European Journal of Operational Research 228 (2013) 635–647

Contents lists available at SciVerse ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Interfaces with Other Disciplines

Periodicity of pricing and marketing efforts in a distribution channel

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ARTICLE INFO

Article history:
Received 13 January 2012
Accepted 6 February 2013
Available online 24 February 2013

Keywords:
Distribution channel
Sequence of move
Cooperative advertising
Pricing
Marketing efforts

ABSTRACT

Most research about cooperative (coop) advertising programs in channels relies on the assumption that manufacturers and retailers decide of pricing and marketing efforts simultaneously. This paper evaluates this central assumption and investigates the optimal periodicity (sequence of move) of pricing and marketing efforts (ME) decisions for a distribution channel. We develop a game theoretic model that accounts for pricing at each level of the channel, for the manufacturer's ME mix strategies (a direct ME to consumers and coop advertising program offered to the retailer) and the retailer's ME as well. We obtain solutions for a bilateral channel under different vertical interaction scenarios; when the channel is led by the manufacturer, the retailer or when channel members decide simultaneously of each of their marketing mix decisions (vertical Nash). We compare the effect of pricing and ME decision periodicity on outputs for each channel member. The main findings suggest that simultaneous decision-making of pricing and ME is optimal only for high enough levels of the manufacturer's ME effects. For very highly effective marketing efforts, sequential play of pricing and ME allows channel members to implement equilibrium strategies and achieve maximum profits that would not be achieved with simultaneous decision-making. This highlights the importance of relaxing the simultaneous play assumption of pricing and ME in a distribution channel.

1. Introduction

Distribution channels invest a large percentage of their marketing budgets into a variety of non-price marketing efforts such as merchandising activities, local advertising, displays and features by the retailer and national advertising and direct consumer promotions by the manufacturer (product sampling, trade fairs, etc.). Cooperative (coop) advertising programs that aim at sharing the costs of retail promotions also represent a significant component of the manufacturer's promotional mix (Nagler, 2006).

A growing literature has studied the effects of such programs in distribution channels and has shown their importance in coordinating strategies and improving overall channel efficiency (Berger, 1972; Bergen and John, 1997; Jørgensen et al., 2000; Huang and Li, 2001; Li et al., 2002; Huang et al., 2002; Xie and Ai, 2006; Karray and Zaccour, 2006, 2007; Yan, 2009; Ahmadi-Javid and Hoseinpour, 2011; Kunter, 2012). The existing research about coop advertising programs considering endogenous pricing decisions relies on the assumption that each channel member decides simultaneously of its pricing and marketing efforts (Karray and Zaccour, 2006, 2007; Yue et al., 2006; Xie and Wei, 2009; Szmerekovsky and Zhang, 2009; He et al., 2009; Ahmadi-Javid and Hoseinpour, 2011; SeyedEsfahani et al., 2011; Kunter, 2012).

However, some marketing scholars considered that marketing efforts and prices are decided at different stages instead of simultaneously by each channel member and argued that this is due to the discrepancy in the periodicity i.e., the timing and frequency of these decisions (Agrawal, 1996; Banerjee and Bandyopadhyay, 2003; Parker and Soberman, 2006; Karray and Martin-Herran, 2008; Draganska et al., 2009). In these papers, the marketing effort decision in the channel, namely advertising, has been assumed to precede prices. This is based on the observation, in some industries, that advertising is usually set for a longer time period than prices and therefore should be decided at an earlier stage, which is especially the case for national advertising campaigns in traditional media outlets (TV, print, radio, etc.). Looking at a wider range of marketing efforts, evidence from the practice of coop advertising programs shows that prices can be decided more frequently than coop advertising rates and promotional budgets, especially for fast moving consumer products. In fact, the National Register Publishing (NRP) for coop advertising programs provides examples of coop advertising programs that are fixed for the entire year while more frequent price negotiations could occur during the year (NRP source book sample, 2012).

Alternatively, marketing effort budgets could also be more frequent decisions than prices. For example, manufacturers which brands benefit from high levels of consumer loyalty usually avoid frequent price adjustments that could damage their brand image (Raju et al., 1990). Pricing can also be a less frequent decision than

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http://dx.doi.org/10.1016/j.ejor.2013.02.012

marketing efforts in case the retailer is adopting a strategy of everyday low pricing, and agrees with the manufacturer to fix wholesale prices in order to avoid uncertainty (Kopalle et al., 1996). In such cases, marketing efforts could be more frequent decisions than prices especially for non-price promotions that inform consumers about the product attributes, build store traffic, or provide additional in-store customer service (e.g., sales support, merchandising activities, social media marketing activities, etc.). Finally, some marketing efforts such as online advertising, local advertising (e.g., in retail flyers or local publications) and in-store promotional activities (e.g., displays and features) that are decided on on-going basis would not necessitate a long budget commitment by the manufacturer and the retailer. For instance, the NRP shows also cases of coop programs agreements that are decided on on-going basis instead of fixed for the entire year. These different examples indicate that marketing efforts can be determined more frequently than prices and therefore could succeed the pricing decisions.

Empirically, the issue of periodicity of pricing and marketing effort (ME) has been described as an important yet unexplored factor that considerably affects our understanding of these strategic decisions (Kadiyali et al., 2001; Rao, 2009). As noted by Rao (2009, p. 120), "*the possible difference in the periodicity of decision-making regarding price versus other decisions, such as advertising*" is a "*tricky issue*" mainly because, in practice, we can observe situations where these decisions can be simultaneous or sequential as shown in the previous examples. In our knowledge, the empirical research does not provide a clear explanation of why such discrepancy might exist; which means that it could be due to various factors such as managerial practice, commitments with media agencies or with channel members. Different choices of periodicity for pricing and marketing efforts could also be due to differing marketing objectives (e.g., encourage short term sales versus build brand equity). This paper suggests that for firms operating under similar conditions and having comparable marketing objectives, the periodicity of pricing and marketing efforts can be endogenously determined by the distribution channel. Such decision can indeed significantly influence the strategies and profits of the manufacturer and the retailer. For example, when advertising is determined on a yearly basis, subsequent quarterly, monthly or weekly prices would be set given the previously decided advertising for that period. Alternatively, in case of long-term price agreements in the channel, marketing efforts such as weekly retail flyer advertising and consumer promotions are chosen subsequently to prices. Since, in practice, the periodicity of pricing and other marketing effort decision varies as shown in the previous examples, the sequence of these decisions can be changed and endogenously chosen by channel members instead of assumed ex-ante.

This paper investigates the optimal periodicity (sequence of move) for pricing and marketing efforts in the channel. It does so considering the main vertical interaction scenarios in the channel studied in the literature; when the manufacturer is leader and the retailer is follower, or vice versa, or when the channel does not have a leader and decisions are made simultaneously (vertical Nash). As defined in the marketing literature, a channel leader is a member that "*can precommit to an action in the channel, which must be given by the other channel member(s) as they take their actions*" (Weitz and Wensley, 2002, p. 233).

A large literature in marketing and operations research has shown that channel leadership considerably impacts the retailers' and manufacturers' prices and profits (e.g., Choi, 1991; Lee and Staelin, 1997). The increasing power of some retailers such as Wal-Mart and Tesco has motivated many researchers in marketing to shift their attention from a traditional channel framework where manufacturers are price leaders to situations where retailers lead in their pricing decisions (Kadiyali et al., 2000; Cotterill and Putsis, 2001; Geylani et al., 2007). Considering both advertising and pricing decisions of channel members, Jørgensen et al. (2001) extended these results and showed that a manufacturer leadership can provide superior channel efficiency levels to a retail leadership.

Most research about coop advertising programs considered a manufacturer Stackelberg sequence of move and a few looked at simultaneous (vertical Nash) games for manufacturers and retailers (Karray and Zaccour, 2006, 2007; Yue et al., 2006; Xie and Wei, 2009; Ahmadi-Javid and Hoseinpour, 2011). Recently, Xie and Neyret (2009) and SeyedEsfahani et al. (2011) proposed bargaining solutions by solving manufacturer as well as retailer Stackelberg games in addition to the cooperative solution. Their results show that marketing efforts, including the cooperative advertising program, and pricing strategies, as well as channel profits vary considerably with the channel leadership. For example, depending on the level of ME effectiveness, the manufacturer (retailer) might prefer to be a leader or a follower. Regardless of which firm leads the channel, both papers assume that each channel member decides simultaneously of its pricing and ME.

This research's objective is to study the effect of the periodicity of pricing and marketing efforts on the equilibrium outcomes. Similarly to the related literature, we assume that the channel leadership is determined exogenously and focus on exploring the effect of separate decision periods of pricing and marketing efforts on equilibrium strategies and outputs given a vertical interaction scenario. That is when the manufacturer or the retailer is the channel leader or when both channel members are not leaders and simultaneously decide of their pricing and ME decisions (vertical Nash). In particular, the paper aims to identify whether the channel members should play the pricing game at a different time than the marketing efforts game or simultaneously, as conventionally assumed in the literature. This gives rise to three situations. Specifically, given a pre-set vertical interaction in the channel (manufacturer leadership, retailer leadership or vertical Nash), each channel member; 1 – decides of its marketing efforts and price simultaneously (benchmark), 2 – chooses first its price, then its marketing efforts, and 3 – decides on its marketing efforts, then on its price.

