Les Cahiers du GERAD ISSN: 0711–2440

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G–2005–36

April 2005

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April 2005

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Abstract

In the last two decades, various studies developed static and dynamic game theory models to demonstrate that the efficiency of marketing channels can be raised through the choice of particular channel structures or the implementation of coordinating mechanisms, e.g. particular pricing schemes, cooperative advertising, channel leadership. The use of the game theory approach to deal with this topic is justified by the fact that marketing channels are composed of a set of independent institutions that interact with each other, and that channel efficiency is affected by the cooperative or non-cooperative behavior of these institutions. This paper reviews the major contributions in the literature that examined the issue of channel coordination according to the game theory approach. It highlights its main results and identifies research questions for further investigation.

Key Words: Game theory, Marketing channels, Coordination, Pricing, Leadership, Cooperative advertising, Incentive strategies, Vertical integration.

Résumé

Dans les deux dernières décennies, plusieurs auteurs se sont intéressés au développement de modèles statiques et dynamiques utilisant la théorie des jeux. Ces modèles mettent en évidence le fait que l'efficacité des circuits de distribution peut être améliorée grâce au choix de la structure du canal et à l'implémentation d'un certain nombre de mécanismes de coordination, par exemple la politique de tarification, la publicité coopérative, le leadership dans le canal, etc. L'utilisation de la théorie des jeux dans ce domaine est justifiée par le fait qu'un circuit de distribution n'est autre qu'un ensemble d'institutions qui interagissent les unes avec les autres, et que l'efficacité du circuit est affectée par les comportements coopératifs ou conflictuels de ces institutions. Cet article fait la synthèse des principaux résultats obtenus dans cette littérature et met en évidence plusieurs voies de recherche nécessitant plus dinvestigation dans ce domaine.

Mots clés : théorie des jeux, circuits de distribution, coordination, tarification, publicité coopérative, stratégies incitatives, intégration verticale.

1 Introduction

An important game theoretic literature on conflict and coordination in marketing channels has developed during the last two decades.[1] This paper reviews a large subset of these contributions with the intention of deriving a list of open problems that may be part of a research agenda in the coming years.

A marketing channel is a set of interdependent institutions (e.g., manufacturers, wholesalers, retailers, etc.) involved in the process of moving products and services to final consumers (Coughlan et al., 2001). When each institution selfishly makes its manufacturing or marketing decisions (e.g., product quality, inventory, pricing, promotion, advertising), we say that the channel is uncoordinated. In the parlance of game theory, this would correspond to a non-cooperative game. It is well known that the resulting equilibrium is generally not Pareto-optimal and thus, there is room to attempt to improve the players' fate. A general result reported in the literature is that the coordination of strategies increases channel efficiency (Stern, 1969; Reve and Stern, 1979, Coughlan et al., 2001). Our objective is precisely to review the coordination mechanisms suggested in the literature, e.g., pricing schemes, cooperative advertising, incentive strategies, channel leadership.

The paper is organized as follows. In Section 2, we first provide a simple motivating example and then discuss the option of full integration of the channel. In Section 3, we review the contributions that adopted a static game approach to coordinate the channel. In Section 4, we review those contributions that assumed that the game is dynamic. In Section 5, we provide some research avenues and concluding remarks.

2 On Uncoordination and Full Integration

One way of eliminating the inefficiencies resulting from a lack of strategy coordination is full integration of the channel. This option cannot be considered, in a usual sense, as a coordination mechanism between two independent entities. It is a rather drastic solution, which eliminates the inefficiency problem, but could be infeasible for reasons not included in the model. We nevertheless review the contributions in this area because full integration can be seen as a benchmark to the coordination mechanisms.

2.1 A Motivating Example

Channel members are independent institutions pursuing their own individual objectives of profit maximization without a consideration of the effect of their decisions on their partners. To show that this lack of coordination leads to channel inefficiencies in the form

[1] The interested reader may consult Moorthy (1993) for a review of static game theory in marketing and Jørgensen and Zaccour (2004) for a review of differential games in marketing. The book by Ingene and Parry (2004) provides an excellent tour of mathematical modelling of marketing channels.

of lower profits for the channel, and possibly of lower consumer welfare, we consider a (classical) simple pricing game.

Let the channel be formed of one manufacturer (player M) and one retailer (player R) and assume that each player's strategy is her margin. Denote by w the wholesale price of the manufacturer and by m the retailer's margin. The retail price is thus given by $p = w + m$. Consumers are represented by the following downward-sloping demand function:

$$q(p) = \alpha - \beta p, \quad \alpha, \beta > 0.$$

Assume that the manufacturer's unit production cost is c, a constant satisfying $0 \leqslant c \leqslant \alpha/\beta$. The players' optimization problems are given by

$$\begin{aligned} \max_w \pi_M &= (w - c)(\alpha - \beta(w + m)), \\ \max_m \pi_R &= m(\alpha - \beta(w + m)). \end{aligned}$$

We consider two scenarios; in the first one, the channel is uncoordinated and the mode of play is noncooperative. A Nash equilibrium is sought and results will be superscripted by N. In the second scenario, the players jointly maximize the channel profit and results will be superscripted by C.

It is easy to check that the unique Nash equilibrium of the non-cooperative game is given by

$$w^N = \frac{\alpha + 2\beta c}{3\beta}, \qquad m^N = \frac{\alpha - \beta c}{3\beta}.$$

The resulting retail price, quantity and profits are as follows:

$$p^N = \frac{2\alpha + \beta c}{3\beta}, \quad q^N = \frac{\alpha - \beta c}{3}, \; \pi_R^N = \pi_M^N = \frac{(\alpha - \beta c)^2}{9\beta}, \quad \pi^N = \frac{2(\alpha - \beta c)^2}{9\beta},$$

where π^N is the channel's total profit.

Turning to the integrated channel scenario where the players jointly optimize their profits, it is easy to obtain

$$p^C = \frac{\alpha + \beta c}{2\beta}, \quad q^C = \frac{\alpha - \beta c}{2}, \quad \pi^C = \frac{(\alpha - \beta c)^2}{4\beta}.$$

Comparing the results of the two scenarios leads to the following observations:

- Retail price is lower, and consequently demand is higher, under full integration than in the uncoordinated equilibrium.
- Total channel profit is higher when the channel is integrated.

These results are due to so-called *double marginalization*, reported first in Spengler (1950), in the uncoordinated scenario, whereas in an integrated channel, only one margin is added to the production cost.

This simple example clearly shows that channel efficiency is seriously affected by the non-cooperative behavior of its members. Given this state of affairs, the literature has put forward some coordinating mechanisms to induce the independent channel partners to act for the best interest of the whole channel.

2.2 Vertical Integration

Vertical integration transforms the two-player game into an optimization problem with one decision-maker. Since total channel cooperative outcome is at least as high as its non-cooperative counterpart, it is easy to accept the motivation behind the prescription of full vertical integration (see, e.g., Young (1991) and Betancourt and Gautschi (1998) for an illustration). What remains to be seen is whether this result still holds when there is competition at the manufacturing level, and if vertical integration is acceptable when one takes into account elements other than profits.

Considering an industry composed of two competitive manufacturers selling their products through two exclusive outlets, McGuire and Staelin (1983) computed the manufacturers' profits, and total channel profits under different channel structures in order to identify the Nash equilibrium one. They investigated three channel structures: a fully integrated channel where the manufacturers own their outlets (II); a fully decentralized channel (DD), where both shift the distribution functions to private outlets; and finally, a mixed structure where one manufacturer is vertically integrated while the other decentralizes (ID). In the first scenario, the integrated manufacturers control their retail prices, while in the remaining scenarios, the decentralized manufacturers are channel leaders who fix (without colluding) their wholesale prices, while the retailers fix the retail prices.

McGuire and Staelin (1983) considered the following linear downward-sloping demand function:

$$q_i\left(p_i, p_j\right) = 1 - p_i + \theta p_j, \quad i = 1, 2; \quad j = 3 - i,$$

where the indices i and j refer to manufacturers, and θ is a positive parameter capturing the substitution between the two products $(\theta < 1)$. Channel members' manufacturing and selling cost functions are assumed linear.

An important result given by McGuire and Staelin (1983) is that the choice of the channel structure depends on the degree of substitutability between products. Indeed, the authors conclude that it is better to decentralize the channel when products are highly substitutable (high levels of θ), while vertical integration is recommended when the demands for both products are not highly interdependent.[2] Furthermore, the authors examined the

[2] These results have been confirmed by Coughlan (1985) with empirical data from the semiconductor industry.

conditions under which decentralization or vertical integration could be part of a Nash equilibrium. They proved that, when the criteria is manufacturers' profit maximization, the mixed structure can never be a Nash equilibrium. For values of $\theta \in [0; 0,931]$, the (II) structure is the only Nash equilibrium, and (DD) is the best channel structure for $\theta \geq 0,708$. For values of $\theta \geq 0,931$, both (II) and (DD) could be Nash equilibria since either manufacturer has an incentive to change the channel structure. When channel coordination aims at maximizing total channel profits, the authors showed that the (DD) structure is a Nash equilibrium only when $\theta \geq 0,771$, while (II) is a Nash equilibrium for all values of θ.

