Who Should Lead the Marketing Channel?

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Abstract

This paper aims to provide an answer to the still open question, namely who should, if any, lead a marketing channel? To achieve this objective, we consider a channel consisting of one manufacturer and one retailer where each player controls his advertising rate and margin. Given the fact that advertising has a carry over effect on demand, we adopt a dynamic model. Nash and Stackelberg equilibria, with in turn manufacturer and retailer is leader, are characterized and outcomes compared to the efficient coordinated solution. Our finding suggests that manufacturer's leadership reduces inefficiency in channel and is more beneficial to consumer. Our prescription is thus the manufacturer should lead.

Résumé

L'objectif de cet article est de répondre à une question restée ouverte dans la littérature portant sur les canaux de distribution, à savoir est-ce qu'un leadership est désirable, et si oui qui devrait assumer ce rôle. Pour atteindre cet objectif, on considère un canal de distribution formé d'un manufacturier et d'un détaillant, où chaque joueur contrôle sa marge bénéficiaire et ses dépenses en publicité. Pour tenir compte des effets de long terme de la publicité, le modèle adopté est dynamique. Les équilibres de Nash et de Stackelberg sont caractérisés et comparés. Les résultats montrent que le leadership du manufacturier réduit l'inefficience dans le réseau et il est préféré par le consommateur au leadership du détaillant et à l'équilibre de Nash.

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1 Introduction

The issue of channel leadership has been extensively studied in the behavioral channel literature (e.g., Stern and El-Ansary (1992)). From a prospective point of view, there are two main questions: Should a marketing channel have a leader? If so, who should be the channel leader. In a thoughtful classical paper, Little (1970) investigated these questions and argued that the need for leadership arises from inefficiencies in channel structure, intrachannel communication and joint decision making. The answer is that the manufacturer should lead to achieve efficiency. Although the environment described by Little has considerably changed, it seems that his view still has a great influence on marketing channel researchers. Bergen *et al.* (1992) observed that many models using agency theory (and related theories) have considered the manufacturer as the natural *chain captain*. Thus, it is generally assumed that it is manufacturer's responsibility to implement appropriate incentive mechanisms in order to align the objectives of channel members. Such mechanisms include pricing schemes (Moorthy (1987), Ingene and Parry (1995a, 1995b), Gerstner and Hess (1995), formal contracts (Lal (1990), Desiraju and Moorthy (1997)) and functional incentives (Chu and Desai (1995), Dant and Berger (1996), Bergen and John (1997)). With the emergence of very large retail chains (e.g., Wal-Mart, Sears, K-Mart), some marketing scholars claim that the power in channels has shifted gradually from manufacturers to retailers (e.g. Choi (1991)). If it were the case, manufacturers may not be able to enforce their marketing decisions upon the retailers. The latter become autonomous partners who can set their marketing strategies by themselves and even enforce their decisions upon manufacturers. Further, in the trade literature the debate have been occasionally quite emotional where manufacturers' and retailers' lobbies argued in turns that they are less powerful and earn less profits (Boudet (1990)). This issue has been addressed empirically by Messenger and Narasimham (1995) who did not find a clear-cut evidence that retailers are gaining more power (profits) than manufacturers. Ailawadi *et al.* (1995) reached similar result, although they found some exceptions (for instance in the case of Wal-Mart). The issue is still widely open.

One should note that the term *leadership* is used in quite different meanings. In the behavioral literature, leadership is rather a broad concept which refers to the use of any kind of power, while in the marketing science literature, leadership is interpreted in the Stackelberg sense, that is, one channel member (the leader) determines his optimal decision taking into account the other channel member's (the follower) reaction function. The emphasis of the marketing science literature is mainly on the decision making process, rather than on the channel structure and communication. A Stackelberg leader is expected to improve his profit (with respect to profit earned in a Nash game), otherwise he can always disregard his knowledge of the follower's rational reaction function.

A handful of theoretical models, similar in some respects to the seminal one in Jeuland and Shugan (1983), have assessed the effects of leadership (Shugan (1985), Moorthy (1985), Moorthy and Fader (1989), Lee and Staelin (1997)). They addressed questions like: What is the effect of leadership on prices? Does price leadership improve channel profit? Should the manufacturer or the retailer be the price leader? Who benefits from price leadership? Using a constant-elasticity demand function, Shugan (1985) showed that if one channel member has a control over partner's margin, then the total channel profit is greater than in the case where both members set their margins independently and, not unexpectedly, lower than in the coordinated one. The retail price is found to be higher than the channel coordinated price and lower than Nash retail price. Using a linear demand function, Moorthy (1985) obtained opposite findings. Price leadership is damaging for channel efficiency. Indeed, it lowers channel profits and increases retail price. Facing such different results, the natural question is how comes a simple change in the shape of demand function can change so radically the predictions? Moorthy and Fader (1989) solved the puzzle by showing that regardless of demand function form, price leadership always benefit the leader and that the key point in the analysis is the concept of vertical strategic interaction. If the best response functions are increasing (decreasing, constant) we have strategic complementarity (strategic substitution, independence). A channel member will prefer to be leader (follower) in a pricing game if there is strategic substitution (complementarity). If there is no vertical strategic interaction, channel members are indifferent toward the price leadership issue. Lee and Staelin (1997) generalized Moorthy and Fader's findings to a setting where two manufacturers sell competing products carried by two competing retailers. They found that neither horizontal price competition nor product line pricing at the retail level change those effects of vertical price leadership obtained in a bilateral monopoly setting.