More specifically, the paper aims to provide answers to the following research questions:

- What are the implications of relaxing the simultaneous move assumption for marketing efforts and pricing? Are these implications different when the manufacturer or the retailer is the channel leader or when channel members play a vertical Nash game?
- Which periodicity (sequence of move) of pricing and ME is optimal for which channel member, and under what conditions?

In order to address these problems, we develop a game-theoretic model and solve for the equilibrium pricing and marketing efforts decisions of the manufacturer (including the coop program) and of the retailer. We do so for different periodicity of pricing and marketing efforts and for the three commonly used vertical interaction scenarios in channels; in case the manufacturer is the leader, follower or plays Nash with the retailer. Comparison of the equilibrium solutions within each vertical interaction scenario shows the impact of the periodicity of pricing and marketing efforts and identifies the preferred periodicity by each channel member.

The rest of the paper is organized as follows. Section 2 introduces the model. In Sections 3 and 4, we derive the equilibrium solutions and analyze results for the cases when the manufacturer (retailer) is the channel leader. Section 5 includes results for the case of no channel leadership (vertical Nash). Section 6 concludes and discusses future research avenues.

2. Model and assumptions

We consider a distribution channel formed by one manufacturer selling its product through an exclusive retailer. Most of the literature dealing with cooperative advertising considers a one-manufacturer, one-retailer channel (bilateral channel). Since we are exploring the implication of relaxing the simultaneous play assumption of marketing efforts and pricing, we also consider in our paper a bilateral channel.

For simplicity and consistency with previous papers in the related literature, we also assume the following;

- The channel leader, if any, is exogenously determined. Similarly to the related literature, we assume that the leader moves first in all of the decisions he is undertaking. He can declare both pricing and marketing efforts decisions simultaneously as commonly assumed in the literature. Alternatively, he could have a multistage decision approach where he would choose pricing on a separate period (before or after) than marketing efforts. In this case, the manufacturer can be a first-mover in the pricing game then in the marketing effort game or vice versa.
- We do not take into account channel members' budget and resource constraint in order to keep the results manageable.
- The manufacturer's production costs are taken equal to zero.

The decision variables for the manufacturer are his wholesale price (w), his non-price marketing efforts (m) such as consumer promotions, national advertising, etc., and his coop participation rate (in percentage) in the ME costs of the retailer ($t \in (0, 1)$). The retailer decides of his retail price (p), and his non-price marketing efforts (r) such as local advertising, merchandising activities, displays and features, etc.

We choose a demand function that is linear in pricing (McGuire and Staelin, 1983; Choi, 1991) and concave in marketing efforts to account for diminishing effects of marketing efforts on sales (Kim and Staelin, 1999; Desai, 2000; Karray and Zaccour, 2007). The demand decreases in price and increases with both of the channel members' marketing efforts. The consumers' demand (q) is given by

$$q = v - p + d_1\sqrt{m} + d_2\sqrt{r}, \tag{1}$$

where v represents the product's baseline demand. The marginal effects of marketing efforts on demand are represented by the positive parameters d_1 and d_2.[1] Marketing efforts of the manufacturer (m) and the retailer (r) could expand demand in many ways; for example by increasing awareness for the product, therefore attracting additional consumers, or by increasing the sales volume by current buyers. The ME effectiveness level would vary with the kind of effort undertaken by the manufacturer (e.g., advertising versus consumer promotion), and the retailer (e.g., in-store displays versus merchandising activities or local advertising) as well as other factors such as ME content and media choice.

We assume the same cost structure for both channel members and take production costs equal to zero mainly for tractability. Using the expression of the demand function in (1), the profits of the manufacturer (Π), the retailer (π) and the entire channel (Γ) are given by

$$\Pi = wq - (tr + m), \quad \pi = (p - w)q - (1 - t)r, \quad \Gamma = \Pi + \pi.$$

We focus our analysis on three sequences of move mainly to separate the decision periods for marketing efforts and pricing in order to address our research objective. Specifically, when a channel member assumes a leadership position, it is assumed in the literature that the Stackelberg leader moves first and chooses all of its decisions simultaneously and the follower chooses next, also simultaneously, all of its decisions knowing the leader's announced actions (this is the benchmark scenario). Similarly, we consider that the leader will move first for each element of the marketing mix (ME and prices) but allow for different periods of decision-making. Hence, the Stackelberg leader can play two separate games at different periods. He can lead first in the pricing game then in the marketing effort game or vice versa. In case the channel does not have a leader, channel members can decide of their marketing mix strategies simultaneously as assumed in the existing literature. However, we allow for different periods of decision-making for pricing and ME.

In order to represent different periodicity for pricing and marketing efforts decisions under a given vertical interaction scenario (manufacturer leadership, retailer leadership, and vertical Nash), we solve the following three games;

(1) Game 1: This is the commonly used sequence of move where each channel member decides of all of its marketing mix variables (price and ME) simultaneously. When the channel has a leader, the manufacturer and the retailer play a two-stage non-cooperative game. In the first stage, the leader sets simultaneously its price and marketing efforts. In the second stage, the follower simultaneously decides of its price and marketing efforts given the leader's decisions. In case the channel does not have a leader, the channel members play a one-stage game and decide simultaneously of all of their marketing mix variables.

(2) Game 2: In this case, channel members decide of prices before they decide of their ME. In case there is a channel leader, the latter plays two sequential games; first in prices then in ME. Overall, the channel members play a four-stage, non-cooperative game. First, the leader sets its price. Second, the follower decides of its price given the leader's announced price. Third, the leader sets its marketing effort given both wholesale and retail prices. Finally, the follower chooses its ME knowing all previous decisions. In case the channel does not have a leader (vertical Nash), the manufacturer and the retailer play a two-stage game where wholesale and retail prices are decided simultaneously in a first stage and ME are decided simultaneously in a second stage given the previously announced prices.

(3) Game 3: In this last scenario, channel members decide of prices after they decide of their ME. In case there is a channel leader, the latter plays two sequential games; first in ME then in prices. The four-stage, non-cooperative game starts with the leader setting its ME strategies, then the follower deciding of its ME given the leader's announced decision. Third, the leader sets its price given the previously decided ME levels. Finally, the follower chooses its price knowing all other decisions. In case the channel does not have a leader (vertical Nash), the manufacturer and the retailer play a two-stage game where ME are decided simultaneously in a

Table 1
Specification of non-cooperative games.

Channel leader	Sequences of move		
	Game 1 (Prices and ME)	Game 2 (Prices, then ME)	Game 3 (ME, then prices)
Manufacturer	M1	M2	M3
Retailer	R1	R2	R3
None (Vertical Nash)	N1	N2	N3

[1] An extension of the model to the case where the effect of price on demand is different from one can be easily obtained without loss of generability by assuming the parameters d_1 and d_2 as relative marketing effort effects.

first stage, and wholesale and retail prices are decided simultaneously in a second stage given the previously announced ME.

Given that the channel leader can be the manufacturer or the retailer and adding the scenario of no leadership (vertical Nash), we solve in total nine non-cooperative games as illustrated in Table 1.

3. Effect of ME and price sequence of move when the manufacturer is the channel leader

3.1. Equilibrium solution and feasible domain

We start by solving the three games for the case where the channel is led by the manufacturer. In M1, the manufacturer decides first of its price (w) and marketing efforts mix (m and t). Second, the retailer sets its price (p) and ME level (r) given the announced manufacturer's strategies. In M2 and M3, the manufacturer plays two Stackelberg games for prices and ME.

In M2, the pricing game is played first; the manufacturer decides of w then the retailer decides of p given the announced wholesale price. The ME are decided next in a second manufacturer Stackelberg game; knowing both retail and wholesale prices, the manufacturer decides of m and t, and in a final stage the retailer sets its ME (r) given all previously decided actions. Similarly, in M3, the manufacturer plays first the Stackelberg game in ME then in price. The solution to each of these games is obtained by backward induction and is provided in Table 2. All proof is included is in Appendix 1.[2]

We identify the market conditions for which each of the three Mi (i = 1, 2, 3) games is feasible before comparing these equilibrium outputs to identify which sequence of move in price and ME is optimal for each channel member (i.e., provides maximum profits).

Using the second-order conditions as well as the necessary and sufficient conditions for positive equilibrium solutions (see Appendix 1); we identify the feasible domain for each Mi, which is represented in Fig. 1.[3]

Given the feasible domain, we can now state the equilibrium solution for each channel member.

Proposition 1. *Under the manufacturer's leadership, the equilibrium solution for each channel member in the feasible domain is given in Table 3*

Proposition 1 shows that in some regions of the feasible domain, only one sequence of move can be chosen by both channel members (II and IV) while in others (I and III), the optimal sequence of move for each of the manufacturer and the retailer would be the one that maximizes its profits.

For example, in region (II), characterized by the highest levels of d_2, only M3 is feasible. Under such conditions, the manufacturer should decide of ME before setting prices in order to achieve optimal strategies. However, for the highest levels of d_1 in the feasible domain (region IV), the manufacturer can only play M2. In such cases, the equilibrium solution is reached only if the manufacturer leads the channel first in pricing then in ME.