The above results point to a relationship between the channel structure and the manufacturers' optimization criterion of setting prices. Indeed, when the manufacturer maximizes her own profits, the critical values of θ, for which decentralization is better than vertical integration are higher than those obtained when the criterion is the maximization of total channel profit.[3] The explanation for this result is that, for an integrated channel structure, manufacturer profit is equal to total channel profit, while for a decentralized channel, total channel profit is shared between the manufacturer and her dealer. Hence, for decentralization to be the best channel structure for a largest range of values of θ, mechanisms should be introduced to allow the manufacturer to appropriate the retailer's share of profits.

Moorthy (1988) showed that the results obtained by McGuire and Staelin (1983) do not only involve the parameter capturing demand substitutability (θ), but depend also on the strategic dependence between manufacturers. Strategic dependence relates to the reaction of each manufacturer to the actions of her rivals. When an aggressive behavior by one firm leads to an aggressive behavior by its competitor, the situation is one of strategic complementarity. In a situation of strategic substitutability, the aggressive behavior of one firm induces a conservative reaction from the other. Finally, strategic independence describes situations where the actions of each firm do not induce any reaction from the other.

The importance of considering strategic dependency lies in the fact that, under strategic complementarity (substitution), a vertically integrated manufacturer who decides to switch to a decentralized structure, not only affects her retail price, by increasing it (because of double marginalization), but also induces the competing manufacturer to increase (decrease) her retail price. When products are demand substitutes, the increase (decrease) of the competitor's price leads to an increase (decrease) of the firm's sales and profits. We can then expect that the results will differ when products are demand complements. Moorthy (1988) proved such results by providing four examples that differed in the functional forms of the demand and cost structures (hence implying different situations of demand dependence and strategic dependence). According to him, vertical integration is superior

[3] McGuire and Staelin (1986) is an extention of McGuire and Staelin (1983) where the authors examine the impact of other criteria on the choice of particular channel structures. An example of such criteria is maximization by the manufacturer is the sum of her profit and a fraction of her dealers' profits.

to decentralization in the absence of strategic interactions. However, decentralization could be preferable when one of these mutually exclusive conditions hold:

- products are demand substitutes and strategic complements, or
- products are demand complements but strategic substitutes.

Finally, Coughlan and Wernerfelt (1989) proved that the equilibrium channel structure is always the decentralized one, no matter if the products are demand substitutes or complements. Their result is also independent of the level of competition at the manufacturing and retail levels and the functional form of the demand function. According to the authors, the choice of the optimal channel structure relies only on the observability of contracts.

Another solution to double marginalization, investigated in literature, is the imposition of a retail price by the manufacturer (Retail Price Maintenance or RPM). This price is derived by the maximization of the joint channel members' profits as in the case of vertical integration. The difference between RPM and vertical integration is that, in the former, both parties remain independent institutions. Such a price can be included in a simple contract that specifies every channel member's price decisions (Thépot, 1999).

Although vertical integration and RPM lead to better channel efficiency, both solutions may be hard to implement. Indeed, vertical integration involves many other variables not accounted for here (not the least of which are financial and legal issues) and thus, one has to look for a second-best solution in the event that full integration is not on the menu. On top of being complicated to enforce by a contract, RPM may also be legally challenged on the grounds that it may restrict competition in retailing.

Finally, Shugan (1985) examined pricing strategies in a bilateral monopoly and showed that channel outcome is higher when channel members are smart enough (i.e., they learn from the past behavior of their partners) to make implicit understanding of other members' reactions and include them in their decisions. Nevertheless, the author considered that implicit understanding must be taken as a substitute for explicit control mechanisms, as the latter lead to higher channel efficiency. In fact, according to the author, channel efficiency results from the understanding of the mutual interdependencies between channel members' decisions, and when this influence is used by channel partners to acheive partial coordination. Since none of the channel partners has the control over the decisions of the other, understanding cannot lead to complete coordination. Jeuland and Shugan (1988b) generalized Shugan (1985) results to different functional forms for the demand equation.

For Jeuland and Shugan (1983), channel coordination could be better achieved with incentives that induce more spending in marketing activities than with vertical integration or contracts. Such incentives are called "coordinating mechanisms".

3 Coordination Mechanisms in Static Games

One common assumption in all the references appearing in this section is that the game is played once, i.e., that there is no repetition and there are no dynamics. This section is divided into three subsections dealing with coordination through, respectively, profit sharing, leadership, and advertising and promotional activities. Two preliminary remarks can be made. First, when it comes to a marketing instrument, pricing has been the dominant coordinating variable in this literature. Second, and as in any literature review, our classification is far from being the only one possible. We could have considered a classification based on the adopted equilibrium concept in the non-cooperative games (Nash or Stackelberg), on the number of players (two or more), on the coordinating variable (transfer price, retail price, advertising expenditures, etc.) or possibly, on another variable.

3.1 Profit Sharing through Pricing

3.1.1 Bilateral Monopoly Structure The first studies that examined the issue of channel coordination through the design of pricing schedules considered simple channel structures, where an exclusive retailer distributes the product of a manufacturer (i.e., a dyad or a bilateral monopoly). We first begin by exposing the results for bilateral monopolies and then extend them to channel structures with competition at the retail and/or manufacturing levels when it applies.

A seminal paper on channel coordination is Jeuland and Shugan (1983). By examining a game that takes place in a bilateral monopoly, where channel members make marketing decisions (relative to pricing, product quality, and shelf space), Jeuland and Shugan confirmed that joint ownership (i.e., vertical integration) maximizes total channel profits in a symmetric channel.[4]In the event that the manufacturer and the retailer remain independent institutions, the authors showed that an adequate profit-sharing mechanism can achieve coordination. More precisely, this mechanism is based on a linear relationship between the total channel profit and individual ones. The idea here is that the total channel profit is always maximized when a channel member optimizes her own profit.

Jeuland and Shugan (1983) showed that total-profit sharing can be realized in a much subtle manner by a pricing schedule with a quantity discount. This mechanism allows the retailer's costs (i.e., wholesale price) to decrease when the retailer orders a larger quantity. Consequently, the retailer is encouraged to order and sell additional units of the product, and the additional profits are shared between channel members. The quantity discount $w(q)$ that coordinates the channel must have the following structure:

$$w(q) = k_1 (p(q) - c - f) + c + \frac{k_2}{q},$$

[4] A channel where the members act simultaneously and share the same information. The authors also extend their conclusions on the inefficiencies of uncoordination to cases of multiple retailers and multiple manufacturers.

where $p(q)$ is the price at which demand is q, c is the manufacturer's production cost and f is the retailer's selling cost. Finally, k_1, k_2 are positive parameters, with $k_1 < 1$. When the above quantity discount is implemented, then a linear relationship between the total channel profit, given by $(p - c - f)\,q$, and individual profits guaranteeing channel coordination is induced. The total channel profit is then divided among channel members according to the following rules:

$$\begin{aligned} \pi_M &= k_1\left[(p - c - f)\,q\right] + k_2, \\ \pi_R &= (1 - k_1)\left[(p - c - f)\,q\right] - k_2. \end{aligned}$$

Thus, the manufacturer gets a fraction k_1 of the total profit plus a fixed amount k_2, and the remaining amount goes to the retailer. The sharing parameters k_1 and k_2 can be determined by negotiation between channel members.

McGuire and Staelin (1986) criticized the quantity discount mechanism proposed by Jeuland and Shugan (1983) on the grounds that the variable part of the pricing scheme requires from the manufacturer (*i*) to be informed about the retailer's selling costs, and (*ii*) to apply different quantity discounts if her dealers face different selling costs. McGuire and Staelin (1986) suggested that the problem be circumvented by setting k_1 equal to zero, and adding a franchise fee tax. In this case, only knowledge of the retailer's gross profit is necessary, an information normally available to manufacturers in franchised systems.

Moorthy (1987) showed that a two-part tariff scheme can achieve the same result (coordination) as the quantity discount pricing (QDP) scheme in Jeuland and Shugan (1983) with an additional advantage. First, Moorthy observed that the QDP scheme actually induces the independent retailer to choose the retail price that coordinates the channel (p^*) by ordering the quantity $q(p^*)$.The latter is equal to the quantity that would be ordered if the channel were coordinated. The necessary condition that satisfies this is that the retailer's marginal cost must be equal to the channel's total marginal cost. Second, Moorthy (1987) proved that this condition is easily verified by a two-part tariff, a pricing scheme that removes the variable part in the quantity discount suggested by Jeuland and Shugan (1983). Now, the additional advantage of a two-part pricing scheme is that it is easier to implement than a QDP scheme and is less prone to the potential legal problem of discrimination between retailers.

3.1.2 Competitive Retailers Some contributions dealt with the issue of channel coordination through pricing strategies in channels exhibiting competition at the retail level. The assumption of multiple retailers is more realistic. Actually, it is the rule rather than the exception that manufacturers distribute their products through multiple dealers.

Ingene and Parry investigated the issue of channel coordination via two-part tariffs by examining two channel structures: a manufacturer with multiple exclusive retailers (1995a), and a manufacturer with two competing retailers (1995b).