The aim of this paper is to reexamine the issue of leadership in a setting where prices (actually margins) are no longer the only strategic variables. Indeed, we assume that channel members invest also in advertising. Given the wisdom that the latter has a carry-over effect on demand, we adopt a dynamic model, recognizing also simultaneously that channel members are engaged in a long term relationship. We believe that the substantive contribution of the paper is by far more than adding one variable (although models of marketing mix interactions are still needed) and extending existing static models to a dynamic setting (although it is not clear-cut how introduction of dynamic effects affects established static results). Indeed, as seen above, the corner-stone element in the price leadership models is the concept of vertical strategic interaction which may no longer hold in a context where there is interdependencies among a channel member's own strategic variables. For instance, when the retailer raises his margin, his own advertising rate may increase or decrease.

The model assumes that manufacturer's advertising is brand-oriented whereas retailer's advertising is short term demand oriented. This assumption seems to be congruent with usual practice where a manufacturer announces his product in national medias (pull strategy) to build a goodwill for his brand and retailers advertise in local medias (newspapers, local radio and TV stations and store circular) to attract attention on particular products, whose prices are eventually reduced, and boost current period demand. For a case where both players invest in both types of advertising (see e.g. Jørgensen *et al.* (1999)).

The following scenarios are examined in this paper:

(a) Each channel member determines independently its margin and advertising rate (Nash game).

(b) Each member is in turn leader in a Stackelberg game.

(c) Channel members coordinate their margin and advertising strategies.

Scenarios (a) and (b) are non cooperative games and (c) is a cooperative one. Scenarios (a) and (c) provide benchmarks to which can be compared retailer and manufacturer leadership.

The rest of the paper is organized as follows. Section 2 states the model. Section 3 characterizes equilibria of the non cooperative games. Section 4 provides the optimal solution to the cooperative game. Section 5 compares the different results and Section 6 concludes.

2 The Model

Let the marketing channel be formed of one manufacturer, denoted M, and one retailer, denoted R. This dyadic structure is very common in the conflict and cooperation in channels literature. Let t, $t \in [0, \infty[$, denote time. The manufacturer controls its margin, $m_M(t)$, and rate of advertising, $a_M(t)$. Similarly, the retailer controls $m_R(t)$ and $a_R(t)$. The rate of consumer demand, $q(t)$, depends on retail price, $p_R(t)$, retailer's advertising and brand's goodwill $G(t)$. The following functional form is assumed for consumer demand

$$q(t) = a_R(t)(\alpha - \beta p_R(t))\gamma\sqrt{G(t)} \tag{1}$$

where α, β and γ are positive parameters. Clearly, the rate of consumer demand is increasing in retailer's advertising and goodwill, and decreasing in retail price. Following Fershtman *et al.* (1990) and Jørgensen and Zaccour (1999), this multiplicative separable form is chosen for mathematical tractability and to reflect the fact that advertising (in its both forms) is more effective in raising sales when accompanied by a low price. The square root accounts for marginal decreasing returns in $G(t)$ which is rather a standard assumption. Linearity in retail price has been widely used in channel literature (see, e.g. Moorthy (1985), Desiraju and Moorthy (1997)) and it is adopted here to ease comparison with previous studies. The retail price is simply the sum of both channel members' margins,

$$p_R(t) = m_M(t) + m_R(t) \tag{2}$$

This characterization is also adopted in Jeuland and Shugan (1983), Moorthy and Fader (1989) and Lee and Staelin (1997). The technical reason behind assuming that margins are the strategic variables and not prices is simply to ease the characterization of Nash and Stackelberg equilibria without altering qualitatively the game. The stock of goodwill evolves according to the classical Nerlove-Arrow (1962) dynamics,

$$\dot{G}(t) = a_M(t) - \delta G(t), \quad G(0) = G^0 \geq 0 \tag{3}$$

where δ is the decay rate. As stressed before, this formulation reflects the assumption that only manufacturer invests in brand goodwill. Chintagunta and Jain (1992) studied a case where manufacturer and retailer use their individual marketing efforts to build their own respective goodwill stock. Jørgensen and Zaccour (1999) assumed that there is a retailer-specific goodwill stock which is built up by advertising expenditures of both players. Here the roles are somehow separated. The manufacturer's advertising aims to strengthen preference for his brand (pull strategy) whereas the retailer's advertising focus on short term demand (push strategy). Advertising costs are convex and given by $\frac{1}{2}w_i a_i^2, i = M, R$. The different parameters w_i reflect different advertising cost structures due eventually to the use of different medias by both players. We assume that manufacturer's marginal production cost is constant and set it at zero without loss of generality. For simplicity, the retailer does not incur any operating cost. Both players are assumed to maximize their discounted stream of profit over an infinite horizon. Although it has been argued that retailers are more short-term oriented than manufacturers (see, e.g. Chu and Desai (1995)), we stick to the common made assumption that both players discount their profits at the same (market) rate r. Note, however, that this issue is somehow handled by the different postulated purposes of advertising by the channel members. The objective functionals are as follows:

$$J_M = \int_0^\infty e^{-rt}\left[m_M(t)a_R(t)\left(\alpha - \beta p_R(t)\right)\gamma\sqrt{G(t)} - \frac{1}{2}w_M a_M^2(t)\right]dt \qquad (4)$$

$$J_R = \int_0^\infty e^{-rt}\left[m_R(t)a_R(t)\left(\alpha - \beta p_R(t)\right)\gamma\sqrt{G(t)} - \frac{1}{2}w_R a_R^2(t)\right]dt \qquad (5)$$

3 Noncooperative games

In a channel context, a manufacturer and a retailer are in conflict when each of them maximizes his own payoff independently of the other channel member. Two game theoretic solution concepts are commonly used to predict the outcome in such a context. Nash equilibrium is employed when both players make their decisions simultaneously (e.g., Chintagunta and Jain (1992) and Jørgensen and Zaccour (1999)). In an asymmetric information structure, i.e. decisions are announced sequentially so that one of the player knows the decision made by the other before making his own decision, Stackelberg equilibrium is used (e.g., Ingene and Parry (1995a,b) and Desiraju and Moorthy (1997). We shall exploit both solution concepts to capture the effect of leadership on strategies and outcomes.