In the remaining feasible domain, a menu of M1, M2 and M3 is available to the channel. Notably, for low levels of d_2, pricing can be decided before, after or simultaneously with ME, whereas for higher ranges of d_2, pricing can be decided either after or before ME.

[2] Note that since sequential games are considered in the paper, the reaction functions illustrate the relationship between the marketing efforts decision variables (m and r) and the pricing variables (p and w). These functions are included in Appendix 1.

[3] Outside of the feasible domain, at least one channel member is getting negative profits at equilibrium, and the game assumed in the paper cannot be played.

Table 2
Equilibrium solutions for each Mi (i = 1, 2, 3).

	M1	M2	M3
w	$\frac{v(16-3d_2^2)}{32-9d_2^2-4d_1^2}$	$\frac{4v(64+d_2^4+2d_1^2d_2^2-12d_2^2)}{512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)}$	$\frac{16v(32-d_2^2)}{1024-192d_2^2-d_1^2d_2^2-128d_1^2}$
m	$\frac{16v^2d_1^2}{(32-9d_2^2-4d_1^2)^2}$	$\frac{4v^2d_1^2(64-12d_2^2+d_2^4+2d_1^2d_2^2)^2}{[512-d_2^2(208+16d_1^2-24d_2^2+4d_1^4+d_2^4)]^2}$	$\frac{v^2d_1^2(128+d_2^2)^2}{(1024-192d_2^2-d_1^2d_2^2-128d_1^2)^2}$
t	$\frac{1}{3}$	$\frac{48+d_2^4-8d_2^2+4d_1^2d_2^2-8d_1^2}{80+d_2^4-16d_2^2+8d_1^2}$	$\frac{48+d_2^2}{80}$
Π	$\frac{4v^2}{32-9d_2^2-4d_1^2}$	$\frac{4v^2(16+d_1^2d_2^2)}{512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)}$	$\frac{v^2(128+d_2^2)}{1024-192d_2^2-d_1^2d_2^2-128d_1^2}$
p	$\frac{3v(8-d_2^2)}{32-9d_2^2-4d_1^2}$	$\frac{4v(8-d_2^2)(12-d_2^2+2d_1^2)}{512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)}$	$\frac{24v(32-d_2^2)}{1024-192d_2^2-d_1^2d_2^2-128d_1^2}$
r	$\frac{36v^2d_2^2}{(32-9d_2^2-4d_1^2)^2}$	$\frac{4v^2d_2^2(80+d_2^4-16d_2^2+8d_1^2)^2}{[512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)]^2}$	$\frac{(160vd_2)^2}{(1024-192d_2^2-d_1^2d_2^2-128d_1^2)^2}$
$p-w$	$\frac{8v}{32-9d_2^2-4d_1^2}$	$\frac{16v(4-d_2^2)(d_1^2+2)}{512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)}$	$\frac{8v(32-d_2^2)}{1024-192d_2^2-d_1^2d_2^2-128d_1^2}$
π	$\frac{8v^2(8-3d_2^2)}{(32-9d_2^2-4d_1^2)^2}$	$\frac{32(8-d_2^2)[v(d_2^2-4)(d_1^2+2)]^2}{[512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)]^2}$	$\frac{128v^2(16-3d_2^2)(32-d_2^2)}{(1024-192d_2^2-d_1^2d_2^2-128d_1^2)^2}$
q	$\frac{8v}{32-9d_2^2-4d_1^2}$	$\frac{v(128-16d_1^2d_2^2-12d_2^4+32d_2^2+d_2^6+64d_1^2+2d_1^2d_2^4)}{512-d_2^2(16d_1^2-24d_2^2+4d_1^4+d_2^4+208)}$	$\frac{8v(32-d_2^2)}{1024-192d_2^2-d_1^2d_2^2-128d_1^2}$

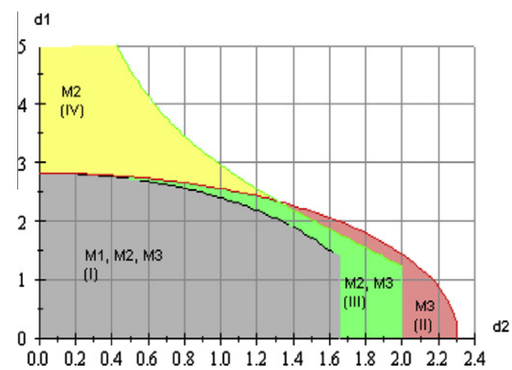

Fig. 1. Feasible domain for Mi.

Table 3
Equilibrium solution for Mi (i = 1, 2, 3) given the domain regions represented in Fig. 1.

Domain region	Manufacturer	Retailer
I	M1 if $\Pi_{M1} > \max(\Pi_{M2}, \Pi_{M3})$, M2 if $\Pi_{M2} > \max(\Pi_{M1}, \Pi_{M3})$, M3 otherwise.	M1 if $\pi_{M1} > \max(\pi_{M2}, \pi_{M3})$, M2 if $\pi_{M2} > \max(\pi_{M1}, \pi_{M3})$, M3 otherwise.
II	M3	M3
III	M2 if $\Pi_{M2} > \Pi_{M3}$, M3 otherwise.	M2 if $\pi_{M2} > \pi_{M3}$, M3 otherwise.
IV	M2	M2

Therefore, the identification of the optimal sequence of move for price and ME would depend on which region of the feasible domain is considered for analysis. We now compare equilibrium solutions in the domain regions where more than one game is feasible (I and III).

In the rest of the paper, all analytical results are presented in Propositions. Given the complexity of some expressions, we will use notations α_i for functions of d_1 and d_2, and x_i for functions of d_1 or d_2, and include them in Appendix 2 for simplicity. All proof is in Appendix 1.

Numerical results are presented whenever we obtain closed-form conditions that are not amenable to analytical analysis because of their complexity. In such cases, we obtain results by varying d_1 and d_2 in the feasible domain with a pace of 0.001 or smaller.

3.2. Effect of sequence of move of pricing and marketing effort decisions

In order to determine the preferred equilibrium solution for each channel member in regions (I) and (III) of the feasible domain, we start by comparing equilibrium outputs in M2 and M3.

Proposition 2. *Under the manufacturer's leadership, equilibrium solutions in M2 and M3 in the feasible domain (I and III) compare as follows;*

$$\Pi_{M3} > \Pi_{M2} \Leftrightarrow d_1 > \frac{d_2}{4}\sqrt{\frac{-2864d_2^2 + 104d_2^4 + d_2^6 + 13\,824}{-380d_2^2 + 47d_2^4 + 512}},$$

$$\pi_{M3} > \pi_{M2} \Leftrightarrow \alpha_1 > 0, \quad \Gamma_{M3} > \Gamma_{M2} \Leftrightarrow \alpha_2 > 0,$$

$$w_{M3} > w_{M2} \Leftrightarrow d_1 \in (x_0, x_1), \quad m_{M3} > m_{M2} \Leftrightarrow d_1 > x_2,$$

$$p_{M3} > p_{M2} \Leftrightarrow d_1 > x_3, \quad r_{M3} > r_{M2} \Leftrightarrow d_1 > x_4,$$

$$t_{M3} > t_{M2} \Leftrightarrow d_1 > d_2\sqrt{\frac{-48d_2^2 + d_2^4 - 48}{8\left(39d_2^2 - 128\right)}}, \quad q_{M3} > q_{M2} \Leftrightarrow d_1 > x_5.$$

We now explore further the analytical conditions obtained in this Proposition in each of the domain regions where M2 and M3 can both be played (I and III). As we can see in Fig. 2, the manufacturer prefers M3 in the feasible domain (III) for high levels of d_1 because of the associated gains in unit margin and sales volume, hence revenues and prefers M2 for lower levels of d_1 (more details about these conditions are discussed in Appendix 1).

Numerical Result 1. *Under the manufacturer's leadership and in the feasible domain (III),* $\pi_{M3} > \pi_{M2}$ *for low or high values of* d_1 *and* $\pi_{M3} < \pi_{M2}$ *otherwise.*

These findings show that although the retailer can prefer the same sequence of move as the manufacturer for extreme values of d_1 (M3), it also prefers M3 in case of very low levels of d_1 (Fig. 2). This suggests a possible conflict in the channel about the preferred sequence of move. In case of divergent preferences in the channel for M2 and M3, i.e., for very low d_1 levels, comparison of channel profits obtained in each game can give some insight about whether the conflict could be resolved through redistribution of total channel profits.

Numerical Result 2. *Under the manufacturer's leadership and in the feasible domain (III),* $\Gamma_{M3} > \Gamma_{M2}$ *for very high values of* d_1 *and* $\Gamma_{M3} < \Gamma_{M2}$ *otherwise.*

This result indicates that resolution of channel conflict through redistribution of overall profits cannot be achieved in the domain region (III). In this case, the total channel profit is higher in M3 whenever it is also preferred by the manufacturer, and is lower otherwise. This means that the retailer will have to bear the opportunity cost from not playing M3 because the retailer's gains from playing M3 will not be sufficient to overcome the manufacturer's opportunity cost. The channel conflict arising from different preferences for M2 and M3 cannot be solved with a side-payment agreement (Fig. 2).

