features of the model include availability-based service competition between the channels, and a detailed consumer channel choice model based on the service levels at each channel. The model enables us to identify various insights into dual channel management. It address availability-based service competition in a dual channel setting , focusing on the strategic interaction between the manufacturer and the retailer. In addition, we contribute to the literature by developing a detailed consumer channel choice model to drive the manufacturer's and the retailer's operational decisions.

Keywords:

Dual channel management；Service competition；Operational decisions；Supply chain

1. Introduction

Recent business trends have caused supply chain members to assume new roles down the chain. Suppliers are undertaking tasks that were once in the manufacturers' domain such as procurement and design. while manufacturers have been entering into the retail domain by opening direct sales channels.

There is a growing literature on dual channel management. Most papers in this research stream study price competition and/or marketing effort [1-2]. Unlike these papers, we study availability-based service competition. In addition, we incorporate a detailed consumer channel choice model. Hendershott[3] also consider a consumer choice model. However, they do not study availability-based competition.

Another factor that distinguishes our model in the dual channel literature is the consideration of stochastic demand. With the exception of Boyaci[4] and Seifert[5], all other works in this literature assume deterministic demand and ignore the effects of inventory. In Boyaci's model [4], a fraction of consumers who encounter a stock-out in their preferred channel subsequently search the other channel before walking away. Boyaci, however, focuses on channel coordination with various contracts. He does not consider the consumer choice process, and he assumes an exogenous wholesale price. Seifert [5] quantifies the benefits of using retailers' excess inventory to satisfy the demand in the direct channel. The aforementioned papers do not model the consumer choice process, and assume independent demand across retailers and the direct channel.

Some researchers study availability-based service competition between firms [6-7]. Similar to these models, the channels' demand in our model depends on the retailer's availability level. In our model, however, availability determines demand through the individual consumers' channel choice process, rather than as the parameter of an exogenously determined demand function. Within this literature [8-9] . Consideration of the dual channel setting, in which the manufacturer is both a supplier and a competitor to the retailer, distinguishes our work from this literature. We study retail channel competition between the manufacturer's direct channel and an independent, but not

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competition at the manufacturer or retailer levels.

The rest of the paper is organized as follows. In section 2, we describe the overall model. In section 3, we give consumers' channel choice. In section 4, we determine optimal dual channel strategies for the manufacturer and characterize how these strategies change study with respect to the channel environment. In section 5 given conclusions.

2. The overall model

Consider a manufacturer who sells a product through his direct online channel and retail channel during a sales season. The sequence of events is as follows (and summarized in Figure 1).

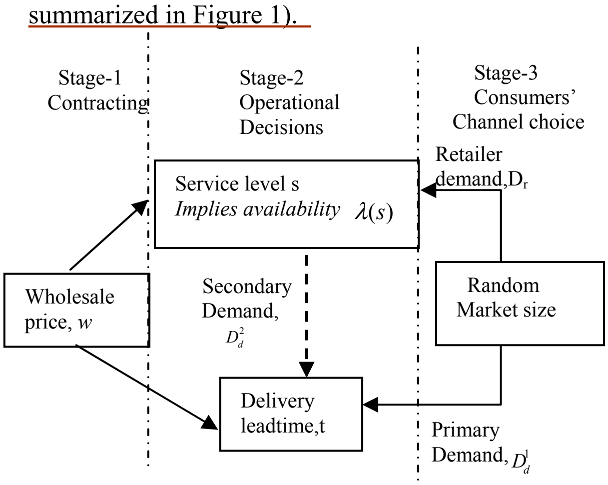

Figure 1. : Sequence of Events

During the contracting stage, the manufacturer sets the wholesale price w and offers the contract to the retailer. If the retailer accepts the contract, the manufacturer establishes a retail channel to sell his product. Given the wholesale price, both firms make operational decisions without observing each other's actions. In particular, the retailer chooses an inventory level without observing the manufacturer's decision for the direct channel. Choosing an inventory level is equivalent to setting the service level s, the probability of not stocking out during the sales season. The problem can be formulated in either variable. The manufacturer sets the delivery lead time t in the direct channel without observing the retailer's decision. During the sales season, consumers decide which channel to buy from (consumers' channel choice). To do so, they consider the delivery lead time in the direct channel, the retailer's service level, and the retailer inconvenience cost k. Depending on the sales price p, product availability, and the value v the consumer derives from the product, each consumer either buys the product or leaves the system. At the end of the season, the manufacturer's and the retailer's profits and consumers' utilities are realized.