Beside deciding on the equilibrium concept, one has to specify in a differential game the information structure. The open-loop information structure assumes that players' strategies are function of time, whereas the feedback one assumes that the players base their decisions on the state of the system (here the goodwill) and time. Unless one makes the strong assumption that commitments are binding, the open-loop Stackelberg equilibrium is generally time-inconsistent. That is, if the leader is given the option of reoptimizing at an intermediate date, then he would change the initial decision for the remaining horizon. We shall use here the conceptually more attractive feedback information structure. More precisely, we shall confine our interest to Markovian strategies, that is strategies based on current state (and not for instance on the entire history).

3.1 Nash equilibrium

The manufacturer and the retailer determine their marketing policies independently and simultaneously. Since the retailer's advertising and the margins do not enter in the sate dynamics, the game of determining them is a static one at each $(t, G(t))$. The determination however of manufacturer's advertising is dynamic and, as mentioned before, is determined as a feedback strategy. Since the planning horizon is infinite and the problem autonomous, it is reasonable to confine one's interest to stationary feedback Nash equilibria. The brand advertising rate depends then on current stock of goodwill and not on time.

Whenever the margins and retailer's advertising are positive, sufficient (static) optimality conditions are the following:

$$\frac{\partial J_R}{\partial m_R} = \alpha - \beta m_M - 2\beta m_R = 0 \tag{6}$$

$$\frac{\partial J_M}{\partial m_M} = \alpha - \beta m_R - 2\beta m_M = 0 \tag{7}$$

$$\frac{\partial J_R}{\partial a_R} = m_R(\alpha - \beta m_M - \beta m_R)\gamma\sqrt{G} - w_R a_R = 0 \tag{8}$$

The sufficient condition for a stationary feedback Nash equilibrium can now be stated as follows. Let $\phi(G)$ be a function mapping $\Re_+ \times [0, \infty)$ into $\Re_+$ and suppose there is a unique absolutely continuous solution $G : [0, \infty) \to \Re_+$ to the initial value problem $\dot{G} = \phi(G(t)) - \delta G(t)$, $G(0) \geq 0$. Furthermore, suppose there exists a continuously differentiable function $V : \Re_+ \to \Re_+$ such that either V is bounded or V is bounded from below and $\limsup_{t\to\infty} e^{-rt}V(G) \leq 0$ and the Hamilton-Jacobi-Bellman (HJB) equation is satisfied for all $G \geq 0$:

$$\begin{aligned} \max\{m_M a_R(\alpha - \beta p_R)\gamma\sqrt{G} - 1/2w_M(\phi(G))^2 \\ +V'(G)(\phi(G) - \delta G) \mid \phi \geq 0\} = rV(G) \end{aligned} \tag{9}$$

Then the quadruple $(\phi(G), a_R(t), m_M, m_R)$ provides a feedback Markovian Nash equilibrium. Optimality is understood in the sense of catching optimality if one or more of the objective integrals fail to converge. Using the superscript N to identify a Nash equilibrium, the following proposition summarizes our findings.

Proposition 1 *The feedback Nash equilibrium margins and advertising rate are given by*

$$m_M^N = m_R^N = \frac{\alpha}{3\beta} = const. > 0 \tag{10}$$

$$a_R^N(t) = \frac{\alpha^2}{9\beta w_R}\sqrt{G^N(t)} \tag{11}$$

$$a_M^N = \frac{\alpha^4\gamma^2}{81\beta^2 w_M w_R(\delta + r)} = const. > 0 \tag{12}$$

The optimal goodwill trajectory starting at G_0 is given by

$$G^N(t) = (G_0 - G_{ss}^N)e^{-\delta t} + G_{ss}^N \tag{13}$$

and converges toward the steady state $G_{ss}^N = \frac{\alpha^4\gamma^2}{81\beta^2 w_M w_R \delta(\delta+r)} = \frac{a_M^N}{\delta}$

Proof. See Appendix 1. ■

The above proposition shows that at equilibrium, the manufacturer's and the retailer's margins are constant and equal. A similar result was obtained in a pure pricing game in Moorthy (1985). The manufacturer's advertising rate depends on demand and both players advertising cost parameters and is a degenerate feedback strategy (it does not depend on current goodwill stock) which is the product of model's specification. Retailer's advertising rate depends on demand and own advertising cost parameter and on goodwill stock as well. Note that the retailer's advertising rate is increasing in goodwill stock. The latter converges toward steady state, from below if initial goodwill is lower than steady state, or from above otherwise.

3.2 Stackelberg games

As mentioned before, we shall characterize Stackelberg equilibria with respectively the manufacturer and retailer as leader. Leadership is understood here with respect to both marketing instruments (margin and advertising).

3.2.1 Retailer as Stackelberg leader

Due to the structure of the model where there is no direct link between the two players' advertising rates, this game is played as if the retailer is leader with respect to margin and without leadership in advertising. This occurs because the dynamics and players' instantaneous payoffs are separable in advertising rates. We use the superscript SR to identify the Stackelberg retailer equilibrium. The manufacturer's reaction functions are given by

$$m_M^{SR} = \frac{\alpha - \beta m_R^{SR}}{2\beta} \tag{14}$$

$$a_M^{SR} = \frac{1}{w_M}\frac{dV_M^{SR}(G)}{dG} \tag{15}$$

where $V_M^{SR}(G)$ is the manufacturer's value function. Equation (14) shows that both margins are strategic substitutes, that is when one player raises his margin, it is optimal for the second one to reduce his. Manufacturer's advertising rate is determined by the usual dynamic optimization condition which states that marginal cost is equal to marginal benefit (derived from goodwill). Given these reaction functions, by static optimization one gets optimal retailer's margin

$$m_R^{SR} = \frac{\alpha}{2\beta} \tag{16}$$

The next proposition characterizes Stackelberg equilibrium under retailer's leadership.