We now turn to the comparison of equilibrium solutions in region (I) of the feasible domain where all three M*i* games are feasible. We compare pairwise equilibrium solutions in order to draw conclusions about the overall preferred outcome. Since Proposition 2 provides necessary conditions to determine the optimal outcome for (M2, M3), we compare next the equilibria in M1 and M3.

Proposition 3. *Under the manufacturer's leadership, equilibrium solutions in M1 and M3 in the feasible domain (I) compare as follows;*

$$\Pi_{M3} < \Pi_{M1}, \quad \Gamma_{M3} < \Gamma_{M1}, \quad \pi_{M3} < \pi_{M1} \Leftrightarrow d_1 > x_6,$$

$$w_{M3} > w_{M1} \Leftrightarrow d_1 < 4\sqrt{\frac{64 - 27d_2^2}{3d_2^2 + 304}}, \quad p_{M3} < p_{M1},$$

$$m_{M3} < m_{M1}, \quad t_3 < t_1, \quad r_3 < r_1, \quad q_{M3} < q_{M1},$$

$$p_{M3} - w_{M3} < p_{M1} - w_{M1}.$$

This Proposition shows that the leading manufacturer should prefer M1 to M3. This is explained by the fact that simultaneous decision-making of pricing and ME yields higher sales units. In M1, although the manufacturer invests higher levels of direct ME to consumers ($m_{M3} < m_{M1}$), he decreases his participation into the retailer's ME. Overall, the higher sales generated in M1 boosts the manufacturer's revenue levels even when it gets a smaller margin. This explains the higher manufacturer's profits in M1 and means that the leader is better off deciding of pricing and ME simultaneously than setting ME before prices.

On the retail side, lower revenues are generated in M3 than in M1. Although the consumer price is lower in M3, the retailer invests less intensively in ME, which leads to a lower overall demand. The decrease in price is also accompanied by a lower retail margin, which explains the lower retail revenues in M3. Looking at costs, the retailer invests less in ME but does not get as high a manufacturer's coop rate as in M1. Therefore, the retailer's ME costs can be higher or lower depending on the levels of ME effectiveness. The overall effect on the retailer's profits is mixed and the latter would prefer M3 to M1 only when d_1 levels are high enough as shown in Fig. 3.

Proposition 3 also shows that, even when $\pi_{M1} > \pi_{M3}$, the overall channel profits is still lower in M3 compared to its level in M1. This means that any channel conflict that may arise in this case can be resolved through side-payment agreements from the manufacturer to the retailer. Therefore, the leading manufacturer could always avoid playing M3 in the feasible domain (I).

Finally, the optimal sequence of move for each channel member can be determined by comparing the equilibrium outputs in M1 and M2 in the feasible domain (I).

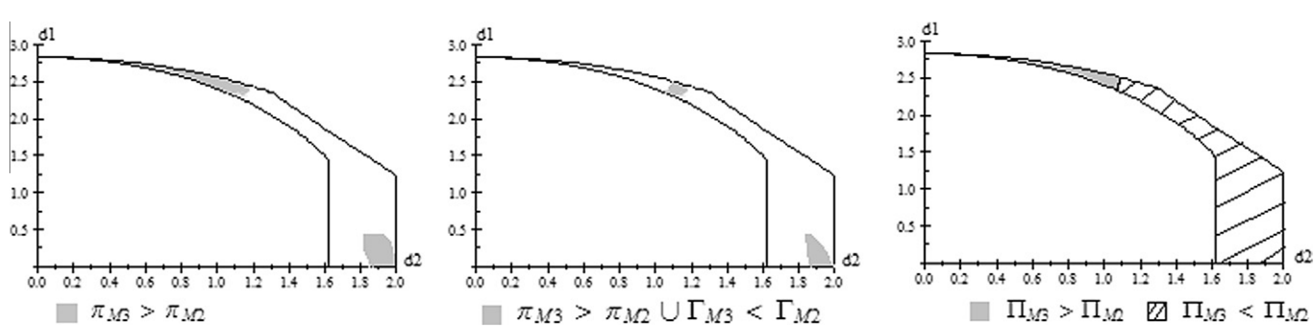

Fig. 2. Channel conflict in region (III).

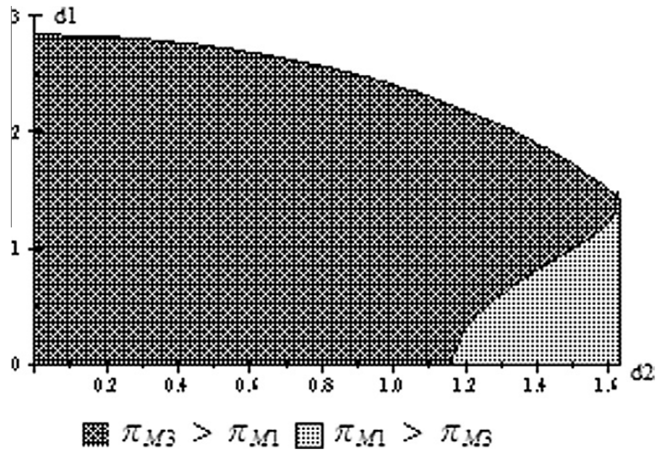

Fig. 3. $\pi_{M3} - \pi_{M1}$ (region I).

Proposition 4. *Under the manufacturer's leadership, equilibrium solutions in M1 and M2 in the feasible domain (I) compare as follows;*

$$\Pi_{M2} > \Pi_{M1} \Leftrightarrow d_1 < \sqrt{\frac{d_2^6 - 24d_2^4 + 64d_2^2}{9d_2^4 + 64 - 48d_2^2}},$$

$$\pi_{M2} > \pi_{M1} \Leftrightarrow \alpha_3 > 0, \quad \Gamma_{M2} > \Gamma_{M1} \Leftrightarrow \alpha_4 > 0,$$

$$w_{M2} < w_{M1} \Leftrightarrow d_1 > x_7, \quad p_{M2} > p_{M1} \Leftrightarrow d_1 \in (x_{11}, x_{12}),$$

$$m_{M2} > m_{M1} \Leftrightarrow d_1 < x_8, \quad q_{M2} < q_{M1} \Leftrightarrow d_1 > x_9,$$

$$r_{M2} < r_{M1} \Leftrightarrow d_1 > x_{10},$$

$$t_{M2} > t_{M1} \Leftrightarrow d_1 < \sqrt{\frac{-d_2^4 + 4d_2^2 - 32}{6d_2^2 - 16}}.$$

This Proposition shows that the leading manufacturer can prefer M2 or M1 depending on market conditions. As we can see in Fig. 4, the manufacturer should choose to lead simultaneously in pricing and ME (M1) only for levels of d_1 that are higher than d_2. Alternatively, the manufacturer will gain higher profits if it leads first in price then in ME (M2) when the retailer's ME are more effective than then manufacturer's ($d_2 > d_1$). The latter situation is not uncommon since the retailer is often more effective at running consumer promotions than manufacturers because of its better knowledge of consumer preferences and access to point of sale data.

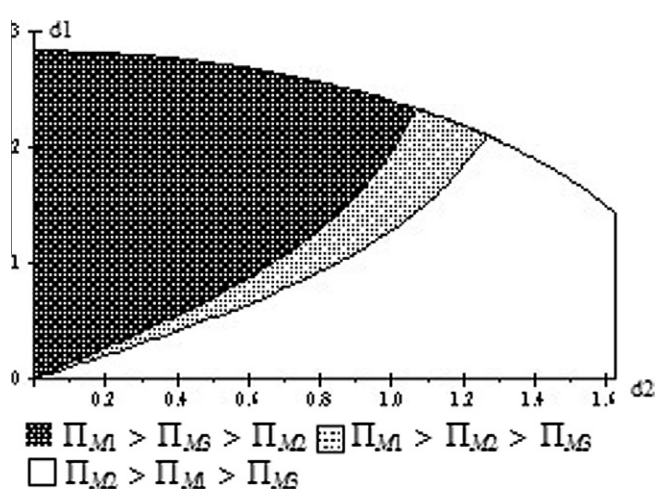

Fig. 4. Comparisons for (Π_{Mi}) in region (I).

This constitutes an important finding; contrary to the common assumption used in the coop advertising literature with bilateral channels (e.g., Karray and Zaccour, 2006; Xie and Wei, 2009; He et al., 2009; Ahmadi-Javid and Hoseinpour, 2011; SeyedEsfahani et al., 2011), a simultaneous decision-making of prices and ME by the channel members under the manufacturer leadership might not be the optimal choice for the leader.

Numerical Result 3. *Under the manufacturer's leadership and in the feasible domain (I), $\pi_{M1} > \pi_{M2}$ for very low or high values of d_1 and $\pi_{M1} < \pi_{M2}$ otherwise.*

Numerical Result 4. *Under the manufacturer's leadership and in the feasible domain (I);*

- $\Pi_{M2} > \Pi_{M1} \cup \pi_{M2} < \pi_{M1} \Rightarrow \Gamma_{M2} > \Gamma_{M1}$,
- $\Pi_{M2} < \Pi_{M1} \cup \pi_{M2} > \pi_{M1} \Rightarrow \Gamma_{M2} > \Gamma_{M1}$ *for high values of* d_1.