In the first study, where N exclusive retailers serve independent areas, the relationship between channel members is modelled as a two-stage game: At the first stage, the manufacturer offers to retailers a wholesale pricing scheme that maximizes total channel profits. At the second stage, each retailer decides whether or not to join the channel, and fixes the quantity to order if she accepts to participate.

Ingene and Parry (1995a) obtained the same results in Moorthy (1987), thus confirming that coordination of each dyad in the channel can be achieved through the same two-part tariff. Furthermore, the authors showed that the number of retailers that will accept to join the channel is determined by the fixed fee, and that their number is generally lower than the number of retailers in a vertically integrated system. Indeed, each retailer is expected to join the channel only if her net profit is non-negative. This means that the relationship between the number of retailers in the channel and the fixed fee must be decreasing, while the manufacturer's profit increases with the number of retailers and the value of the fee. This fee allows the sharing of total profits between the manufacturer and its dealers.

Ingene and Parry (1995a) also examined a case where the manufacturer, who aims at maximizing her individual profit, designs a two-part tariff contract that allows the participation in the channel of as many retailers as are attracted by a coordinating two-part-tariff. One of the surprising results they obtained is that the manufacturer is better off when she chooses the non-coordinating pricing scheme. Hence, in the presence of many retailers, channel coordination is only optimal when (*i*) the marginal retailer orders the same quantity as the average participant retailer, or (*ii*) when the manufacturer has the possibility of discriminating between her retailers by offering different price schedules.

In the second study, Ingene and Parry (1995b) designed different pricing schemes (a quantity discount and many two-part tariffs) to coordinate the channel when retailers compete in the market. The quantity discount offered to retailer i has the following form:

$$w(q_i) = (T - tq_i)\, q_i + K,$$

where q_i represents the quantity ordered by retailer i from the manufacturer, T is a vertical intercept of per-unit transfer price, t is the slope of the per-unit transfer price, and K is a fixed fee paid by the retailer to the manufacturer. The transfer prices that take the form a two-part tariff (with a constant per-unit fee) are obtained by setting $t = 0$. Three tariffs are considered: (1) a tariff that maximizes total channel profit when a manufacturer's product is sold by a unique retailer, (2) a Stackelberg tariff, where the term T maximizes manufacturer profit, and (3) a second-best tariff where T maximizes total channel profit.

Ingene and Parry (1995b) confirmed previous results obtained by Jeuland and Shugan (1983) for bilateral monopolies, stating that a linear quantity discount can coordinate a channel. They generalized these results to a channel structure with competing retailers, but refuted those obtained in Moorthy (1987) for bilateral monopolies, and in Ingene and Parry (1995a) for retailers with exclusive territories, stating that two-part tariffs (with a constant per-unit fee) are channel coordinating.

The authors also proved that the manufacturer is better off when she follows a non-coordinating strategy, a result that they had already found in their (1995a) study. The manufacturer, in this case, is more interested by offering the tariff (2) or (3). This behavior is motivated by the fact that the Robinson-Patman Act obliges manufacturers to treat their multiple dealers equally. For this reason, manufacturers prefer to set simple pricing schedules. In such schedules, the transfer of profit from the retailer to the manufacturer is done via the fixed fee, which is subject to the constraints set by the law. This reduces the transfer of profits to the manufacturer, and induces her non-coordinating choice.

Gestner and Hess (1995) proposed the pull promotions strategy as a way to induce channel coordination. Pull promotions are price discounts offered directly to consumers. According to the authors, such a strategy leads to higher channel profits whenever it targets price-conscious consumers. Indeed, as the market is composed of consumers with high and low willingness-to-pay, a self-interested retailer is inclined to sell only to high consumers with willingness-to-pay, and drop the other parts of the market. A price discount addressed only to consumers with low willingness-to-pay makes the demand more elastic and incites the retailer to reconsider her noncooperative behavior. The authors showed that the total channel profit generated by selling at a reduced price to the whole market is higher than the total profit generated by selling only to one market segment at a high price, thus making the price promotion a good coordinating mechanism in the channel.

3.2 Leadership

Channel leadership is related to the information that some channel members have about other members' reactions. As a channel leader, an intermediary in the channel acts with more information than a follower (as she knows the follower's reaction function). Thus, the channel leader has the opportunity to declare her strategy first, and the follower can only react to this strategy. Since the channel leader has the opportunity to influence the follower's strategic decisions, some marketing scholars have advocated the notion of having a "chain captain", who acts as a coordinator of the channel (see, e.g., Stern and El-Ansary (1992)). Two questions are raised in the literature: Is it beneficial for channel members to have a "chain captain¿'. Add, if so, who should this captain be?

Traditionally, the role of captain was assumed by the manufacturer, because it is usually the manufacturer's brand, goodwill, product quality, and so forth that attract consumers to a retail outlet. Furthermore, the argument was that, since a single retailer buys only a small fraction of a manufacturer's output, the former was thought to be more dependent on the latter (or less powerful in negotiations). The emergence of huge national and international retailers (e.g.,Wal-Mart, Sears) and the success of many private labels have forced marketing scholars to rethink the issue of leadership.

In the game theory literature, the answers to the questions raised above have varied depending on the channel structure and the kind of strategic interactions that take place between channel members.

Choi (1996) considered a channel composed of two competing manufacturers i, k ($i, k = 1, 2; i \neq k$) selling their products through two common retailers j, l ($j, l = 1, 2; j \neq l$). The demand function faced by retailers is the following:

$$q_{ij} = 1 - p_{ij} + \alpha\left(p_{kj} - p_{ij}\right) + \beta\left(p_{il} - p_{ij}\right),$$

where q_{ij} is the quantity of product i sold by retailer j, and $p_{ij}$the retail price. The strategic variables are the wholesale prices for manufacturers and retail margins for retailers. Note that by assigning special values to the product and store substitutability parameters, α and β, one recovers simpler channel structures and the results that would apply. Indeed, setting $\beta = 0$ leads to a channel formed of two competing manufacturers selling their products though a common retailer. A channel structure where two competing retailers sell the product of a unique manufacturer is obtained by setting $\alpha = 0$, and a bilateral monopoly by taking $\alpha = \beta = 0$.

Choi (1996) compared individual and total channel profits under three leadership scenarios: (*i*) a vertical Nash scenario (VN), where manufacturers and retailers play a Nash game and the channel has no leader; (*ii*) a manufacturer Stackelberg scenario (MS), where manufacturers are the channel leaders; and (*iii*) a retailer Stackelberg scenario (RS), where retailers are the leaders. Choi showed that the total channel profit is maximized when there is no channel leader (VN). However, on an individual basis, the channel member that acts as a leader earns higher profits, compared to the cases where she is the follower, or when there is no channel leader. Thus, the vertical Nash leadership is an unstable structure since each channel member has an incentive to act as a leader. Furthermore, the author proved that product differentiation benefits manufacturers but hurts retailers, while store differentiation is preferred by retailers. Therefore, depending on the combination of differentiation parameters, the effect of channel leadership could be beneficial or damaging to total channel profits. Therefore, the leadership structure that allows channel coordination is never stable, since each channel member could increase her individual profit by choosing a channel partner with a high (or low) differentiation parameter compared to its competitors.

Furthermore, according to Choi (1991,1996), the results concerning the effects of leadership on channel efficiency also depend on the type of strategic dependence that takes place between channel members.[5] As in Moorthy (1988), Choi (1991) examined the issue of channel leadership by using two types of demand functions and different cost structures implying multiple situations of strategic dependence. The channel structure examined in the 1991 paper was that of a retailer distributing the products of two competing manufacturers. The results he obtained under a linear demand function are consistent with those obtained later in Choi (1996), and state that channel leadership is not desirable for the whole industry, and that the absence of a channel leader is not a stable solution since each

[5] In Choi (1996), the linear demand function implies a vertical strategic substitutability effect between channel members. Under this condition, the retailer's optimal reaction to an increase in the manufacturer's wholesale price is to decrease her retail margin.

channel member is better off when she is the channel captain. However, for a nonlinear demand function[6], the results are reversed for a large range of product differentiation values: The worst industry profit is obtained for channels without a leader, and each channel member is better off when another is the channel captain. Such results are consistent with those obtained previously by Moorthy and Fader (1988) for the bilateral monopoly case.

Lee and Staelin (1997) also investigated the issue of channel leadership in the same channel structure as the one used by Choi (1996) but used a general demand function that could imply different types of vertical strategic dependence (depending on the slope of the demand function). Their results were consistent with those of Choi (1991,1996) for situations of vertical strategic substitutability. Under vertical strategic complementarity, the results are reversed, and the channel is better off when there is no channel leader. Under strategic independence, channel members are indifferent on the issue of channel leadership.

Trivedi (1998) also examined the effects of channel leadership and channel structure (vertical integration versus decentralization) on profits and prices in a competitive channel. The demand function suggested by the author is linear in prices. Results of this study indicate that, when the level of product substitutability is low and there is no (or very low) store substitutability, total channel profits are higher when the retailers sell both competing products, no matter who is the channel leader. These results also hold for cases when both product and store substitutability parameters are high.

3.3 Advertising and Promotional Strategies

Up to now, the strategic coordinating mechanism has been pricing, of various flavors: price discount, two-part tariff or leadership pricing. Some authors proposed to examine whether non-price marketing variables, mainly promotional activities designed to intermediaries, can induce such results.