Proposition 2 *Under retailer's leadership, margins and advertising rates are as follows*

$$m_R^{SR} = \frac{\alpha}{2\beta} \tag{17}$$

$$m_M^{SR} = \frac{\alpha}{4\beta} \tag{18}$$

$$a_R^{SR}(t) = \frac{\alpha^2\gamma}{8\beta w_R}\sqrt{G^{SR}(t)} \tag{19}$$

$$a_M^{SR} = \frac{\alpha^4\gamma^2}{128\beta^2 w_R w_M(\delta + r)} \tag{20}$$

The optimal goodwill trajectory starting from G_0 is given by

$$G^{SR}(t) = (G_0 - G_{ss}^{SR})e^{-\delta t} + G_{ss}^{SR} \tag{21}$$

and converges toward the steady state which is given by

$$G_{ss}^{SR} = \frac{\alpha^4\gamma^2}{128\beta^2 w_M w_R \delta(\delta + r)} \tag{22}$$

Proof. *See Appendix 2.* ■

The proposition shows that under retailer's leadership, the manufacturer charges a lower margin than the retailer. This result is similar to the one obtained in a pure pricing game in Moorthy (1985) and confirms that under vertical strategic substitutability (in margins), the leader secures himself a higher margin than the follower. Analyzing a pricing game with retailer as leader, Lee and Staelin (1997) raised the issue of credibility of the announcement of retailer's price in the sense that once the product is handed over from manufacturer to retailer, the latter may find it optimal to deviate from the announced price. Credibility can be ensured by binding commitments. Here we do not face this problem since the announced optimal margin by the retailer is constant and remains optimal in the sequel. The remaining results are qualitatively similar to the ones obtained under a Nash mode of play and therefore the same comments apply.

3.2.2 Manufacturer as Stackelberg leader

Unlike in the previous case, here the leader has control over both follower's strategic variables. Identifying by SM this game, the retailer's reaction functions are given by

$$m_R^{SM} = \frac{\alpha - \beta m_M^{SM}}{2\beta} \tag{23}$$

$$a_R^{SM} = \frac{m_R^{SM}}{w_R}\left(\alpha - \beta\left(m_M^{SM} + m_R^{SM}\right)\right)\gamma\sqrt{G^{SM}} \tag{24}$$

Again, margins are strategic substitutes. Retailer's advertising is increasing and concave in goodwill which is influenced by manufacturer's advertising. Following the same procedure as in the previous cases, the manufacturer derives his optimal margin by static optimization and his optimal advertising rate by dynamic optimization. Our results for the SM game follow.

Proposition 3 *The feedback Stackelberg equilibrium with manufacturer as leader is characterized by*

$$m_R^{SM} = \frac{3\alpha}{8\beta} \tag{25}$$

$$m_M^{SM} = \frac{\alpha}{4\beta} \tag{26}$$

$$a_R^{SM}(t) = \frac{9\alpha^2\gamma}{64\beta w_R}\sqrt{G^{SM}(t)} \tag{27}$$

$$a_M^{SR} = \frac{27\alpha^4\gamma^2}{2048\beta^2 w_R w_M(\delta + r)} \tag{28}$$

The optimal goodwill trajectory starting from G_0 is given by

$$G^{SM}(t) = (G_0 - G_{ss}^{SM})e^{-\delta t} + G_{ss}^{SM} \tag{29}$$

and converges toward the steady state which is given by

$$G_{ss}^{SM} = \frac{27\alpha^4\gamma^2}{2048\beta^2 w_M w_R \delta(\delta + r)} \tag{30}$$

Proof. See Appendix 3. ■

The most important result here, contrary to the common obtained result when margins (or prices) are strategic substitutes, is that the leader does not secure himself a higher margin than the follower. An explanation is that the manufacturer's pricing strategy needs to take into account both margin and advertising reaction functions of the retailer. Indeed, from equation (24) one can see that retailer's advertising is decreasing in manufacturer's margin. This amount to say that a Stackelberg manufacturer requires a lower margin to induce the retailer to set an appropriate combination of retail price and advertising. Other results are qualitatively similar to what have been obtained before.

4 Coordinated channel

The assumption now is that channel members can coordinate their strategies (there is no legal barrier) and wish to do so to overcome channel inefficiencies (double marginalization, lack of incentive for collectively optimal advertising rates) by optimizing total channel profits. Denoting by $m(t)$ the overall channel margin, the joint profit functional is then given by

$$J_C = \int_0^{\infty} e^{-rt} \Big(m(t) a_R(t) \left(\alpha - \beta p_R(t)\right) \gamma \sqrt{G(t)} \tag{31}$$

$$- \frac{1}{2} w_M a_M^2(t) - \frac{1}{2} w_R a_R^2(t) \Big) \, dt \tag{32}$$

A triple of margin and advertising rates which maximizes J_C is known to be Pareto efficient. The overall channel margin and retailer's advertising rate can still be obtained by static optimization. The manufacturer's advertising rate is determined by dynamic optimization. The next proposition characterizes the solution of this cooperative game.

Proposition 4 *If the manufacturer and the retailer cooperate to maximize total channel profits, then the channel margin and advertising rates are given by*

$$m = \frac{\alpha}{\beta} \tag{33}$$

$$a_R^C(t) = \frac{\alpha^2 \gamma}{4 \beta w_R} \sqrt{G^C(t)} \tag{34}$$

$$a_M^C = \frac{\alpha^4 \gamma^2}{32 \beta^2 w_R w_M (\delta + r)} \tag{35}$$

The optimal goodwill trajectory starting from G_0 is given by

$$G^C(t) = (G_0 - G_{ss}^C) e^{-\delta t} + G_{ss}^C \tag{36}$$

and converges toward the steady state

$$G_{ss}^C = \frac{\alpha^4 \gamma^2}{32 \beta^2 w_M w_R \delta (\delta + r)} \tag{37}$$

Proof. See Appendix 4. ■

The results obtained here are qualitatively similar to those obtained before but with respect to the fact that in this case we do not have separate margins but an overall channel one. The aim of the computation of this coordinated or cooperative solution is to use it as a benchmark to which the different uncoordinated solutions can be compared.