Each consumer may buy the product from either the direct channel or the retailer, or may not buy at all. Consumers differ in their willingness to wait before receiving the product. To model this heterogeneity, the consumers are uniformly distributed along a unit-length line and indexed by the time-sensitivity index $d \in \{0,1\}$. The consumer with index d derives utility u_d when the purchase is made through the direct channel. This utility depends on the delivery lead time t, which is set by the manufacturer. The direct channel satisfies all orders because the delivery lead time t provides sufficient processing time for the manufacturer. Each consumer also derives an expected utility $E[u_r]$ from visiting the retailer. The expectation is due to the uncertainty in product availability, which depends on the retailer's service level a decision. The retailer instant ownership, hence the consumer's utility does not reduce due to waiting. But, the inconvenience of visiting the retailer reduces the consumer's utility. The consumer decides from which channel to buy after comparing her utility from both channels.

Figure 2 summarizes the channel choice process of consumer.

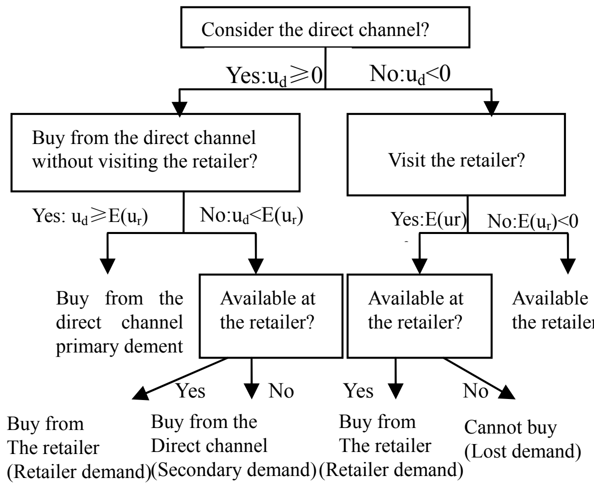

Figure 2: Channel choice process of consumer time

When the consumer is willing to wait long enough, i.e., when $u_d \geq 0$, he considers buying from the direct channel as an alternative. When $u_d \geq E(u_r)$, the consumer buys from the direct channel without visiting the retailer. Such consumers constitute the primary demand D_d^1 in the direct channel. When $u_d < E(u_r)$, the consumer visits the retailer. If the product is available at the retailer, she buys it. If the consumer faces a stock-out, she buys from the direct channel. These consumers constitute the secondary demand D_d^2 in the direct channel.

When the consumer is too time-sensitive to wait and receive the product, i.e. when $u_d < 0$, he does not consider buying from the direct channel at all. In this case, when $E(u_r) > 0$, the consumer visits the retailer. If the product is available at the retailer, he buys it. If the consumer faces a stock-out, then she leaves the retailer without purchasing. If the expected utilities from both channels are negative, then the consumer does not buy from either channel. These last two groups of consumers constitute the lost demand.

3. Consumers' Channel Choice

The total market demand is served through the direct and the retail channels. The percentage of consumers served through each channel depends on the service level a in the retail channel and the delivery lead time t in the direct channel. To characterize this split, we introduce the utility that a consumer derives from visiting either channel. We also identify the resulting market segments.

The consumer with index d derives utility from the direct channel.

$$u_d(d) = v - p - dt$$

The term dt denotes the reduction in consumer d's utility due to waiting t time units before receiving the product. v is the value that a consumer derives from the product and p is the product's sales price (where $p<v$).

Each consumer also derives an expected utility from visiting the retailer, i.e.

$$E[u_r] = f(s)(v-p) - k$$

The expectation is due to the uncertainty in product availability. The term $f(s)$ denotes the retailer's product availability defined as the probability that a consumer finds the product in store. Consumers infer the availability level $f(s)$ from the retailer's service level s.