These numerical results show that the retailer would prefer to play M2 rather than M1 except in some cases of very low or high values of d_1 within the feasible domain (I) (Fig. 5). In case of low values of d_1, whenever the retailer prefers M1, the manufacturer as well as the total channel get higher profits by playing the sequence of move M2 (Fig. 6). Therefore, the manufacturer preferred sequence of play in this case is the one that maximizes total channel profits. The retailer can be "convinced" to choose the sequence of move M2 instead of M1 for this reason, which will alleviate conflict between channel members.

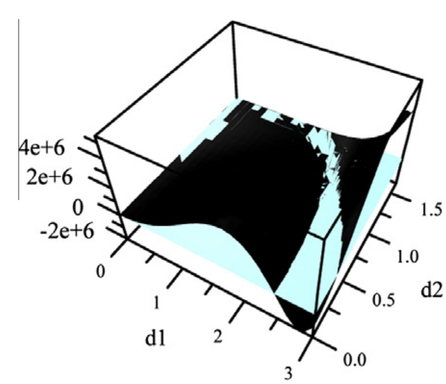

Fig. 5. $\pi_{M2} - \pi_{M1}$.

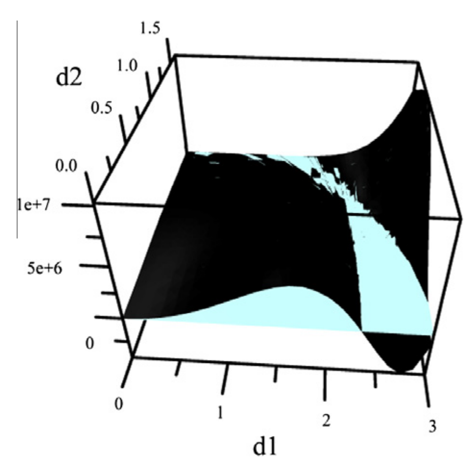

Fig. 6. $\Gamma_{M2} - \Gamma_{M1}$.

For some high values of d_1 in the feasible domain (I), the retailer and the manufacturer also disagree on their preferred sequence of move. In this case, the manufacturer prefers M1 and the retailer prefers M2, and the total channel profit is maximized by the retailer's preferred sequence of move M2. The conflict cannot be easily resolved since the leader's preferred sequence of move is detrimental to both the retailer and the total channel profits.

These numerical results show that for some values of d_1 and d_2 in the feasible domain (I), M1 can be detrimental to the profits of both channel members and even when it is preferred by the leading manufacturer, it can harm the total channel's efficiency. Based on the results obtained in the previous Propositions, we can now draw conclusions about the equilibrium solution for each channel member.

Corollary 1. *Under the manufacturer's leadership, the equilibrium solution for each channel member and the entire channel is given in Table 4*

Corollary 1 shows that the leading manufacturer would prefer to decide simultaneously of pricing and ME only in a small region of the parameters domain and given high enough values of d_1. This result points to the importance of relaxing the simultaneous play assumption of pricing and ME in order to represent the case where the manufacturer explores a wider range of strategies. Namely, the leading manufacturer can choose a more profitable sequence of move when the retailer's ME are more effective than its ME, and lead the channel given a wider range of ME effectiveness levels. In fact, for very high levels of d_1 and d_2, sequential play of pricing and ME allows channel members to implement equilibrium strategies and therefore achieve maximum profits (Figs. 4 and 5).

Further, the leading manufacturer can benefit from implementing a sequence of move that would not maximize its profits but could extract additional channel profits instead (in regions I and III). This not only alleviates possible conflict with the following retailer, when the latter prefers a different sequence of move of pricing and ME, but could also benefit the manufacturer after redistribution of additional channel profits.

4. Effect of ME and price sequence of move when the retailer is the channel leader

4.1. Equilibrium solution and feasible domain

In this case, the retailer is the channel leader. In R1, the retailer decides first simultaneously of its price (p) and ME (r). Second, the manufacturer sets its price (w) and ME mix (m and t) given the retailer's announced decisions. In R2 and R3, the retailer plays two separate Stackelberg games for pricing and ME.

In R2, the pricing game is played first; the retailer decides of p then the manufacturer decides of w given the previously announced retail price. The ME are decided next in a second retailer Stackelberg game; knowing both retail and wholesale prices, the retailer decides of r, and in a final stage the manufacturer sets its ME mix (m and t) given all previously decided actions. Finally, in R3, the retailer plays first the Stackelberg game in ME then in price. The solution for each of these games is obtained by backward induction and is provided in Table 5. All proof is in Appendix 1.

The equilibrium solution shows that when the channel is led by the retailer, the manufacturer does not offer a coop advertising program ($t_{Ri} = 0, i = 1, 2, 3$). This result is in line with Xie and Neyret (2009) and SeyedEsfahani et al. (2011) who also studied coop programs in channels led by the retailer, and generalizes their result to the case where R2 and R3 sequence of move are considered. The intuition for this finding is that the manufacturer does not have an incentive to stimulate the retailer's ME if the retailer has already announced its ME decision.

Similarly to the manufacturer leadership scenario, we first identify the market conditions for which each R*i* game is feasible using the necessary and sufficient conditions for positive equilibrium solutions. Then, we compare these equilibrium outputs in order to identify which sequence of move is optimal for each channel member.

Proposition 5. *Under the retailer's leadership, the equilibrium solution for each channel member in the feasible domain is given in Table 6*

Proposition 5 results are represented in Fig. 7. They show that the acceptable domain for the R*i* games is even more fragmented than in the case of the manufacturer's leadership. In two domain regions (IV and V), the channel members can implement only one sequence of move under the retailer's leadership. On one hand, only R3 is feasible when the manufacturer's ME effectiveness (d_1) is low enough but the retailer's ME effect (d_2) is "very" high or vice versa (region IV). In this case, ME should be decided prior to prices in order to achieve optimal strategies. On the other hand, for intermediate levels of d_2 coupled with very high levels of d_1 (region V), only R2 is feasible; meaning that the optimal solution is reached only if the retailer leads the channel first in prices then in ME.

Table 5
Equilibrium solutions for each R*i* (i = 1, 2, 3).

	R1	R2	R3
w	$\frac{2v}{8-d_2^2-2d_1^2}$	$\frac{2v(4-d_1^2)}{(d_1^2-d_2^2-2)(d_2^2+d_1^2-6)}$	$\frac{2v(8-d_1^2)}{d_1^4-8d_2^2-16d_1^2+64}$
m	$\frac{v^2d_1^2}{(8-d_2^2-2d_1^2)^2}$	$\frac{v^2d_1^2(4-d_1^2)^2}{[(d_1^2-d_2^2-2)(d_2^2+d_1^2-6)]^2}$	$\frac{v^2d_1^2(8-d_1^2)^2}{(d_1^4-8d_2^2-16d_1^2+64)^2}$
t	0	0	0
Π	$\frac{v^2(8-3d_1^2)}{(8-d_2^2-2d_1^2)^2}$	$\frac{v^2(2d_2^2-d_1^2)(4-d_1^2)^2}{[(d_1^2-d_2^2-2)(d_2^2+d_1^2-6)]^2}$	$\frac{v^2(8-d_1^2)^3}{(d_1^4-8d_2^2-16d_1^2+64)^2}$
p	$\frac{4v}{8-d_2^2-2d_1^2}$	$\frac{2v(6-2d_1^2+d_2^2)}{(d_1^2-d_2^2-2)(d_2^2+d_1^2-6)}$	$\frac{4v(8-d_1^2)}{d_1^4-8d_2^2-16d_1^2+64}$
r	$\frac{v^2d_2^2}{(8-d_2^2-2d_1^2)^2}$	$\frac{v^2d_2^2}{(6-d_2^2-d_1^2)^2}$	$\frac{64v^2d_2^2}{(d_1^4-8d_2^2-16d_1^2+64)^2}$
$p-w$	$\frac{2v}{8-d_2^2-2d_1^2}$	$\frac{2v}{6-d_2^2-d_1^2}$	$\frac{2v(8-d_1^2)}{d_1^4-8d_2^2-16d_1^2+64}$
π	$\frac{v^2}{8-d_2^2-2d_1^2}$	$\frac{v^2d_2^2}{(d_1^2-d_2^2-2)(d_2^2+d_1^2-6)}$	$\frac{8v^2}{d_1^4-8d_2^2-16d_1^2+64}$
q	$\frac{v(4-d_1^2)}{8-d_2^2-2d_1^2}$	$\frac{vd_2^2(4-d_1^2)}{(d_1^2-d_2^2-2)(d_2^2+d_1^2-6)}$	$\frac{4v(8-d_1^2)}{d_1^4-8d_2^2-16d_1^2+64}$

Table 4
equilibrium solution for M*i* (i = 1, 2, 3).