5 Comparison of outcomes

This section compares outcomes between games and players' outcomes in each of the games. The following two propositions summarize our findings regarding the first type of comparison.

Proposition 5 *Margins, advertising rates, goodwill stocks and value functions of the different games are related as follows*

$$m_M^{SR} = m_M^{SM} < m_M^N \tag{38}$$

$$m_R^N < m_R^{SM} < m_R^{SR} \tag{39}$$

$$a_M^C > a_M^{SM} > a_M^N > a_M^{SR} \tag{40}$$

$$a_R^C > a_R^{SM} > a_R^{SR}, \qquad \textit{and } a_R^{SM} > a_R^N \tag{41}$$

$$G^C > G^{SM} > G^N > G^{SR} \tag{42}$$

$$V_M^{SM} > V_M^N > V_M^{SR} \tag{43}$$

$$V_R^{SR} > V_R^{SM} > V_R^N \tag{44}$$

Proof. See Appendix 5. ■

The inequalities in (38)-(42) are valid for any t. The result in (38) states that the manufacturer charges a higher margin in the Nash than in the SM and the SR games. In the latter two games, the manufacturer's margin is the same. Thus, when there is a leader in the channel, regardless of whom it is, the manufacturer's margin is lower than in a game with no leader. This result differs from those obtained in the literature studying pricing games exclusively. In this literature, neither under vertical strategic substitutability nor vertical strategic complementarity, the manufacturer's margin is the same in the SM and the SR games. The case of equal margins is only observed under vertical strategic independence. But in that case the margins are also equal to that of the Nash game.

The inequalities in (39) show that the retailer's margin increases (compared to the Nash case) with the introduction of a leader in the channel. The increase is higher in the SR than in the SM game. In pure pricing games with vertical strategic complementarity, the retailer's margin in the SR game is smaller than that in the SM game (Lee and Staelin (1997)).

The result in (40) states that the manufacturer's advertising rate is higher in the cooperative game than in all three noncooperative games. This is not unexpected. Moreover, the manufacturer's advertising rate is greater in the SM game than when there is no leader. This is an expected consequence of manufacturer leadership. Under the retailer's leadership, the manufacturer's advertising is the lowest.

In (41), again not unexpectedly, the retailer's advertising rate in the cooperative game is the highest. However, the retailer invests more in advertising when the manufacturer is the leader than when he himself is the leader. While this result may seem counterintuitive, it can be explained by the substitutability of the retailer's margin and advertising decisions. Recall that in the SR game, the retailer raises his margin compared to that in the Nash and the SM games.

The inequalities in (42) are direct consequences of those in (40). The result in (43) shows that the manufacturer's profit is higher when he is the channel leader than when there is no leader. However, the manufacturer's profit is lower when the retailer is the leader than when there is no leader. A similar result is known from pure pricing games under vertical strategic substitutability (Moorthy and Fader (1989)). Finally, the inequalities in (44) show that the retailer's profit is higher under each type of leadership than when there is no leader. Obviously, the retailer earns higher profits by being the leader.

Before attempting to make a prediction on who would be the leader in the face of such results, let us complete the picture by looking at overall channel profits, retail price and individual profits.

Proposition 6 *Retail prices, quantities and total profits in the different games are related as follows*

$$p_R^C < p_R^{SM} < p_R^N < p_R^{SR} \tag{45}$$

$$q_R^C > q_R^{SM} > q_R^N > q_R^{SR} \tag{46}$$

$$V^C > V_T^{SM} > V_T^N > V_T^{SR} \tag{47}$$

Proof. See Appendix 6. ■

The facts that cooperative retail price is the lowest and that total coordinated profits are the highest are not surprising given the knowledge accumulated in this area of investigation. The purpose of this proposition is to see how the other equilibrium retail prices (quantities are corollaries) and total profits compare to the coordinated solution and eventually to provide answers to the two main questions raised in this paper; should there be a leader and if yes who?

We finally compare profits in each of the noncooperative games.

Proposition 7 *Profits earned by retailer and manufacturer are related as follows*

$$\textit{Nash game:} \qquad V_M^N(G_0) > V_R^N(G_0) \tag{48}$$

$$SR\ game: \qquad V_M^{SR}(G_0) < V_R^{SR}(G_0) \tag{49}$$

$$SM\ game: \qquad V_M^{SM}(G_0) > V_R^{SM}(G_0)\ \textit{if and only if}\ G_0 > \frac{\delta}{r} G_{SS}^{SM} \tag{50}$$

Proof. See Appendix 7. ■

The result that in a Nash game the manufacturer makes more profit than retailer is different from the usual one in pure pricing Nash game where it has been established that both channel members make the same profit. Thus the introduction of advertising and dynamics change the result. The profits ordering in the SR game is in line with previous studies; the leader makes higher profits. In the SM game this rule would apply only under a condition relating initial and steady state goodwill stock and decay and interest rates. Qualitatively speaking, if the latter rates are of the same magnitude, then the leader would make a higher profit than the follower only if initial goodwill is higher than steady state level. For a different interpretation, recall that $\delta G_{SS}^{SM} = a_M^N(SS)$ and therefore the condition can be written $G_0 > \frac{1}{r} a_M^N(SS)$. The interpretation is then, the leader (manufacturer) makes more profits than the follower if initial goodwill is higher than the sum of discounted advertising expenditures.