Note that the retailer sets the service such that $E[u_r] \geq 0$ holds, otherwise consumers do not visit the retailer. This requires

$$f(s) \geq \frac{k}{v-p} \tag{1}$$

We define the retailer's minimum service level as

$$s_{\min} = \left\{ f(s) \geq \frac{k}{v-p}, s \in [0,1] \right\} \tag{2}$$

Next we characterize the market segments formed as a result of the heterogeneity in consumers' willingness to wait and receive the product. Let

$$\begin{aligned} d_1 &= \min\{\{d \mid u_k(d) = E[u_r]\},1\} \\ &= \min\{[(v-p)(1-f(s))+k]/t,1\} \end{aligned} \tag{3}$$

$$\begin{aligned} d_2 &= \min\{\{d \mid u_k(d) = 0,1\} \\ &= \min\{(v-p)/t,1\} \end{aligned} \tag{4}$$

Figure 3. illustrates how d_l and d_2 divide the consumer population into three segments.

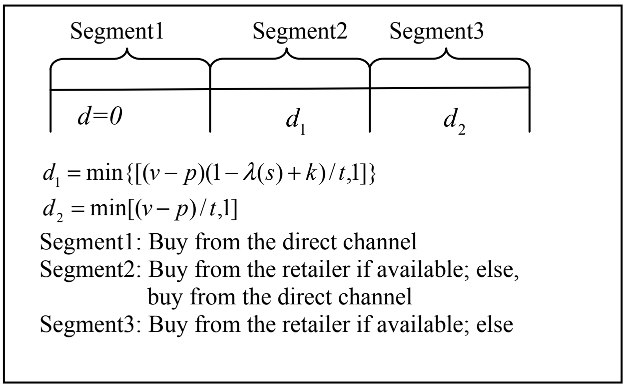

Figure 3: Consumer Segmentation

Note that the consumer's utility from the direct channel is large when her time-sensitivity index d is low. Consumers with a time sensitivity index lower than d_1 buy from the direct channel without visiting the retailer (because $u_d(d) \geq E[u_r]$).Consumers with a time sensitivity index higher than d_1 visit the retailer. If the product is available at the retailer, they buy it. If consumers face a stockout, they buy from the direct channel only when $d \leq d_2$ (because $u_d(d) \geq 0$). Note also that not all consumers derive positive utility from the direct channel. Hence, consumers with index $d > d_2$ do not consider buying from the direct channel at all (because $u_d(d) < 0$).

Random demands in the direct channel and in the retailer are as table 1.

Table 1. Delivery time range and channel coverage

Delivery lead time range	Retailer's status Direct channel coverage
$t \leq t^*$	Inoperative full
$t \in (t^*, v-p)$	Operative Full
$t \in (v-p, \infty)$	Operative Partial
$t \to \infty$	Operative zero

For a given service level s and depending on how the manufacturer sets lead time, the market can be segmented into three segments, two segments or the delivery even a single segment. In particular, by setting the delivery lead time $t > v - p$ (hence d_2<1), the manufacturer segments the market into three and serves part of the market through his direct channel, allows the retailer to sell the product, and lets some consumers leave the system without buying the product.

The manufacturer can also segment the market into two parts by setting $t \le v - p$ (hence d_2=1). In this case, the manufacturer uses the direct channel to provide full coverage.

The manufacturer can decide not to segment the market by setting a short delivery lead time. In this case, he serves all consumers only through his direct channel (hence d_1=1). In particular, where $t^* = (v - p)(1 - f(s)) + k$, when $t \le t^*$, all consumers choose to buy from the direct channel, and the retailer is inoperative. The market can also be left unsegmented by setting $t \to \infty$ (hence d_1=d_2=0). In this case, the manufacturer sells only through the retailer and essentially shuts down the direct channel operation.

The market segmentation also depends on the retailer's availability level. Note that we have only two segments if $f(s) = \frac{k}{v-p}$ and t>v-p (because d_1=d_2=<1). In this case, no consumer finds it optimal to visit the direct channel if she does not find the product at the retailer. That is, there is no secondary demand in the direct channel.

4 Operational Decisions

We characterize the retailer's best response service level $s^*(t)$ to the manufacturer's delivery lead time t at the direct channel. To do so, we first obtain the retailer's order quantity, the availability level and the expected sales for a given service level. Note that the retailer's service level is s.