Cooperative advertising programs were examined by Berger (1972) and Dant and Berger (1996). These programs are incentives that can take the form of an advertising allowance (a lump sum or a fixed discount per item purchased by the retailer from the manufacturer), or a promotional cost-sharing mechanism where the manufacturer reimburses a portion of the promotional fees of the retailer.

Berger (1972) was among the first to use an analytical model to show that coordination can be achieved through advertising allowances. In the franchise system that he considers, the manufacturer, who acts as a leader, gives to the retailer an advertising allowance of X dollars per unit sold. The retailer chooses his advertising level[7], A, and the manufacturer considers the retailer's reaction function when he fixes the level of X.

[6] A constant elasticity demand function of the type: $q_i = \alpha p_i^{-\beta} p_j^{\gamma}$

[7] Advertising costs $C(A)$ are taken linear, i.e., $C(A) = A$.

The manufacturer's and the retailer's profit functions are, respectively,

$$\begin{aligned} P_M &= (c - v - X)\, S(A)\,, \\ P_R &= (m - c + X)\, S(A) - A, \end{aligned}$$

where c is the transfer price, v the variable cost of the manufacturer, m the retailer's profit margin, and $S(A)$ is an advertising response sales function.

It can easily be shown that a non-cooperative equilibrium is a pair (X, A), which solves the following equations:

$$(m - v)\left[S'(A)\right]^3 - \left[S'(A)\right]^2 + S(A)\, S''(A) = 0,$$
$$X = \frac{1}{S'(A)} - (m - c)\,.$$

When total channel profits are maximized, the allowance vanishes from the objective function and the optimal advertising level is obtained by solving

$$S'(A) = \frac{1}{m - v}.$$

The optimal joint profit is shown to be higher than the sum of individual profits. This result is expected. What was actually missing was a comparison of the profits of the two non-cooperative games, one with, and one without, an advertising allowance. This could have provided a hint about whether or not the advertising allowance is a coordinating mechanism. Interestingly, the author illustrates his results with real-world data from the soft-drinks industry.

Dant and Berger (1996) reconsidered the model in Berger (1972) but extended the problem to (i) a situation where the sales function is probabilistic, and (ii) a situation where the channel members have different opinions about the sales function.[8] The results obtained confirmed that, under cooperation, both channel members spend more on local and national advertising, and channel payoff increases.

In Huang and Li (2001), the cooperative advertising program is based on a cost-sharing mechanism. The authors consider a channel where the manufacturer subsidizes some of the retailer's advertising costs. The retailer decides on the amount of local advertising effort she will allocate to the brand: $a \geq 0$. The manufacturer fixes her investment in national advertising, $q \geq 0$, and the participation rate in retailer's local effort, $t \in [0, 1]$.

[8] Note that here, the authors considered a specific functional form for the sales function, which accounts for the decreasing marginal effects of advertising:

$$S(A) = k_1 - k_2 e^{-\theta A}$$

where $k_1 > k_2 > 0$.

The sales function ($S(a,q)$) is nonlinear and depends on the advertising efforts of both channel members as follows:

$$S(a,q) = \alpha - \beta a^{-\gamma} q^{-\delta}.$$

Wholesale and retail margins, denoted by ρ_m and ρ_r, respectively, are considered constant. Advertising costs are taken linear (unit cost = c).

The manufacturer and the retailer aim to maximize their individual profit functions given by

$$\begin{aligned} \pi_m &= \rho_m \left(\alpha - \beta a^{-\gamma} q^{-\delta}\right) - ta - cq, \\ \pi_r &= \rho_r \left(\alpha - \beta a^{-\gamma} q^{-\delta}\right) - (1-t)\, a. \end{aligned}$$

In Huang and Li (2001), the authors examine channel members' decisions and outcomes under a Nash, a Stackelberg, and a cooperative mode of play. In Li et al. (2002), the same model is studied, but an additional case of a higher order Stackelberg equilibrium[9] is introduced. Comparing the results under the different scenarios leads to the following conclusions:

- The manufacturer does not support the retailer's local advertising efforts when there is no channel leader.
- The manufacturer invests more in national advertising under a Nash mode of play compared to the Stackelberg case (where the manufacturer is the leader). The lowest level of national advertising is achieved under the Stackelberg game scenario.
- The manufacturer always prefers to be the channel leader in the cooperative advertising program.[10]
- Retailer preference between for one or the other situation (a channel with or without a leader), depends on channel members' profit margins and on the effect of local and national advertising on sales.
- Depending on the values of the channel members' profit margins and on the effect of local and national advertising (514) 766-3612on sales, the retailer could spend more or less on local advertising when there is no channel leader. The highest level of local advertising effort is achieved under the cooperative scenario, and the lowest level, under the higher order Stackelberg game.
- Both channel members are better off under the high-order Stackelberg scenario compared to the Stackelberg.

Bergen and John (1997) examined the use of cooperative advertising programs as an incentive implemented by the channel leader (the manufacturer) to push the retailer to

[9] Roughly speaking, in a higher-order Stackelberg game, the manufacturer re-optimizes, taking into account the best choice of follower and under the explicit constraint that the follower must still get her optimal profit.

[10] Compared to the case where there is no channel leader,.i.e., Nash game.

choose the cooperative solution. Two channel structures are studied: (*i*) a channel where a unique manufacturer sells her product through multiple competing retailers, and (*ii*) a channel where competition is taken into account at both the manufacturing and retailing levels.

In both situations, each retailer fixes her level of local advertising, her retail price, and the distance over which the advertisement will be sent. The manufacturer chooses the transfer price and a participation rate into retailer's local advertising effort. The transfer prices and the participation rate selected at the equilibrium are those allowing the implementation of the same levels of price, advertising, and retailer participation in the channel as would have been obtained in a vertically integrated channel. Further, the authors obtained that:

- The optimal participation rate increases with greater spillovers in local promotions and intrabrand competition between retailers.
- In the absence of interbrand competition, the optimal participation rate increases with the consumers' willingness to pay for the product.
- When interbrand competition is introduced in the model, the authors do not find any relationship between the participation rate and consumers' willingness to pay.

Although the advertising allowance is given by the manufacturer to retailers in order to induce them to more promotional spending, it is proven in practice that retailers do not pass-through the total amount of the side payment to final consumers.[11] Kim and Staelin (1999) showed that manufacturers are still interested by participating in a cooperative advertising program even though they are aware of the fact that retailers do not pass-through the total amount of the funds. The authors identify a set of conditions on the model's parameters that lead to higher allowances and lower pass-through rates.

As mentioned at the beginning of this section, all the studies cited above use static[12] models to examine the interactions in the marketing channel. Although these studies undoubtedly give interesting insights into the issue of cooperation and conflict in marketing channels, there is still a need to introduce the temporal dimension into the study of marketing channels. The next section deals with this topic.

[11] According to a Cannondale Associates Report (2001) on trade promotions, manufacturers believe that 52% of their trade funds are passed through to consumers while retailers assert that the pass-through is 62%.

[12] Some authors examined the issue of channel coordination by using multi-stage games. These are games where players take into account the history of the game. They are dynamic; however, contrary to differential games, the dynamic feature is not endogenous. An example of mutli-stage games applied to the problem of channel coordination is found in Chu and Desai (1995).

4 Coordination Mechanisms in Differential Games

The motivation for adopting a dynamic game formalism to analyze conflict and coordination issues in channels is twofold. First, manufacturers and retailers usually interact repeatedly over time. Second, many marketing instruments have carryover effects. Therefore, their impact cannot be fully accounted for by a static approach. In this section, we first contrast the results of coordinated and uncoordinated strategies in a channel and show that the result obtained in a static setting can be easily generalized to dynamic games. We then review the coordination mechanisms that have been used in differential games, namely cooperative advertising, leadership and incentives strategies.[13]

4.1 Coordinated and Uncoordinated Strategies

Chintagunta and Jain (1991, 1992) were among the first to study the channel coordination problem using differential games. They consider a two-member channel in which firms advertise to increase their respective goodwill among consumers. Let $a_M(t)$ and $a_R(t)$ denote the two firms' advertising efforts at time $t \in [0, \infty)$. Let $G_M(t)$ and $G_R(t)$ be the goodwill stocks of the two firms and suppose that these stocks evolve according to the Nerlove-Arrow (1962) dynamics:

$$\dot{G}_j(t) = a_j(t) - \delta G_j(t); \quad G_j(0) = G_{0j}, \quad j \in \{M, R\}, \tag{1}$$

where δ is the decay rate.

The consumer sales response function $S(G_M, G_R)$ is quadratic in the goodwill stocks, i.e.,

$$S(G_M, G_R) = \alpha_M G_M + \alpha_R G_R - \beta_M G_M^2 - \beta_R G_R^2 + \gamma G_M G_R \tag{2}$$

where all the coefficients are positive. Note that $S(G_M, G_R)$ is expressed in dollars and that it accounts for decreasing marginal returns and for interaction between the goodwill stocks. Note also that the control variables, i.e., advertising expenditures, affect only indirectly sales (via the goodwill stocks).