Region	Manufacturer	Retailer	Channel
I	$M2 \succ M1 \Leftrightarrow d_1 < \sqrt{\frac{d_2^6-24d_2^4+64d_2^2}{9d_2^4+64-48d_2^2}}$	$\begin{cases} M3 \succ M2 \Leftrightarrow \alpha_1 > 0 \\ M2 \succ M1 \Leftrightarrow \alpha_3 > 0 \\ M3 \succ M1 \Leftrightarrow d_1 > x_6 \end{cases}$	$M2 \succ M1 \Leftrightarrow \alpha_4 > 0$
II	M3	M3	M3
III	$M3 \succ M2 \Leftrightarrow d_1 > \frac{d_2}{4}\sqrt{\frac{-2864d_2^2+104d_2^4+d_2^6+13\ 824}{-380d_2^2+47d_2^4+512}}$	$M3 \succ M2 \Leftrightarrow \alpha_1 > 0$	$M3 \succ M2 \Leftrightarrow \alpha_2 > 0$
IV	M2	M2	M2

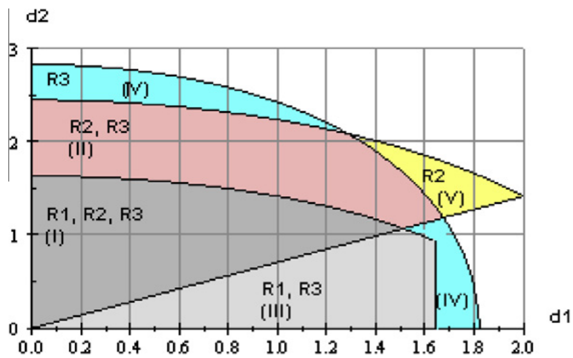

Fig. 7. Feasible domain for Ri.

In the remaining feasible domain, different menus of R1, R2 and R3 are available to the channel. For example, for intermediate levels of both d_1 and d_2; pricing cannot be decided simultaneously with ME (region II) and the retailer will choose the sequence of move that maximizes its profits. In these regions (I, II and III), the optimal sequence of move for pricing and ME for each channel member is the one that yields maximum profits.

As in the previous section, determining the optimal Ri game would depend on which region of the feasible domain is considered for analysis. Therefore, we compare equilibrium solutions when more than two games are feasible (regions I, II and III).

4.2. Effect of sequence of move of price and marketing effort decisions

Proposition 6. *Under the retailer's leadership, equilibrium solutions in R1 and R3 in the feasible domain (I and III) compare as follows;*

$$\Pi_{R3} > \Pi_{R1}, \quad \pi_{R3} < \pi_{R1}, \quad \Gamma_{R3} > \Gamma_{R1} \Leftrightarrow d_2 < x_{13},$$
$$w_{R3} < w_{R1}, \quad p_{R3} < p_{R1}, \quad (p_{R3} - w_{R3}) < (p_{R1} - w_{R1}),$$
$$m_{R3} < m_{R1}, \quad r_{R3} < r_{R1}, \quad q_{R3} > q_{R1}.$$

Corollary 2. *Under the retailer's leadership, at equilibrium and in the feasible domain (III); $\Gamma_{R3} < \Gamma_{R1}$.*

Proposition 6 suggests that the retailer should prefer R1 to R3 while the manufacturer should choose R3. For the retailer, R1 provides higher margins and lower ME costs. For the manufacturer, the increased margins and gains on ME costs in R1 are not sufficient to compensate for the drop in sales; which explains its preference for R3.

The first implication of this result is that when only these two games are feasible (in region III); the optimal sequence of move is R1 for the leading retailer and R3 for the following manufacturer. The result in Corollary 2 shows that the total channel profit is also higher in R1 than it is in R3 in this domain region. Therefore, the manufacturer would not be able to convince the retailer to play R3 and will have to assume the opportunity cost of playing R1. Secondly, in the feasible domain (I) where all three Ri games can be played by the channel members, the manufacturer will prefer Ri such as $\Pi_{Ri} = \max(\Pi_{R2}, \Pi_{R3})$ and the retailer will choose Ri such as $\pi_{Ri} = \max(\pi_{R1}, \pi_{R2})$.

The optimal game for the overall channel will be Ri such as $\Gamma_{Ri} = \max(\Gamma_{R1}, \Gamma_{R2}, \Gamma_{R3})$. Next, we compare equilibrium outputs from R2 and R3.

Table 6
Equilibrium solution for Ri (i = 1, 2, 3) given the domain regions represented in Fig. 7.

Region	Manufacturer	Retailer
I	Ri such as $\Pi_{Ri} = \max(\Pi_{R1}, \Pi_{R2}, \Pi_{R3})$	Ri such as $\pi_{Ri} = \max(\pi_{R1}, \pi_{R2}, \pi_{R3})$
II	R2 if $\Pi_{R2} > \Pi_{R3}$, R3 otherwise	R2 if $\pi_{R2} > \pi_{R3}$, R3 otherwise
III	R1 if $\Pi_{R1} > \Pi_{R3}$, R3 otherwise	R1 if $\pi_{R1} > \pi_{R3}$, R3 otherwise
IV	R3	R3
V	R2	R2

Proposition 7. *Under the retailer's leadership, equilibrium solutions in R2 and R3 in the feasible domain (I and II) compare as follows;*

$$\pi_{R3} > \pi_{R2} \Leftrightarrow d_2 < \sqrt{\frac{8\left(d_1^2 - 6\right)\left(d_1^2 - 2\right)}{32 - 16d_1^2 + d_1^4}},$$
$$\Pi_{R3} > \Pi_{R2} \Leftrightarrow \alpha_5 > 0, \quad \Gamma_{R3} > \Gamma_{R2} \Leftrightarrow \alpha_6 > 0,$$
$$w_{R3} < w_{R2}, \quad p_{R3} < p_{R2}, \quad (p_{R3} - w_{R3}) < (p_{R2} - w_{R2}),$$
$$m_{R3} < m_{R2}, \quad r_{R3} < r_{R2}, \quad q_{R3} > q_{R2} \Leftrightarrow d_2 < x_{14}.$$

Corollary 3. *Under the retailer's leadership, at equilibrium and in the feasible domain (I); $q_{R3} > q_{R2}$.*

In the feasible domain (I), Proposition 7 and Corollary 3 show that R2 provides larger margins but higher ME costs and fewer sales for both channel members; mainly because of the increase in the retail price. This means that R2 does not always lead to higher revenue levels for the retailer and the manufacturer compared to the sequence of move in R3. These results also show that, at equilibrium, both channel members spend higher amounts for marketing efforts in R2 than in R3. Therefore, R2 can be preferred by each channel member only if it also increases their revenues. As shown in Proposition 7, the preferred sequence of move (R2 or R3) will depend on the values of d_1 and d_2.

On the retail side, when only R2 and R3 are feasible (region II), the retailer should implement R2 in most cases except when both d_1 and d_2 take low values in the acceptable domain (Fig. 8). When R1 is also a feasible game (region I), the comparison of retail profits in R2 and R3 is not very important to identify the optimal game in region (I) since we have already established in Proposition 6 that the retailer will choose Ri such as $\pi_{Ri} = \max(\pi_{R1}, \pi_{R2})$.

For the manufacturer, it is important to compare outputs from R2 and R3 in order to determine the optimal game in the feasible domain (I and II). As illustrated in Fig. 9, the manufacturer would gain higher profits in R3 than in R2 when d_1 is either low enough or very high in the acceptable domain.

Numerical Result 5. *Under the retailer's leadership, numerical analysis of the total channel's equilibrium profits in R2 and R3 in the feasible domain (II) shows that*

$$\Pi_{R2} > \Pi_{R3} \Rightarrow \Gamma_{R2} > \Gamma_{R3}.$$

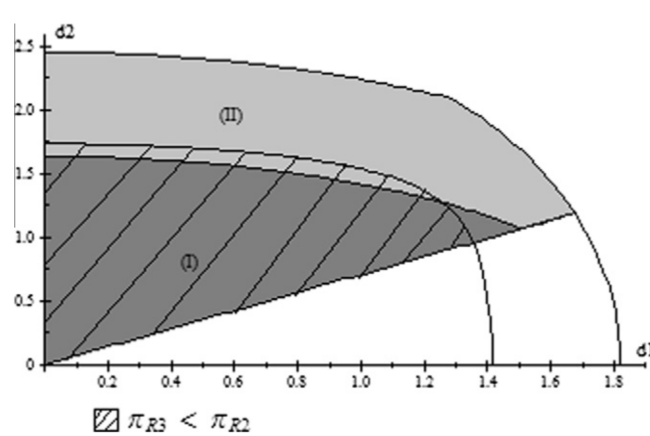

Fig. 8. $\pi_{R3} - \pi_{R2}$ in regions (I) and (II).

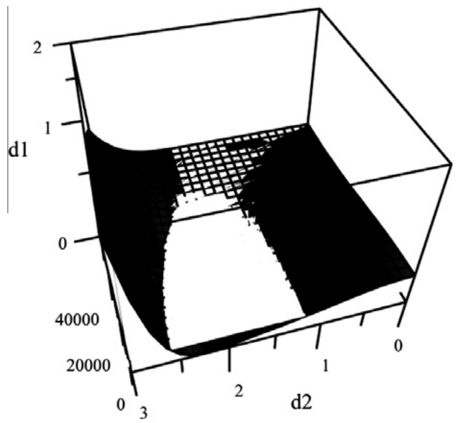

Fig. 9. $\Pi_{R3} - \Pi_{R2}$ (in I and II).