Let us now address the main questions raised in this paper, namely should a channel have a leader and if yes who should assume this role? Three elements must be taken into account in answering these questions, namely channel efficiency, consumer welfare and individual profits. The analysis must be of course made having in mind the results obtained in the cooperative or coordinated situation. We claim that, all elements put together, manufacturer should lead the marketing channel. The "proof" follows.

From the perspective of channel efficiency (total channel profit), the inequalities in (47) show that manufacturer leadership is the second best solution. Further, absence of leadership (Nash equilibrium) is preferable to retailer leadership. If channel efficiency were the only concern, there is absolutely no rational way in justifying retailer leadership.

From consumer perspective, inequalities in (45) show that the same ordering as above is the desirable one. Therefore the same comment applies. Note that this result provides a powerful argument to manufacturers' lobbyists.

From individual profits perspective, obviously both players would like to lead the channel (see inequalities in (43)-(44)). However, under a standard game theoretic assumption of rational and intelligent players, retailer leadership can be excluded. To show this, let us think about the problem of selecting a mode of play (i.e. which equilibrium to select) as a bargaining problem. In such circumstances, one needs to make an assumption about the status quo point which gives to each player his (security) payoff if negotiation breaks down. It is rather standard to assume that such point corresponds to Nash equilibrium. The players will be willing to consider a different solution if and only if the following two conditions are satisfied; (i) this solution creates a surplus (it provides a total payoff higher than the sum of individual status quo payoffs), and (ii) each player will be better off, eventually after applying a suitable side payment. These two conditions correspond to collective and individual rationality. The inequalities in (47) show that retailer leadership does not satisfy the first condition but manufacturer leadership creates a surplus with respect to Nash equilibrium. Therefore, there is no room for retailer to use an argument like "accept my leadership and I will give you a side payment such that both of us would be better off than under Nash". However, the manufacturer can make such proposition. Further, with or without the option of applying side payment, the manufacturer can threat credibly the retailer by playing Nash strategy if his leadership is not accepted. The reverse is not true. Indeed, the manufacturer prefers Nash to retailer leadership but retailer prefers any leadership to Nash. For the manufacturer, the implementation of this requires that he disregards the announcement of strategies that would be made under retailer leadership.

All these elements put together provide, we believe, an endogenous answer to the raised questions.

6 Conclusion

We have extended the literature on leadership roles in marketing channels in two directions. For the first time the problem has been studied in the framework of a differential game and channel members' interactions are simultaneous in pricing and advertising. We investigated whether manufacturer or retailer leadership over pricing and advertising leads to channel efficiency and looked at the effects of leadership on both players' strategies. Who benefits from leadership? Who should be the channel leader ? To answer these questions we considered a model in which the retailer's advertising effort is directed to increase current sales while the manufacturer's advertising effort is intended to build up brand goodwill which influences current and future sales.

Our findings suggest that the concept of vertical strategic interaction, which has been proved to be a driving factor in determining the effects of leadership roles in pricing games, may just tell a partial history. In their conclusion, Lee and Stealin (1997, p. 201) asked "whether these three types [vertical strategic substitutability, vertical strategic independence, vertical strategic complementarity] of vertical strategic interaction all exist in the real world". However, if channel members are concerned with their partner's reactions on their pricing decisions, they should also be concerned with reactions on other marketing decision variables since that pricing is not the only element of their marketing mix. Thus we studied a model in which channel members are also concerned by reactions on advertising policies and by making this extension there will also be interactions among a player's own controls. Of course, our analysis has only produced partial answers since there are many more components in the marketing mix. However, to know how channel members set their marketing strategies or which decisions of their channel partner they take into consideration is ultimately a matter of empirical investigation.

We also departed from the symmetric outcomes known from pure pricing games and showed that manufacturer and retailer leadership in a channel are not symmetric. While the former leadership over pricing and advertising improves channel efficiency and is desirable in terms of consumer welfare, the latter is not desirable neither for the channel efficiency nor consumer welfare. With the retailer as the leader, the retail price is higher, both members' advertising rates are lower and the quantities sold are lower than under the cooperative, the Nash and the SM games. We also found that every channel member is better off with his own leadership. We observed that if the manufacturer, for any reason, does not realize that the retailer takes into account the current brand goodwill stock in setting his advertising policy, the retailer invests less. This result is intuitive and more realistic than the one available in the pricing literature under vertical strategic substitutability. Here it is better to be the follower than being the leader. Moreover, the unresolved question of who should be the channel leader has found a solution in the present context. While everybody would like to be the channel leader, the retailer would also accept to be the follower rather to play a Nash game which would be the manufacturer's second best. This result is an interesting contribution and should have implications for marketing modelers and managers. First, marketing modelers have often assumed that the manufacturer is the channel leader (Moorthy 1987; Ingene and Parry 1995a,b; Gerstner and Hess 1995; Bergen and John 1997; Desiraju and Moorthy 1997) although this choice is somewhat arbitrary (Jeuland and Shugan 1983, 1988). Our findings provide a rational explanation for choosing the manufacturer as the leader since endogenously we showed that manufacturer leadership is preferred to retailer leadership and symmetric roles. This seems to be consistent with statements of some marketing scholars in the behavioral channel literature who advocate the introduction of a "chain captain" as a management device in a channel (Alderson 1957; Bowersox *et al.* 1980; Stern and El-Ansary 1992). However, manufacturer's leadership does not fully coordinate the channel, compared to the joint profit maximization case and should only be considered as a second best.

The results presented here are limited by our assumptions. It may be interesting to relax some of the assumptions, for example, new formulations of the demand function with respect to price, the goodwill stock and the retailer's advertising are to be explored. We have assumed that channel partners play a static pricing game which is not realistic when a retailer uses "every low prices" since then his pricing strategy influences his outlet's reputation which is an important element for overall strategy. We have also assumed that the manufacturer adopts exclusively a pull marketing strategy and the retailer follows a push marketing strategy. This is an extreme case and it would be fruitful to study a specification in which the manufacturer uses both push and pull marketing strategies.