The authors assume that the costs of advertising efforts are quadratic and that total sales revenues are divided exogenously between the firms such that the manufacturer gets the proportion π and the retailer $1 - \pi$. Each firm wishes to maximize her discounted stream of profits over an infinite horizon.

In the absence of coordination, the firms implement an open-loop Nash equilibrium (OLNE). Otherwise, the players agree to maximize channel profits (i.e., a fully coordinated solution). The main findings are as follows: (i) Both players invest more in advertising effort when they coordinate their strategies. (ii) Coordination of strategies leads, as expected, to higher channel profits. The authors also provide some (numerical) findings regarding

[13] For a refresher on differential games, the interested reader may consult the tutorial chapter in Jørgensen and Zaccour (2004).

the impact of the key model's parameters on the likelihood of channel coordination. The message is that the higher the discount rate ρ, the carryover effect of advertising efforts in (1), and the larger the interaction term γ between the goodwill stocks in (2), the higher the likelihood of channel coordination. These findings provide interesting insights into the issue of coordination in marketing channels. A drawback however is that they are generated with an open-loop information structure that is basically static.

Jørgensen and Zaccour (1999) reconsider the channel coordination problem, but make some changes in the setup. First, there is only one goodwill stock, $G(t)$, whose evolution is given by

$$\dot{G}(t) = a_M(t) + a_R(t) - \delta G(t), \quad G(0) = G_0. \tag{3}$$

Second, control variables also include prices. The consumer price $p_R(t)$ is decided by the retailer and the transfer price $p_M(t)$ by the manufacturer. Third, when the firms do not coordinate their marketing strategies, they implement a Markovian Nash equilibrium (MNE), rather than an OLNE. The authors assume symmetric and quadratic advertising cost functions and the following consumer sales response function:

$$S(p_R, G) = [\alpha - \beta p_R]\left[g_1 G - \frac{g_2}{2} G^2\right],$$

where α, β, g_1 and g_2 are positive constants. This specification says that sales are decreasing in consumer price p_R and are affected (shifted) by the level of goodwill, but subject to diminishing marginal effects of goodwill on sales.

The firms maximize their stream of discounted profit over an infinite horizon. The main results are as follows: (i) Prices are constant, due to their absence in (3). Retail price is higher under noncooperation than under coordination. This confirms, in an intertemporal setting, the double marginalization result exhibited in a static context. (ii) Optimal advertising strategies are affine decreasing in the goodwill level, meaning that more advertising is needed when goodwill is low than when it is high, which is rather intuitive. (iii) As expected, joint optimization advertising and goodwill steady state values are higher than their uncoordinated counterparts.

The model suffers from two limitations. First, prices do not influence the dynamics and hence play a static role. Second, symmetric advertising costs may be a strong assumption since manufacturers and retailers do not advertise in the same type of media. However, imposing an asymmetry would probably not qualitatively change the optimal advertising strategies.

To summarize, the two models surveyed above show, for both Markovian and open-loop information structures, that uncoordinated marketing strategies are different from their coordinated counterparts, and that using the former comes with a loss of profits. We now turn to the review of different coordination mechanisms.

4.2 Cooperative Advertising

Studies of cooperative advertising as a coordinating mechanism in a dynamic context are of recent vintage (see, e.g., Jørgensen et al. (2000, 2001a,b, 2003)).

Jørgensen et al. (2000) examine a case where both channel members make long- and short-term advertising efforts to stimulate current sales and build up goodwill. The authors suggest a cooperative advertising program that can take different forms:

- A full-support program where the manufacturer contributes to both types of the retailer's advertising expenditures (long- and short-term)
- Two partial-support programs where the manufacturer supports only one of the two types of retailer advertising.

For the manufacturer, let $P(t)$ be the short-term and $B(t)$ be the long-term effort. Similarly, let $p(t)$ and $b(t)$ denote the retailer's short- and long-term efforts. All cost functions $C_P(P), C_B(B), C_p(p)$, and $C_b(b)$ are quadratic and increasing.

The evolution of the retailer's stock of goodwill depends on both firms' long-term advertising efforts:

$$\dot{G}(t) = \lambda_M B(t) + \lambda_R b(t) - \delta G(t), \tag{4}$$

in which λ_M, λ_R, and δ are positive constants. The retailer's sales function depends on the firms' short-term advertising efforts and goodwill

$$S(P, p, G) = (\alpha_M P + \alpha_R p)\sqrt{G},$$

in which α_M and α_R are positive constants. Note that the marginal effect of goodwill in raising demand is diminishing.

The manufacturer also decides $D_p(t)$ and $D_b(t)$, which are the percentages he will pay of the costs of the retailer's short- and long-term advertising efforts $p(t)$ and $b(t)$. Each firm maximizes the present value of its profits over an infinite horizon, assuming that margins are fixed.

The manufacturer acts as a leader in a Stackelberg differential game with Markovian strategies. Comparing profits, the authors show that both channel members prefer full-support to any of the partial support schemes which, in turn, are preferred to no support at all. Therefore, all three cooperative advertising programs are Pareto-improving, and hence the programs are coordinating mechanisms. Since the full support program, for each firm, dominates the partial ones, there is no ambiguity in what the players should do.

Due to the special structure of the game, long-term advertising strategies are constant over time. This is less realistic in a dynamic game with an infinite time horizon. A more intuitive strategy is obtained in Jørgensen et al. (2001a). This paper reconsiders the issue of cooperative advertising in a two-member channel in which there is, however, only one type of advertising by each player. The manufacturer advertises in national media while the retailer promotes the brand locally. The sales response function is linear in promotion and concave in goodwill. The dynamics are a Nerlove-Arrow-type equation of goodwill evolution, depending only on the manufacturer's national advertising. In this case, one obtains a nondegenerate Markovian advertising strategy, linearly decreasing in goodwill.

In Jørgensen et al. (2000, 2001a) it is an assumption that the retailer's promotion positively affects the brand image (goodwill stock). Jørgensen, Taboubi and Zaccour (2003) study the case where promotions damage the brand image. One reason for the erosion of goodwill is that consumers may perceive that excessive promotions are used to a cover up for poor product quality. Advertising executives have discommended the use of frequent promotions because it can harm a brand's image (Blattberg and Neslin (1990)). Despite this, frequent promotions for specific brands are often encountered. Marketing scholars disagree on whether or not promotions can negatively impact on brand image. Some empirical studies suggest that negative effects can exist; others do not (see, e.g., Neslin and Schoemaker (1989), Papatla and Krishnamurthi (1996), Raghubir and Corfman (1999), Yoo et al. (2000)).

Nevertheless, Jørgensen et al. (2003) ask whether a cooperative advertising program is meaningful when promotions damage the brand image. The model here involves a single retailer goodwill stock that evolves according to

$$\dot{G}(t) = \alpha a(t) - \beta p(t) - \delta G(t), \tag{5}$$

where $a(t)$ denotes the manufacturer's national advertising effort rate and $p(t)$ represents the retailer's local promotion efforts; α, β and δ are positive parameters. The sales response function is

$$S(p, G) = \gamma p + \theta G$$

where γ and θ are positive constants. Advertising and promotion cost functions $C(a)$ and $C(p)$ are quadratic. The firms implement an MNE if the manufacturer does not support the retailer's promotional effort, and an FSE otherwise.

An additional feature of the paper is the introduction of two types of retailer behavior in the no-support game. The retailer can choose to act as a *far-sighted* player who takes into account the goodwill dynamics (5) when optimizing her payoff, or she can choose to be *myopic* and ignore the evolution of goodwill. In the latter case, she solves a static optimization problem at time $t = 0$.[14] The retailer's choice between the two behaviors is determined endogenously by profit comparisons.

In a situation where the retailer's promotion damages the brand image, a cooperative advertising program is of interest (as far as profits are concerned),

[14] See Taboubi and Zaccour (2002) for a full characterization of equilibria in a marketing channel model under different types of retailer behavior.

- If the initial brand image G_0 is "weak";
- If the initial brand image is at an "intermediate" level and retailer promotions are not "too" damaging to the brand image.

On the other hand, if the initial brand image is "strong" or if promotion causes severe damage to the brand image, no agreement is possible. Consequently, the noncooperative no-support game will be played. In this game, it is best for the retailer to behave myopically and to pay no attention to the evolution of the brand image. This is quite intuitive.

Jørgensen and Zaccour (2003a) suggest an extension of the setup in Jørgensen et al. (2003). The idea now is that the negative impact of retailer promotions is not necessarily instantaneous, as it was in the brand-image dynamics stated in (5). More specifically, the hypothesis is that retailer promotions may have carryover effects and that, therefore, an additional state variable is needed to capture this. The authors study a finite time horizon game and obtain, due to the structure of the game, degenerate Markovian strategies. A cooperative situation is also considered. It turns out that the cooperative promotion rate is higher than the noncooperative one, unless there are many retailers (N large), promotions do considerable damage to the brand image (β large), or the effects of promotion disappear only slowly (μ small).