This result indicates that when R2 is the manufacturer's optimal game, it would also provide maximum profits to the entire channel. In this case, any conflict that may arise from a different sequence of move preferred by the retailer can be resolved by redistribution of channel profits. Note however that the opposite is not true; the numerical analysis shows that it is possible to have $\Pi_{R2} < \Pi_{R3}$ and $\Gamma_{R2} > \Gamma_{R3}$ in region (II) as illustrated in Figs. 9 and 10. In this situation, the retailer prefers R2 and would not be willing to play R3 (the manufacturer's preferred sequence of move) because of the detrimental effects not only on its profits but also on the overall channel profits. Therefore, conflicted choices of R*i* games would still persist in the channel. Next, we compare equilibrium outputs from R1 and R2.

Proposition 8. *Under the retailer's leadership, equilibrium solutions in R1 and R2 in the feasible domain (I) compare as follows;*

$$\pi_{R2} < \pi_{R1} \Leftrightarrow d_1 > \sqrt{2}, \quad \Pi_{R2} > \Pi_{R1} \Leftrightarrow \alpha_7 > 0, \quad \Gamma_{R2} > \Gamma_{R1} \Leftrightarrow \alpha_8 > 0,$$
$$w_{R2} > w_{R1}, \quad p_{R2} > p_{R1}, \quad m_{R2} > m_{R1},$$
$$r_{R2} > r_{R1}, \quad q_{R2} > q_{R1}, \quad (p_{R2} - w_{R2}) > (p_{R1} - w_{R1}) \Leftrightarrow d_1 < \sqrt{2}.$$

This result shows first that the retailer can find it optimal to play R1 only for high levels of the manufacturer's ME effectiveness ($d_1 > \sqrt{2}$); mainly because the product sales are higher and so is the retail margins, which leads to higher revenues in R1 than in R2. This means that when the retailer leads the channel and can decide of prices not only simultaneously but also prior or after ME, the best sequence of move could be to play R1 only when the manufacturer's direct ME to consumers are high enough. Note that a very small part of the feasible domain (I) corresponds to values of $d_1 > \sqrt{2}$ (Fig. 7); which means that the necessary conditions for R1 $\succ$ R2 are very restrictive.

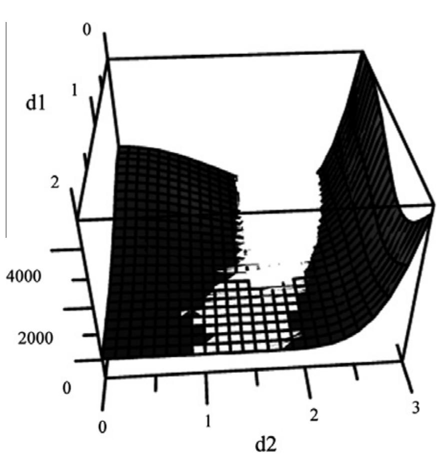

Fig. 10. $\Gamma_{R3} - \Gamma_{R2}$ (in I and II).

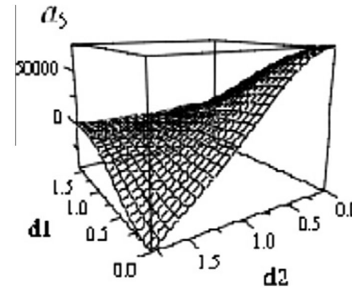

Fig. 11. α_5 for $d_2 < \sqrt{2}$.

Therefore, the assumption that a retailer plays a two-stage Stackelberg game to decide of pricing and ME does not reflect the optimal periodicity choice for the leading retailer (Xie and Neyret, 2009; SeyedEsfahani et al., 2011). Indeed, the retailer could choose different periodicity for its decisions for high values of the manufacturer's ME effect.

For the manufacturer, the choice between R1 and R2 is not very relevant since in the feasible domain (I), it gets maximum profits either from playing R2 or R3 (Proposition 6). It is however interesting to analyze further the situation when both channel members favor the same sequence of move (R2).

Given the results in Propositions 7 and 8, the manufacturer and the retailer prefer R2 at equilibrium when these conditions are verified;

$$d_1 < \sqrt{2}, \quad \alpha_5 < 0.$$

Fig. 11 represents values of $\alpha_5(d_1, d_2)$, which is included in Appendix 2, for $d_1 < \sqrt{2}$. We can see that α_5 takes negative values mainly for high values of d_2. Therefore, for high levels of d_2 and low levels of $d_1 (d_1 < \sqrt{2})$; there is no conflict between channel members about their favorite sequence of move since they would both prefer R2. However, the channel conflict would persist in the remaining domain, specifically in the following situations;

(1) The manufacturer prefers R3 and the retailer prefers R2 or R1;
- $\alpha_5 > 0 \cup d_1 > \sqrt{2}$; in this case, conflict can be resolved iff $\Gamma_{R3} > \Gamma_{R1} \Leftrightarrow d_2 < x_{13}$ (Proposition 6).
- $\alpha_5 > 0 \cup d_1 < \sqrt{2}$; in this case, conflict can be resolved iff $\Gamma_{R3} > \Gamma_{R2} \Leftrightarrow \alpha_6 > 0$ (Proposition 7).

(2) The manufacturer prefers R2 and the retailer prefers R1 ($\alpha_5 < 0 \cup d_1 > \sqrt{2}$); in this case, conflict can be resolved iff $\Gamma_{R2} > \Gamma_{R1} \Leftrightarrow \alpha_8 > 0$ (Proposition 8).

We conduct numerical simulations in order to explore the total channel profits under these different conditions and find evidence that in each of these cases, conflict could be resolved only for some values of d_1 and d_2.

Finally, we can state the equilibrium solution for the channel in the entire feasible domain.

Corollary 4. *Under the retailer's leadership, the preferred game by each channel member and by the entire channel is given in Table 7*

Corollary 4 shows that the leading retailer would prefer to decide simultaneously of pricing and ME only in a restricted region of the parameters domain and given values of d_1 that are higher than d_2. This indicates that the Stackelberg game in price and ME

Table 7
equilibrium solution Ri (i = 1, 2, 3).

Region	Manufacturer	Retailer	Channel
I	$R3 \succ R2 \Leftrightarrow \alpha_7 > 0$	$R2 \succ R1 \Leftrightarrow d_1 < \sqrt{2}$	$\begin{cases} R3 \succ R2 \Leftrightarrow \alpha_8 > 0 \\ R2 \succ R1 \Leftrightarrow \alpha_{10} > 0 \\ R3 \succ R1 \Leftrightarrow d_2 < x_{13} \end{cases}$
II	$R3 \succ R2 \Leftrightarrow \alpha_7 > 0$	$R3 \succ R2 \Leftrightarrow d_2 < \sqrt{\frac{8(d_1^2-6)(d_1^2-2)}{-16d_1^2+d_1^4+32}}$	$R3 \succ R2 \Leftrightarrow \alpha_8 > 0$
III	R3	R1	$R3 \succ R1 \Leftrightarrow d_2 < x_{13}$
IV	R3	R3	R3
V	R2	R2	R2

under the retailer's leadership (i.e., R1) does not represent the optimal strategy for both channel members in most cases. Relaxing this assumption by considering alternative periodicity scenarios of prices and ME, would therefore allow the retailer to choose a more profitable sequence of move, especially when its ME are more effective than the manufacturer's. It also allows a more thorough examination of channel strategies for a wide range of ME effectiveness levels.

In fact, for very high levels of d_1 and d_2, sequential play of pricing and ME allows channel members to implement equilibrium strategies and therefore achieve maximum profits. Further, when the manufacturer and the retailer prefer different periodicity of pricing and ME decisions (regions I, II and III), conflict could be resolved through redistribution of overall channel profits but only for some values of d_1 and d_2.

5. Effect of ME and price sequence of move in case of no leadership (vertical Nash)

5.1. Equilibrium solution and feasible domain

In case the channel does not have a leader, the manufacturer and the retailer choose simultaneously their pricing and marketing effort strategies. In N1, the retailer and the manufacturer decide simultaneously of their prices (p, w) and ME (r, m, t). In N2, the manufacturer and the retailer decide simultaneously of their prices (p, w) in a first stage and of their ME mix (r, m and t) in a second stage given the previously decided prices. Finally, in N3, the manufacturer and the retailer decide simultaneously of their ME mix (r, m and t) in a first stage and of their prices (p, w) in a second stage given the previously decided ME levels. The solution for each of these games is obtained by backward induction and is provided in Table 8. All proof is in Appendix 1.

Similarly to the retailer leadership scenario, when channel members play Nash, the manufacturer does not offer a coop advertising program at equilibrium ($t_{Ni} = 0, i = 1, 2, 3$). This is because the manufacturer does not have an incentive to stimulate the retailer's ME since the latter does not consider the coop rate when making the retail ME decision.

As in the previous sections, we first identify the market conditions for which each Ni game is feasible using the necessary and sufficient conditions for positive equilibrium solutions. Then, we compare these equilibrium outputs in order to identify which sequence of move is optimal for each channel member.