Lemma 1. For a given service level s,

(1)The retailer optimally orders $q(s) = gs(1 - d_1(s))$ *units of product from the manufacturer;*

(2) The corresponding availability level is:

$f(s) = s(1 - \ln(s))$;

(3) The expected sales in the retailer is:

$$E[\min\{D_r, q\}] = g(1 - d_1(s))(s - \frac{s^2}{2}) = q(1 - \frac{s}{2})$$

Part (2) illustrates the one-to-one relationship between the retailer's service level (s) and the corresponding availability level ($f(s)$). Recall that we define the service level as the probability that the retailer does not stockout during the sales season. This definition corresponds to the type-1 service level in inventory management. We define the availability level as the probability that a particular consumer finds the product in stock. In our setting, this definition is equivalent to the fill-rate (type-2) service level, which is defined as the percentage of demand satisfied from on-hand inventory [10].

Setting a high service level requires the retailer to order more from the manufacturer for two reasons. First, by carrying more products, the retailer increases the probability of no-stockout and satisfies more consumers. Second, having more products increases the percentage of total consumers who visit the retailer. Recall that the market segment served by the retailer increases with high service. Hence, ordering q units from the manufacturer serves for two purposes: larger market share and lower stockouts.

The retailer's expected profit as a function of the service level s is given by $P(s) = pE[\min\{D_r, q\}] - wq$.

If demand at the retail channel turns out to be higher than the stocking level, the retailer loses sales (i.e. there is no backordering); whereas, if demand turns out to be less than the stocking level, the retailer ends up having excess inventory that has zero salvage value. Substituting q and $E(\min\{D_r - q\})$ from Lemma 1,

$$P(s) = gs(1 - d_1(s))(p - w - \frac{s}{2}p) \quad (5)$$

Substituting d_1 from Equation (3), we write the retailer's problem as

$$\max_s P(s)$$

$$= \frac{gs}{t}(t - k - (v - p))(1 - s(1 - \ln(s)))(p - w - \frac{s}{2}p) \quad (6)$$

Subject to $s \in \{s_0, [s_{\min}, 1]\}$, where $s_{\min}$ is defined in Equation (2) and s_0 is such that $d_1(s_0) = 1$. The term, p-w is the retailer's profit margin per unit sold. The term $\frac{s}{2}p$ can be conceived as a service cost that the retailer incurs per product stocked, to offer service level s. The proposition characterizes the retailer's best response.

Proposition 1 the retailer's expected profit function has a unique local maximizes in the domain (0,∞). Let this local maximizes be $s_i(t)$, which is decreasing in the wholesale price w. The retailer's best response is

$$s^*(t) = \begin{cases} s_{\min}, & s_i(t) \le s_{\min} \\ s_i(t), & s_i(t) \in (s_{\min}, 1) \\ 1, & s_i(t) \ge 1 \end{cases}$$

If $\Pi_r s^*(t) \ge 0$ *holds. Otherwise, the retailer sets* $s^*(t) = s_0$.

Proof: The proof proceeds in four steps. First, we characterize the s values at which $\prod_r s$ crosses zero. Second, we show that $\prod_r s$ has a unique local maximum that we refer to as s_i. Third, we show that the best response s* is equal to either s_i, or one of the boundary values s_{min} and 1. Fourth, we show that s^* is decreasing in the wholesale price w.

The best response service level decreases in the wholesale price. A high wholesale price w may force the retailer to offer the minimum service level, because ordering a high quantity of products would be costly. Conversely, a low wholesale price makes increasing the service level less costly for the retailer. A very high wholesale price may cause retailer's maximum expected profit to be negative, in which case the retailer sets $s^*(t) = s_0$ and does not order any products.

The following corollary explains the retailer's reaction to the manufacturer's shutting down the direct channel.