Appendix 1: Derivation of the feedback Nash equilibria

Since a_R, m_R and m_M do not appear in the dynamics(3), they can be determined by static optimization. Manufacturer's advertising rate is determined as function of the current goodwill stock, i.e., $a_M^N = \phi(G)$. The following conditions are sufficient for a Markovian Nash equilibrium

$$\frac{\partial J_R}{\partial m_R} = \alpha - \beta m_M - 2\beta m_R = 0 \tag{51}$$

$$\frac{\partial J_M}{\partial m_M} = \alpha - \beta m_R - 2\beta m_M = 0 \tag{52}$$

$$\frac{\partial J_R}{\partial a_R} = m_R(\alpha - \beta m_M - \beta m_R)\gamma\sqrt{G} - w_R a_R = 0 \tag{53}$$

$$\begin{aligned} &\max\{m_M a_R(\alpha - \beta p_R)\gamma\sqrt{G} - 1/2 w_M a_M^2 \\ &+\frac{dV_M^N}{dG}(a_M - \delta G) \mid a_M \geq 0\} = rV_M^N(G) \end{aligned} \tag{54}$$

From (52)-(53), one gets

$$m_M^N = m_R^N = \frac{\alpha}{3\beta} = const. > 0 \tag{55}$$

$$a_R^N(t) = \frac{\alpha^2}{9\beta w_R}\sqrt{G^N(t)} \tag{56}$$

Maximizing the left hand side of (54) with respect to a_M gives the following

$$a_M = \frac{1}{w_M}\frac{dV_M^N}{dG} \tag{57}$$

Substituting m_M, m_R, a_R and a_M in (54) leads to

$$rV_M^N(G) = \frac{\alpha^4\gamma^2 G}{81\beta^2 w_R} + \frac{1}{2w_M}\left(\frac{dV_M^N}{dG}\right)^2 - \delta G\frac{dV_M^N}{dG} \tag{58}$$

It is easy to verify that a linear form for the value function provides a solution to the HJB equation

$$V_M^N(G) = l_1 G + l_2 \tag{59}$$

where

$$l_1 = \frac{\alpha^4\gamma^2}{81\beta^2 w_R(r+\delta)}, \qquad l_2 = \frac{\alpha^8\gamma^4}{2r(r+\delta)^2 w_R^2 w_M} \tag{60}$$

Equation (57) now becomes

$$a_M^N = \frac{l_1}{w_M} = \frac{\alpha^4\gamma^2}{81\beta^2 w_R w_M(r+\delta)} \tag{61}$$

The goodwill state equation becomes

$$\dot{G}^N = \frac{\alpha^4\gamma^2}{81\beta^2 w_R w_M(r+\delta)} - \delta G \tag{62}$$

By integration, one obtains the equilibrium goodwill trajectory starting at G_0

$$G^N(t) = (G_0 - G^N_{SS})e^{-\delta t} + G^N_{SS} \tag{63}$$

where the steady state is given by

$$G^N_{SS} = \frac{\alpha^4\gamma^2}{81\beta^2 w_R w_M \delta(r+\delta)} \tag{64}$$

Appendix 2: Derivation of Stackelberg equilibrium with retailer as leader

As in the Nash game, retailer's advertising and margin strategies are determined by static optimization. Manufacturer's margin is also determined by static optimization and his advertising rate by dynamic optimization. Manufacturer's HJB equation is

$$\begin{aligned}&\max\{m_M a_R(\alpha - \beta p_R)\gamma\sqrt{G} - 1/2 w_M a_M^2 \\ &+\frac{dV_M^{SR}}{dG}(a_M - \delta G) \mid a_M \geq 0\} = rV_M^{SR}(G)\end{aligned} \tag{65}$$

The manufacturer's best response is obtained by maximizing the left hand side with respect to a_M which leads to

$$m_M^{SR} = \frac{\alpha - \beta m_R^{SR}}{2\beta} \tag{66}$$

$$a_M^{SR} = \frac{1}{w_M}\frac{dV_M^{SR}}{dG} \tag{67}$$

Substituting the above results into the retailer's objective functional and maximizing with respect to a_R and m_R leads to

$$m_R^{SR} = \frac{\alpha}{2\beta} \tag{68}$$

$$a_R^{SR} = \frac{\alpha^2\gamma}{8\beta w_R}\sqrt{G^{SR}} \tag{69}$$

Equations (66)-(68) lead to

$$m_M^{SR} = \frac{\alpha}{4\beta} \tag{70}$$

The HJB equation now becomes

$$rV_M^{SR}(G) = \frac{\alpha^4\gamma^2 G}{128\beta^2 w_R} + \frac{1}{2w_M}\left(\frac{dV_M^{SR}}{dG}\right)^2 - \delta G\frac{dV_M^{SR}}{dG} \tag{71}$$

It can be easily shown that a linear value function provides a solution to the above equation. As a consequence, manufacturer's advertising rate would be given by

$$a_M^{SR} = \frac{\alpha^4\gamma^2}{128\beta^2 w_R w_M (r+\delta)} \tag{72}$$

The goodwill stock becomes

$$\dot{G}^N = \frac{\alpha^4\gamma^2}{128\beta^2 w_R w_M (r+\delta)} - \delta G \tag{73}$$

By integration, one obtains the equilibrium goodwill trajectory starting at G_0

$$G^{SR}(t) = (G_0 - G_{SS}^{SR})e^{-\delta t} + G_{SS}^{SR} \tag{74}$$

where the steady state is given by

$$G_{SS}^{SR} = \frac{\alpha^4\gamma^2}{128\beta^2 w_R w_M \delta (r+\delta)} \tag{75}$$