4.3 Coordination through Leadership

Extending the study of leadership to a dynamic context with prices and advertising as strategic variables is the focus of Jørgensen et al. (2001a). This paper is, to the best of our knowledge, the only one that deals with leadership in a marketing channel in a differential game setup. The paper considers a two-firm marketing channel and the benchmark case is one in which firms are symmetric and make independent and simultaneous decisions. Here, an MNE is identified. Two leadership games are studied: one with the manufacturer as leader and one with the retailer as leader. The solution concept here is a feedback Stackelberg Equilibrium.

In an infinite horizon differential game, the manufacturer controls his margin $m_M(t)$ and national advertising rate $a_M(t)$. The retailer controls her margin $m_R(t)$ and local advertising rate $a_R(t)$ for the manufacturer's brand. The consumer price is simply the sum of margins: $p_R(t) = m_M(t) + m_R(t)$; see also Jeuland and Shugan (1983).

The sales response function depends on consumer price $p_R(t)$, the retailer's local advertising efforts, and the stock of goodwill $G(t)$:

$$S(p_R, G) = a_R[\alpha - \beta p_R]\sqrt{G}, \tag{6}$$

where α, β are positive parameters. Note in (6) that local advertising is more effective in raising sales when accompanied by a low price. The square root accounts for a decreasing marginal influence of the goodwill stock G. The latter evolves according to the standard

Nerlove-Arrow (1962) dynamics:

$$\dot{G}(t) = a_M(t) - \delta G(t) \tag{7}$$

Advertising costs are quadratic, and given by $w_i a_i^2(t)/2$, $i = \{M, R\}$. The parameters w_i reflect differences in costs due to the use of different media. The players maximize their objective functionals defined as a stream of discounted profit over an infinite horizon.

In the benchmark Nash scenario (equilibrium values are superscripted by N in the table below), the firms determine their marketing policies simultaneously and noncooperatively. Two leadership games are studied, in each of which one firm is a leader with respect to both marketing instruments. These games are denoted as SR (**S**tackelberg game with the **R**etailer as leader) and SM (**S**tackelberg game with the **M**anufacturer as leader).

Equilibrium strategies, goodwill, and individual and total profits are summarized in the following table (J_T denotes total channel's profits).

Table 1: Summary of results for the leadership games

Margins	Advertising	Profits
$m_M^{SR} = m_M^{SM} < m_M^N$	$a_M^{SM} > a_M^N > a_M^{SR}$	$J_M^{SM} > J_M^N > J_M^{SR}$
$m_R^{SR} > m_R^{SM} < m_R^N$	$a_R^{SM} > a_R^{SR},\ a_R^{SM} > a_R^N$	$J_R^{SR} > J_R^{SM} > J_R^N$
Consumer price	Goodwill	$J_T^{SM} > J_T^N > J_T^{SR}$
$p_R^{SM} < p_R^N < p_R^{SR}$	$G^{SM}(t) > G^N(t) > G^{SR}(t)$	$J_M^N > J_R^N$
		$J_M^{SR} < J_R^{SR}$
		$J_M^{SM} > J_R^{SM}$

Now, given the profit orderings stated in the table, could one predict who should lead the channel? Three elements can be taken into account in answering these questions, namely, channel profits, consumer welfare and individual profits. Putting these elements together, the authors argue that (i) the channel should have a leader, and (ii) the manufacturer should assume this role.

4.4 Incentive Strategies

Channel coordination through the implementation of incentive strategies has also been explored in a dynamic setting. Jørgensen and Zaccour (2003b) show in a two-member marketing channel differential game that it is possible to support the implementation of the joint optimization solution as an incentive equilibrium.[15] The manufacturer controls the transfer price $p_M(t)$ and national advertising expenditures $a_M(t)$. The retailer controls the consumer price $p_R(t)$ and her local advertising expenditures $a_R(t)$. Both advertising

[15] Incentive strategies are also used in Ehtamo and Hämäläinen (1986, 1989, 1993), although not in a marketing context.

efforts contribute to the manufacturer's brand goodwill, which evolves according to the dynamics:

$$\dot{G}(t) = k_M a_M(t) + k_R a_R(t) - \delta G(t), \tag{8}$$

where k_M, k_R and δ are positive constants. The sales response function is

$$S(p_R, G) = (\alpha - \beta p_R)\left[g_1 G - \frac{g_2}{2}G^2\right].$$

Each firm has a quadratic advertising cost $C_j(a_j)$ and the game is played over a fixed and finite planning period $[0, T]$.

The "algorithm" to determine incentive strategies and equilibrium is as follows: First, compute the cooperative solution (or any other desired solution). Let $s_R^d(t)$ and $s_M^d(t)$ be these desired levels of a certain marketing instrument at t. Second, for each player define an incentive strategy that depends on the other player's choice. One option is to assume these strategies linear, i.e.,

$$\begin{aligned}\gamma_M(s_R)(t) &= \max\left\{0, s_M^d(t) + \mu_M(t)\left[s_R(t) - s_R^d(t)\right]\right\}\\ \gamma_R(s_M)(t) &= \max\left\{0, s_R^d(t) + \mu_R(t)\left[s_M(t) - s_M^d(t)\right]\right\},\end{aligned}$$

where $\mu_M(t)$ and $\mu_R(t)$ are "penalties" to apply to deviations with respect to the desired levels. These penalties (or weights) satisfy $\mu_M(t) = (\mu_R(t))^{-1} > 0$ for $t \in [0, T]$. These variables are solutions to a pair of optimal control problems in which each player optimizes her payoff subject to the state dynamics and to $s_i = \gamma_i(a_j)$ where $i, j = M, R, i \neq j$. In an incentive equilibrium, these penalties are designed in a manner such that each player finds it optimal to pick up the desired level.

The main point of this approach is that one can obtain channel coordination *without* designating a coordinator or leader, and without requiring that the players make a binding agreement. A shortcoming of decision-dependent incentive strategies is the assumption that the firms are able monitor their partners' decisions without any delay.[16]

5 Concluding Remarks

The objective of this section is twofold. We first summarize, in the form of a series of propositions, what the literature has achieved up to now. Second, we provide a list of still open questions which deserve attention.

[16] Observation lags can be introduced, at the cost of some technicalities; see Ehtamo and Hämäläinen (1989).

5.1 A Summary of Results

The following propositions recapitulate our understanding of what the reviewed models have achieved. Many of the results are the fruit of theoretical modeling and thus the following propositions are the fruit of what Moorthy (1993) would call logical experiments. Writing the results in this format should simplify the task of researchers interested in testing their empirical validatity.

Proposition 1 *Vertical integration coordinates dyad marketing channels.*

Proposition 2 *Vertical integration is a Nash equilibrium. Channel decentralization is a Nash equilibrium only when product substitution is high.*

Proposition 3 *If the manufacturers are strategically independent, then vertical integration is preferable to decentralization.*

Proposition 4 *If the manufacturers are strategically dependent, then they may prefer decentralization to vertical integration.*

Proposition 5 *Vertical integration coordinates a competitive marketing channel only when products are highly differentiated (i.e., low values of product substitution). In absence of retail competition, coordination can be reached in a fully competitive structure*[17] *through the decentralization of the distributive activity to the retailer, only when the level of product substitution is high. This result holds true if the channel has a leader, no matter who is playing this role.*

Proposition 6 *When the retailers compete, coordination can be reached in a fully*[18] *competitive structure through the decentralization of the distributive activity to the retailer, for each level of product substitution. This result holds under the assumption that the channel has a leader, no matter who is playing this role.*

Proposition 7 *When retailers are exclusive, but compete in the same territory, coordination can be reached only when the level of product substitution is high. This result holds under the assumption that the channel has a leader, no matter who is playing this role.*

Proposition 8 *Retail competition removes the need to vertically integrate in order to coordinate the channel.*

Proposition 9 *In a bilateral monopoly, channel leadership removes the necessity to vertically integrate in order to reach channel coordination.*

Proposition 10 *In a bilateral monopoly, manufacturer leadership (at least in terms of total channel profits) is better than retailer leadership.*

[17] A channel structure where each retailer sells the products of two competing manufacturers.
[18] A channel structure where each retailer sells the products of two competing manufacturers.

Proposition 11 *In a competitive marketing channel, leadership does not necessarily coordinate the channel. It depends on the combination of store and brand substitutability parameters, and the strategic relationship between channel members.*

Proposition 12 *In a competitive marketing channel, leadership is not (generally) an equilibrium.*

Proposition 13 *In a competitive marketing channel with a channel leader, total channel profit is independent of the identity of the leader.*

Proposition 14 *In a bilateral monopoly, quantity discount and two-part tariff are coordinating mechanisms. Two-part tariff allows also a unique manufacturer to coordinate her channel formed of multiple retailers serving independent areas.*

Proposition 15 *When the channel is composed of one manufacturer selling her product through competing retailers, a quantity discount is a coordinating mechanism. Two-part tariff may not always be a coordinating mechanism (unless retailers are identical).*

Proposition 16 *In a channel with multiple retailers, serving independent or overlapping areas, the manufacturer is better off when she offers a non-coordinating two-part tariff rather than a coordinating quantity discount. (This result is the opposite to the one obtained in a bilateral monopoly channel).*

Proposition 17 *When marketing effort has carry over effects, channel coordination is more likely to occur when the players are far sighted.*

Proposition 18 *Assuming positive effect of promotion on brand image, cooperative advertising is a coordinating mechanism in a bilateral monopoly channel. (The result holds in static and dynamic settings).*

Proposition 19 *If promotion damages the brand image, then a cooperative advertising program is channel coordinating if (i) the initial brand image is weak or (ii) the initial brand image is at an intermediate level, and the negative effect of retailer's promotion on brand image is low.*

5.2 A Research Agenda

The studies on channel coordination, and their stylisized results, are based on a set of working assumptions regarding (*i*) the channel structure, (*ii*) the channel members' order of play, (*iii*) the planning horizon of the game, (*iv*) the functional forms of demand and costs faced by channel members, (*v*) the state of the world and the (*vi*) the relevent strategic variables. In any area of scientific investigation, it is always of interest to assess to which extent the results remain valid when a restrictive assumption is removed or softened. Having in mind the previous remark and the desire of achieving at least some empirical relevance, the next paragraphs attempt to provide a list of open problems were a research effort is definitely welcome.