Corollary 1. If the man shuts down his direct channel by setting t= ∞ , then the retailer's response is to set

$$\lim_{t\to\infty} s^*(t) = \max\{s_{\min}, \frac{p-w}{p}\}$$

Proof : From Equation (6), we have

$$\lim_{t\to\infty} \prod_r (s,t) = gs(p-w-sp/2)$$

This function is maximized at $s = (p-w)/p$. Considering the minimum service level condition, we find $\lim_{t\to\infty} s^*(t) = \max\{s_{\min}, (p-w)/p\}$

In the absence of competition from the direct channel, the retailer need not consider the effect of his service level on demand determination. All consumers visit the retailer as long as he provides at least the minimum service level s_{min}. Hence, the retailer optimally sets the critical service level $\frac{p-w}{p}$ unless this level is below the minimum service level.

To find the manufacturer's optimal wholesale price, we perform a grid-search over the wholesale price values $w \in [c, p]$. We choose the wholesale price for which the resulting.

Nash equilibrium yields the highest expected profit for the manufacturer. The manufacturer considers the voluntary participation constraint of the retailer because the retailer can always make zero profit by setting service level $s=s_o$.

We use follows algorithm to find the manufacturer's optimal wholesale price and the resulting Nash equilibrium as the fixed point of the best response functions of the manufacturer and the retailer.

Step 1: Set $\alpha = \varepsilon = \prod_m^*$=small number;

Step 2: for $w=c$ to $w=p$ do

Step 3: for i=1 to i=number of initial seeds do

Step 4: Set j=0 and s_j^* = (seed i) and

$s_{j+1} = t_j^*$=large number

Step5: while $s_{j+1}^* - s_j^* > \varepsilon$ and $t_{j+1}^* - t_j^* > \varepsilon$ do

$t_{j+1}^*(s_j^*) \leftarrow s_j^*$ (Find the manufacturer's best response)

$s_{j+1}^*(t_{j+1}^*) \leftarrow t_{j+1}^*$ (Find the retailer's best response)

$j \leftarrow j+1$

Report the Nash equilibrium as the pair $(s_j^*(i), t_j^*(i))$

Step 6: check whether there are multiple equilibrium

$t^* \leftarrow t_j^*(1)$ And $s^* \leftarrow s_j^*(1)$

If $\prod_m^* \le \prod_m^*(t^*)$

Then $\prod_m^* \leftarrow \prod_m(t^*)$ and $w^* \leftarrow w$

$w \leftarrow w + \alpha$

Report w^* , $\prod_m^*$ and the corresponding (t^*, s^*)

The algorithm uses the manufacturer's best response function to numerical optimization methods to obtain the retailer's best response because that function cannot be characterized in closed form (see Proposition 1))

4. Conclusions

While the manufacturers' direct online channel offers certain advantages, the inherent delivery lead time makes it unattractive to some consumers. By far the most important reason why consumers shop online but buy at retail is that they want product immediately. Visiting a retail store, however, does not guarantee instant ownership. Due to operational efficiency concerns, even the largest retailer aims for imperfect service levels, resulting in frequent stock outs. In this paper, we present a strategic analysis of manufacturer-retailer interaction in a dual channel setting. We suggest dual channel strategies to the manufacturer by integrating a consumer channel choice model with the manufacturer and the retailer's operational decisions.

In the model, the strategic interaction between the manufacturer and the retailer is driven by a consumer channel choice model that considers the consumers' willingness-to-wait and product availability concerns as well as the relative convenience of shopping from the channels. The analysis illustrates how the manufacturer can use the dual channel structure to his advantage.

We find three types of optimal channel strategies for the manufacturer depending on the environment.

We show that the model provides good directional prediction with respect to parameter changes when human behavior is taken into account. This provides a basis for using the analytical results to improve the wholesale price contract and the operational decisions involved in establishing the dual channel strategy. Furthermore, the model is also useful in comparing alternative strategies and wholesale price contracts, because of its robustness in predicting the direction of changes with respect to behavioral.

However, human subjects have bias compared to, and dispersion from, the model's quantitative predictions. These observations that one should perhaps be cautious in using the model to determine the exact quantities or values corresponding to each decision.

In the perspective of supply chain management, one overriding issue is to study how the behavioral factors affect the optimality of contract policies (the wholesale price, in this case). In the absence of an accurate behavioral model, we can experimentally determine whether the true optimal wholesale price is higher or lower than the one suggested by the pure rational model. An alternate approach is to conduct experiments to pinpoint the root causes of behavior and use that information to construct analytical models that incorporate more accurate behavioral assumptions.

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