Appendix 3: Derivation of Stackelberg equilibrium with manufacturer as leader

Retailer's best response functions are obtained by maximizing his objective with respect to his margin and advertising rate

$$m_R^{SM} = \frac{\alpha - \beta m_M^{SM}}{2\beta} \tag{76}$$

$$a_R^{SM} = \frac{\left(\alpha - \beta m_M^{SM}\right)^2}{4\beta w_R}\gamma\sqrt{G^{SM}} \tag{77}$$

The manufacturer's HJB equation is given by

$$\begin{aligned} &\max\{m_M a_R(\alpha - \beta p_R)\gamma\sqrt{G} - 1/2 w_M a_M^2 \\ &+\frac{dV_M^{SM}}{dG}(a_M - \delta G) \mid a_M \geq 0\} = rV_M^{SM}(G) \end{aligned} \tag{78}$$

Substituting for retailer's margin and advertising and maximizing the left hand side leads to

$$m_M^{SM} = \frac{\alpha}{4\beta} \tag{79}$$

$$a_M^{SM} = \frac{1}{w_M}\frac{dV_M^{SM}}{dG} \tag{80}$$

Given this, retailer's advertising and margin become

$$m_R^{SM} = \frac{3\alpha}{8\beta} \tag{81}$$

$$a_R^{SM} = \frac{9\alpha^2}{64\beta w_R}\gamma\sqrt{G^{SM}} \tag{82}$$

Again, it can be easily shown that a linear form solves the HJB equation. Following the same steps as in the previous case leads to the results stated in the proposition.

Appendix 4: Derivation of the joint optimization solution

The HJB equation is given by

$$\begin{aligned} &\max\{ma_R(\alpha - \beta p_R)\gamma\sqrt{G} - 1/2w_M a_M^2 - 1/2w_M a_M^2 \\ &+\frac{dV^C}{dG}(a_M - \delta G) \mid m, a_R, a_M \geq 0\} = rV^C(G) \end{aligned} \tag{83}$$

Maximizing the left hand side leads to

$$m = \frac{\alpha}{\beta} \tag{84}$$

$$a_M^C = \frac{1}{w_M}\frac{dV_M^C}{dG} \tag{85}$$

$$a_R^C = \frac{\alpha^2\gamma}{4\beta w_R}\sqrt{G^C} \tag{86}$$

It suffices to substitute for m, a_M^C, a_R^C in the HJB equation and to follow the same procedure as before, that is to take a linear form for the value function, to get the results stated in the proposition.

Appendix 5: Proof of Proposition 5.

Results for margins are obvious from (10), (17)-(18) and (25)-(26).

Let

$$T = \frac{\alpha^4\gamma^2}{\beta^2 w_R w_M(r+\delta)} \tag{87}$$

Manufacturer's advertising strategies can be expressed

$$a_M^C = \frac{T}{32}, \;\; a_M^{SM} = \frac{27T}{2048}, \;\;\; a_M^N = \frac{T}{81}, \;\;\; a_M^{SR} = \frac{T}{128} \tag{88}$$

and hence the result.

The goodwill trajectories can be written as follows

$$G^i(t) = G_0 e^{-\delta t} + (1 - e^{-\delta t})\frac{a_M^i}{\delta}, \quad i = C, SM, SR, N \tag{89}$$

The result is then a consequence of (88).

Let

$$U = \frac{\alpha^2 \gamma}{\beta w_R} \tag{90}$$

The retailer's advertising strategies can be expressed as follows

$$a_R^C = \frac{U}{4}\sqrt{G^C}, \quad a_R^{SM} = \frac{9U}{64}\sqrt{G^{SM}}, \quad a_R^{SR} = \frac{U}{9}\sqrt{G^C}, \quad a_R^N = \frac{U}{9}\sqrt{G^C} \tag{91}$$

Given the results regarding goodwill ordering, it is easy to verify retailer's advertising one.

To compare payoffs, we compute first value functions at G_0 to obtain

$$V_M^N(G_0) = \frac{ZG_0}{81} + \frac{Z^2}{13122 r w_M}, \quad V_R^N(G_0) = \frac{ZG_0}{162} + \frac{Z^2}{13122 r w_M} \tag{92}$$

$$V_M^{SR}(G_0) = \frac{ZG_0}{128} + \frac{Z^2}{32768 r w_M}, \quad V_R^{SR}(G_0) = \frac{ZG_0}{128} + \frac{Z^2}{16384 r w_M} \tag{93}$$

$$V_M^{SM}(G_0) = \frac{27ZG_0}{2048} + \frac{(27)^2 Z^2}{2(2048)^2 r w_M}, \quad V_R^{SM}(G_0) = \frac{81ZG_0}{8192} + \frac{2187 Z^2}{4(2048)^2 r w_M} \tag{94}$$

where

$$Z = \frac{\alpha^4 \gamma^2}{\beta^2 w_R (r + \delta)} \tag{95}$$

From this the result is obvious.

Appendix 6: Proof of Proposition 6

Recall that retail price is equal to the sum of manufacturer's and retailer's margin. The retail price ordering is then very easy to verify.

Denote by

$$D = \frac{\alpha^3 \gamma^2}{\beta w_R} \tag{96}$$

Demand rates can then be expressed as follows

$$q^C = \frac{DG^c}{8}, \quad q^{SM} = \frac{27DG^c}{512}, \quad q^N = \frac{DG^c}{27}, \quad q^{SR} = \frac{DG^c}{32} \tag{97}$$

Exploiting the goodwill ordering obtained in the previous proposition leads to the result.

The total channel profit under coordination is obtained by evaluating the value function at initial goodwill stock

$$V_T^C(G_0) = \frac{1}{32} Z G_0 + \frac{Z^2}{(2048) r w_M} \tag{98}$$

The noncooperative total profits are simply sum of individual profits in each game. Simple comparisons lead to the result.

Appendix 7: Proof of Proposition 7

Straightforward comparison of individual profits, given by (92)–(94), in each game leads to the result.

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