5.2.1 Channel Structure Relationships between the players in dyad channels are by now well understood. Assuming a static setting, some of the results have been successfully extended to competitive channel's structure. The following items (problems, questions or settings) still deserve some research attention.

- The growing importance of retailers' private labels has the implication that these agents are playing a dual role. At the same time, they offer an outlet to manufacturers' products and sell their own products. Given this dual role of retailers, one may wonder whether coordination is still feasible, especially whether the pricing strategies (e.g., price discounting, two-part tariffs, etc.) which have proved to be coordinating mechanisms in the classical dyad case, can still do the job.
- The manufacturers are adopting the internet as an alternative way to reach consumers. This dual channel structure is creating opportunities for them, but may also be a source of tension with their retailers. This situation is a mirror to the above-mentioned one and hence raises the same questions regarding the feasibility and the tools of coordination.
- In a dynamic setting, all models assumed a two-member channel structure. (An exception is Jørgensen and Zaccour (2003a)). The introduction of competition at one or both levels of the marketing channel is clearly needed to test the generalizability of results obtained in a static environment to a dynamic one.

These extensions to more complicated (but realistic) market structures will come at a cost. It will be hard, and often impossible, to obtain analytical solutions. Numerical methods can be used to obtain solutions for specific parameter values and to do simulations with respect to key parameters. Numerical studies can give valuable insights into the influence of competition on coordination in marketing channels. Interestingly, numerical approaches open also the door to the consideration of more realistic demand and cost functions which could take into account, e.g., non-linearties and threshold effects in marketing instruments. This will possibly lead to different types of strategic dependence between channel members and hence to different implementations of coordination mechanisms (e.g., pricing, cooperative advertising).

5.2.2 Non-price Variables and interface with other Functional Areas Almost all the reviewed models considered mainly pricing and/or advertising as the strategic (and coordinating) variables. Further research should consider:

- The introduction of non-price marketing variables (e.g., product quality, retail inventory, display) and the analysis of channel coordination in view of the eventual interactions between these variables.

- The design of incentive strategies that lead to channel coordination when channel members can set some requirements concerning the level of effort to be done by their partners. Specific ideas have been provided in some contributions. For instance, Huang and Li (2001) suggest to study the case where the manufacturer participates in a cooperative advertising program but sets an upper bound on advertising cost for which he is willing to pay some of the promotional activities of the retailer. Desiraju and Moorthy (1997) suggest to study a pricing game of pay-for-performance where the manufacturer offers a transfer price as a baseline that can be reduced by good performance by the retailer.
- The literature has almost completely ignored the impact (and vice versa) of marketing decisions of channel's members on decisions of other functional areas[19] (production, investment, logistics, inventories, etc.). Any attempt to design models and solves problems related to the unavoidable interactions between these functional areas would provide valuable insight.
- In the differential games literature, most of the studies examined promotions and advertising strategies as marketing tools used by channel members to coordinate the channel. Prices or margins do not enter into the dynamics and the model is stationary, hence, prices are constant. Since it is driven by an artifact of the model, such a feature is less desirable. Furthermore, for some models that do not consider prices as control variables, some profit sharing mechanisms are introduced. What is needed here are more realistic models that represent the interaction between pricing and advertising in a more adequate way. however, such models are complicated and analytical tractability will most likely be lost. Numerical solutions should be considered as an attractive alternative in these settings.

5.2.3 Dynamic and Stochastic Features of the Game Most of the studies are based on static models which do not account for the carryover effects of marketing decisions, including the effort invested in developing and sustaining a good relationship with the other channel's partners. There is a need to expand the literature to a dynamic setting, more particularly on the issue of channel pricing.

Moving towards a more dynamic environment, it becomes interesting to investigate the impact of different channel members' having different horizon planning. Indeed, it has been often mentioned that retailers are more interested in short-term sales whereas manufacturers are more inclined to invest in brand's goodwill. The issue of myopia has been investigated in simple channel structures. There is a need to attempt to extend the models to more competitive channel structures.

Most of the models in our literature review are deterministic. A few studies examined the issue of channel coordination by considering some stochastic elements (mainly by in-

[19] See for example Kohli and Park (1989) who suggested a model where the manufacturer (the seller) controls the quantity discount to offer to the retailer (the buyer) while the latter controls the order quantity to purchase from the manufacturer.

troducing uncertainty in the demand function)[20] and deal with pricing issues. Further research should examine the effect of uncertainty about channel members' cost functions. Other extensions should include situations where one channel member do not observe the reaction function of the other(s).[21]

5.2.4 Empirical Validation of Results There is clearly a lack of empirical validation of most of the findings obtained in game theoretic models that examined the issue of channel coordination. Some laboratory experiments have been done, however they still suffer from lack of external validity. Studies that tested empirically some of the hypothesis and findings in the channel coordination literature are, among others, Cotterill and Putsis (2001), and Choi and Messinger (2003).

References

[1] Bergen, M. and John, G. (1997), "Understanding Cooperative Advertising Participation Rates in Conventional Channels", *Journal of Marketing Research*, Vol.34, Iss.3, pp.357–369.

[2] Berger, P.D. (1972), "Vertical Cooperative Advertising Ventures", *Journal of Marketing Research*, Vol.9, Iss.3, pp.309–312.

[3] Blattberg, R.C. and Neslin, S.A. (1990), *Sales Promotions:concepts, Methods, and Strategies*, Prentice-Hall, Englewood-Cliffs, NJ.

[4] Chintagunta, P.K., and Jain, D. (1991), "A Study of Manufacturer-Retailer Marketing Strategies: A Differential Game Approach". In *Dynamic Games in Economics*, Hämäläinen and Ehtamo (Eds). Lecture Notes in Control and Information Sciences, Vol.157, Springer-Verlag.

[5] Chintagunta, P.K., and Jain, D. (1992), "A Dynamic Model of Channel Member Strategies for Marketing Expenditures", *Marketing Science*, Vol.11, Iss.2, pp.168–188.

[6] Choi, C.S. (1991), "Price Competition in a Channel Structure with a Common Retailer", *Marketing Science*, Vol.10, Iss.4, pp.271–296.

[7] Choi, C.S. (1996), "Price Competition in a Duopoly Common Retailer Channel", *Journal of Retailing*, Vol.72, Iss.2, pp.117–134.

[8] Choi, S. and Messinger, P. *Power Relations in a Two-Manufacturer/One Retailer Channel: an Experimental Study*, mimeo.

[9] Chu, W. and Desai, P.S. (1995), "Channel Coordination Mechanisms for Customer Satisfaction", *Marketing Science*, Vol.14, Iss.4, pp.343–359.

[20] See for example Desai (1996), Ernst and Powell (1998), Qi et al. (2004).

[21] Lal (1990) considers a situation where the game between a manufacturer and a retailer is modeled as an agency problem. The demand function is affected by both the retail price and the service level. The manufacturer do not observe retailer's service level but can affect it through monitoring.

[10] Cotterill, R. W. and W. P. Putsis, Jr., (2001), "Testing the Theory: Assumptions on Vertical Strategic Interaction and Demand Functional Form", *Journal of Retailing*, Vol.77, pp.83–109.

[11] Coughlan, A.T. (1985), "Competition and Cooperation in Marketing Channel Choice: Theory and Applications", *Marketing Science*, Vol.4, Iss.2, pp.110–129.

[12] Coughlan, A.T., Anderson, E., Stern, L.W., and A. I. El-Ansary, *Marketing Channels*, Sixth Edition, Prentice Hall, 2001.

[13] Coughlan, A.T. and Wernerfelt, B. (1989), "On Credible Delegation by Oligopolists: A Discussion of Distribution Channel Management", *Marketing Science*, Vol.35, Iss.2, pp.226–239.

[14] Dant, R.P. and Berger, P.D. (1996), "Modeling Cooperative Advertising Decisions in Franchising", *Journal of the Operational Research Society*, Vol.47, Iss.9, pp.1120–1136.

[15] Desai, V. S. (1996), "Interactions between members of a marketing-production channel under seasonal demand'', *European Journal of Operational Research*', Vol.90, Iss.1; pp.115–141.

[16] Desiraju, R. and Moorthy, S. (1997), "Managing a Distribution Channel Under Asymmetric Information with Performance Requirements", *Management Science*, Vol.43, Iss.12, pp.1628–1644.

[17] Ehtamo, H, and Hämäläinen, R.P. (1986), "On Affine Incentives for Dynamic Decision Problems", in Basar, T. (Ed), *Dynamic Games and Applications in Economics*, (Springer-Verlag, Berlin), pp.46–63.

[18] Ehtamo, H, and Hämäläinen, R.P. (1989), "Incentive Strategies and Equilibria for Dynamic Games with Delayed Information", *Journal of Optimization Theory and Applications*, Vol.63, Iss.3, pp.355–369.

[19] Ehtamo and Hämäläinen (1993), "A Cooperative Incentive Equilibrium for a Resource Management Problem", *Journal of Economic Dynamics and Control*, Vol.17, pp.659–678.

[20] Ernst, R. and Powell, S.G. (1998), "Manufacturer Incentives to Improve Retail Service Levels". *European Journal of Operational Research*, Vol.104, pp.437–450.

[21] Gerstner, E. and J.D. Hess (1995), "Pull Promotions and Channel Coordination", *Marketing Science*, Vol.14, Iss.1, pp.43–60.

[22] Huang, Z. and Li, S.X. (2001), "Co-op Advertising Models in Manufacturer-Retailer Supply Chains: A Game Theory Approach", *European Journal of Operational Research*, Vol.135, pp.527–544.

[23] Ingene, C.A. and M.E. Parry (1995a), "Coordination and Manufacturer Profit Maximization: The Multiple Retailer Channel", *Journal of Retailing*, Vol.72, Iss.2, pp.129–151.

[24] Ingene, C.A. and M. E. Parry (1995b), "Channel Coordination when Retailers Compete", *Marketing Science*, Vol.14, Iss.4, pp.360–377.

[25] Ingene, C. A. and M.E. Parry (2004), *Mathematical Models of Distribution Channels*, International Series in Quantitative Marketing, Kluwer Academic Publishers, Boston.

[26] Jeuland, A.P. and S.M. Shugan (1983), “Managing Channel profits”, *Marketing Science*, Vol.2, Iss.3, pp.239–272.

[27] Jeuland, A.P. and S.M. Shugan (1988b), “Channel of Distribution Profits when Channel Members form Conjectures”, *Marketing Science*, Vol.7, Iss.2, pp.202–239.

[28] Jørgensen, S., Sigué, S. P., and Zaccour, G. (2000), “Dynamic Cooperative Advertising in a Channel”, *Journal of retailing*, Vol.76, Iss.1, pp.71–92.

[29] Jørgensen, S., Sigué, S. P., and Zaccour, G. (2001a), “Stackelberg Leadership in a Marketing Channel”, *International Game Theory Review*, Vol.3, Iss.1, pp.13–26.

[30] Jørgensen, S., Taboubi, S., and Zaccour, G. (2001b), “Cooperative Advertising in a Marketing Channel”, *Journal of Optimization Theory and Applications*, Vol.110, Iss.1, pp.145–158.

[31] Jørgensen, S., Taboubi, S. and Zaccour, G. (2003), “Retail Promotions with Negative Brand Image Effects: Is Cooperation Possible?”, *European Journal of Operational Research*, Vol.150, Iss.2, pp.395–405.

[32] Jørgensen, S. and Zaccour, G. (1999), “Equilibrium pricing and Advertising Strategies in a Marketing Channel”, *Journal of Optimization Theory and Applications*, Vol.102, Iss.1, pp.111–125.

[33] Jørgensen, S. and Zaccour, G. (2002), “Time Consistency in Cooperative Differential Games”. In Zaccour, G. (ed.), *Decision and Control in Management Science: Essays in Honor of Alain Haurie*, Kluwer, Boston.

[34] Jørgensen, S. and Zaccour, G. (2003a), “A Differential Game of Retailer Promotions”, *Automatica*, Vol.39, Iss.7, pp.1145–1155.

[35] Jørgensen, S. and Zaccour, G. (2003b), “Channel Coordination over Time: Incentive Equilibria and Credibility”, *Journal of Economic Dynamics and Control*, Vol.27, pp.801–822.

[36] Jørgensen, S. and Zaccour, G. (2004), *Differential Games in Marketing*, International Series in Quantitative Marketing, Kluwer Academic Publishers, Boston.

[37] Kim S.Y. and Staelin, R. (1999), “Manufacturer Allowances and Retailer Pass-Through Rates in a Competitive Environment”, *Marketing Science*, Vol.18, Iss.1, pp.59–76.

[38] Kohli, R. and Park, H. (1989), “A Cooperative Game Theory Model for Quantity Discounts”, *Management Science*, Vol.35, Iss.6, pp.693–707.

[39] Lal, R. (1990), “Improving Channel Coordination Through Franchising”, *Marketing Science*, Vol.9, N.4, pp.299–318.

[40] Li, S.X, Huang, Z., Zhu, J. and Chau, P.Y.K. (2002), “Cooperative Advertising, Game Theory, and Manufacturer-Retailer supply Chains”, *Omega*, Vol.30, pp.347–357.

[41] Lee, E. and Staelin, R. (1997), “Vertical strategic interaction: Implications for channel pricing strategy”. *Marketing Science*, Vol.16, Iss.3, pp.185–207.

[42] McGuire T. and Staelin, R. (1983), "An Industry Equilibrium Analysis of Downstream Vertical Integration", *Marketing Science* , Vol.2, Iss.2, pp.161–192.

[43] McGuire T. and Staelin, R. (1986), "Channel Efficiency, Incentive Compatibility, Transfer Pricing, and Market Structure: An Analysis of Channel Relationships", *Research in Marketing*, Vol.8, pp.181–223.

[44] Moorthy, S. (1993), "Theoretical Modeling in Marketing", *Journal of Marketing*, April, pp.92–106.

[45] Moorthy S. (1987), "Managing Channel Profits: Comments", *Marketing Science* , Vol.6, Iss.4, pp.375–379.

[46] Moorthy S. (1988), "Strategic Decentralization in Channels", *Marketing Science* , Vol.7, Iss.4, pp.335–355.

[47] Moorthy, S. (1993), "Competitive Marketing Strategies: Game-Theoretic Models", in *Handbooks in OR and MS*, Eliashberg, J. and Lilien, G.L. (eds.), Vol.4, Amsterdam: North-Holland, pp.143–190.

[48] Moorthy, S., Fader, P. (1988), "Strategic Interaction Within a Channel", *Retail and Marketing Channels*, Pellegrini, L. and Reddy, S. (editors), London: Routledge. pp.84–99.

[49] Nerlove, M. and Arrow, K.J. (1962), "Optimal Advertising Policy Under Dynamic Conditions", *Economica*, Vol.39, Iss.114, pp.129–142.

[50] Neslin, S.A., Schoemaker, R.W. (1989), "An Alternative Explanation for Lower Repeat Rates After Promotion Purchases". *Journal of Marketing Research*, Vol.26, pp.205–213.

[51] Papatla, P., Krishnamurthi, L., (1996), "Measuring the Dynamic Effects of Promotions on Brand Choice". *Journal of Marketing research*, Vol.33, pp.20–35.

[52] Qi, X., Bard, J.F., and Yu, g. (2004), "Supply Chain Coordination with Demand disruptions". *OMEGA, The International Journal of Management Science*, Vol.32, pp.301–312.

[53] Raghubir, P., Corfman, K., (1999), "When do Price Promotions Affect Pretrial Brand Evaluations?". *Journal of Marketing Research*, Vol.36, pp.211–222.

[54] Reve, T. and Stern, L.W. (1979), "Interorganzational Relations in Marketing Channels", *Academy of Management Review*, Vol.4, Iss.3, pp.4065–416.

[55] Shugan, S.M. (1985), "Implicit Understandings in Channels of Distribution", *Management Science*, Vol.31, Iss.4, pp.435–460.

[56] Spengler, J.J. (1950), "Vertical Integration and Antitrust Policy", *Journal of Political Economy*, Vol.58, pp.347–352.

[57] Stern, L.W., *Distribution channels: Behavioral Dimensions*, Houghton Mifflin Company, Boston, 1969.

[58] Taboubi, S. and Zaccour, G. (2002), "Impact of Retailer's Myopia on Channel's Strategies", in *Optimal Control and Differential Games: Essays in Honor of Steffen Jørgensen*, G. Zaccour ed., Kluwer Academic Publishers, pp.179–192.

[59] Thépot, J. (1999), “Interactions dans les Canaux de Distribution: Quelques Apports de la Théorie des Jeux”, *Recherche et Applications en Marketing*, Vol.14, Iss.4, pp.55–64.

[60] Trivedi, M. (1998), “Marketing Channels: An Extension of Exclusive Retailership”, *Management Science*, Vol.44, Iss.7, pp.896–909.

[61] Yoo, B., Donthu, N., and Lee, S. (2000), “An Examination of Selected Marketing Mix Elements and Brand Equity”, *Journal of The Academy of Marketing Science*, Vol.28, pp.195–211.

[62] Young, A. R. (1991), “Vertical Structure and Nash Equilibrium: A Note”, *The Journal of Industrial Economics*, Vol.39, Iss.6; pp.717–723.