Proposition 9. *When the channel does not have a leader, the equilibrium solution for each channel member in the feasible domain is given by;*

Fig. 12 and Table 9 show that in the domain region (III), the channel members can implement only the sequence of move N3. In this case, highly effective marketing efforts are performed either by the retailer or by the manufacturer, and ME should be decided prior to prices in order to achieve optimal strategies. However, in the remaining feasible domain, different menus of N1, N2 and N3 are available to the channel. In this case, the optimal sequence of move for pricing and ME for each channel member is the one that yields maximum profits.

As in the previous sections, the optimal sequence of move would depend on which region of the feasible domain is

Table 8
Equilibrium solutions for each Ni (i = 1, 2, 3).

	N1	N2	N3
w	$\frac{2v}{6-d_2^2-d_1^2}$	$\frac{4v}{4d_2^2-2d_1^2-d_2^4+4}$	$\frac{2v}{8-d_2^2-d_1^2}$
m	$\frac{4v^2}{(6-d_2^2-d_1^2)^2}$	$\frac{4v^2 d_1^2}{(4d_2^2-2d_1^2-d_2^4+4)^2}$	$\frac{v^2 d_1^2}{(8-d_2^2-d_1^2)^2}$
t	0	0	0
Π	$\frac{v^2(4-d_1^2)}{(6-d_2^2-d_1^2)^2}$	$\frac{4v^2(2d_2^2-d_1^2)}{(4d_2^2-2d_1^2-d_2^4+4)^2}$	$\frac{v^2(8-d_1^2)}{(8-d_2^2-d_1^2)^2}$
p	$\frac{4v}{6-d_2^2-d_1^2}$	$\frac{2v(2+d_2^2)}{4d_2^2-2d_1^2-d_2^4+4}$	$\frac{4v}{8-d_2^2-d_1^2}$
r	$\frac{v^2 d_2^2}{(6-d_2^2-d_1^2)^2}$	$\frac{v^2 d_2^6}{(4d_2^2-2d_1^2-d_2^4+4)^2}$	$\frac{v^2 d_2^2}{(8-d_2^2-d_1^2)^2}$
$p-w$	$\frac{2v}{6-d_2^2-d_1^2}$	$\frac{2vd_2^2}{4d_2^2-2d_1^2-d_2^4+4}$	$\frac{2v}{8-d_2^2-d_1^2}$
π	$\frac{v^2(4-d_2^2)}{(6-d_2^2-d_1^2)^2}$	$\frac{v^2 d_2^4(4-d_2^2)}{(4d_2^2-2d_1^2-d_2^4+4)^2}$	$\frac{v^2(8-d_2^2)}{(8-d_2^2-d_1^2)^2}$
q	$\frac{2v}{6-d_2^2-d_1^2}$	$\frac{2vd_2^2}{4d_2^2-2d_1^2-d_2^4+4}$	$\frac{4v}{8-d_2^2-d_1^2}$

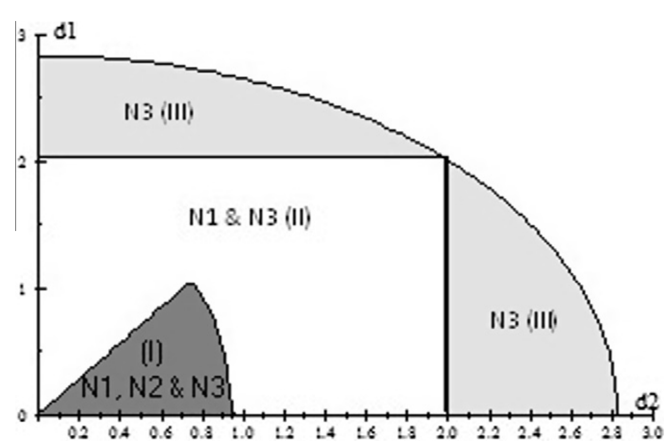

Fig. 12. Feasible domain for Ni.

Table 9
Equilibrium solution for Ni (i = 1, 2, 3) given the domain regions represented in Fig. 12.

Region	Manufacturer	Retailer
I	Ni such as $\Pi_{Ni} = \max(\Pi_{N1}, \Pi_{N2}, \Pi_{N3})$	Ni such as $\pi_{Ni} = \max(\pi_{N1}, \pi_{N2}, \pi_{N3})$
II	N1 if $\Pi_{N1} > \Pi_{N3}$, N3 otherwise	N1 if $\pi_{N1} > \pi_{N3}$, N3 otherwise
III	N3	N3

considered for analysis. Therefore, we compare equilibrium solutions when more than two games are feasible (regions I and II).

5.2. Effect of sequence of move of price and marketing effort decisions

Proposition 10. *When the channel does not have a leader, equilibrium solutions in N1 and N3 in the feasible domain (I and II) compare as follows;*

$$\Pi_{N3} < \Pi_{N1} \Leftrightarrow d_1 > \sqrt{\frac{8 + d_2^4 - 8d_2^2}{1 - d_2^2}},$$

$$\pi_{N3} < \pi_{N1} \Leftrightarrow d_1 \in (x_{15}, x_{16}), \quad \Gamma_{N3} < \Gamma_{N1} \Leftrightarrow d_1 \in (x_{17}, x_{18}),$$

$$w_{N3} < w_{N1}, \quad p_{N3} < p_{N1}, \quad (p_{N3} - w_{N3}) < (p_{N1} - w_{N1}),$$

$$m_{N3} < m_{N1}, \quad r_{N3} < r_{N1}, \quad q_{N3} > q_{N1} \Leftrightarrow d_1 < \sqrt{4 - d_2^2},$$

where x_{15} to x_{18} are functions of d_2, and are included in Appendix 2.

These results indicate that, whenever channel members can choose between N1 and N3, the simultaneous decision making of pricing and marketing mix strategies in N1 would yield higher wholesale and retail prices and marketing efforts at equilibrium as well as higher margins. Since both ME and prices are higher in N1 than in N3, demand obtained in N1 is expanded by the additional ME but reduced by the higher price. These opposite effects on demand can lead to higher or lower demand in N1 than in N3 depending on market conditions. Consequently, for both channel members, N1 is associated with higher profit margins, but higher ME costs than N3. Hence, comparison of profits obtained in N1 and N3 would ultimately depend on the associated revenues in each scenario.

Further analysis of the effects on profits and demands is explored by looking at the feasible region (I).

Corollary 5. *When the channel does not have a leader, equilibrium retail and total channel profits in N1 and N3 in the feasible domain (I) compare as follows;*

$$\Pi_{N3} > \Pi_{N1}, \quad \pi_{N3} > \pi_{N1}, \quad q_{N3} > q_{N1}, \quad \Gamma_{N3} > \Gamma_{N1}.$$

Both the manufacturer and the retailer prefer N3 to N1 in the feasible domain (I). Although N1 provides both channel members with higher profit margins, the demand is lower than in N3. This is because the consumer price is higher in this scenario. While channel members invest in more marketing efforts in N1 than in N3, the demand expansion due to the additional ME is not sufficient to counter the lost unit sales due to a higher price. The ME costs are also higher in N1, which ultimately results in lower profits in N1 than in N3. It follows that higher overall channel profit is achieved at equilibrium by playing the sequence of move N3 (ME, then prices) instead of N1 in this region of the parameters domain.

Table 10
equilibrium solution Ni (i = 1, 2, 3).

Region	Manufacturer	Retailer	Channel
I	N3	N3	N3
II	$N1 \succ N3 \Leftrightarrow d_1 \in \left(\sqrt{\frac{8+d_2^4-8d_2^2}{1-d_2^2}}, 2\right)$	$N1 \succ N3 \Leftrightarrow d_1 \in (x_{15}, x_{16})$	$N1 \succ N3 \Leftrightarrow d_1 \in (x_{17}, x_{18})$
III	N3	N3	N3

Since channel members can also play the sequence of move N2 in the feasible domain (I), we now compare N2 and N3 in order to determine which scenario represents the optimal sequence of move for each channel member.

Proposition 11. *When the channel does not have a leader, equilibrium solutions in N2 and N3 in the feasible domain (I) compare as follows;*

$$\Pi_{N3} > \Pi_{N2}, \quad \pi_{N3} > \pi_{N2}, \quad \Gamma_{R3} > \Gamma_{R2},$$

$$w_{N3} < w_{N2}, \quad p_{N3} < p_{N2}, \quad (p_{N3} - w_{N3}) > (p_{N2} - w_{N2}),$$

$$m_{N3} < m_{N2}, \quad r_{N3} > r_{N2}, \quad q_{N3} > q_{N2}.$$

Proposition 11 shows that, in the feasible domain (I), N3 is preferred to N2 by both channel members. This is mainly because N3 provides higher unit sales at equilibrium than N2. It also provides higher revenues to the retailer given that its profit margin is higher in N3 than in N2. While the retail ME costs are higher in N3, the increase in revenues compensates for the additional costs and overall profit is higher in N3. Next, we now summarize the results for the three Ni games.

Corollary 6. *When the channel does not have a leader, the preferred game by each channel member and by the entire channel is given in Table 10*

Corollary 6 indicates that the sequence of play N2 is not an optimal scenario in a channel where the retailer and the manufacturer make each of their marketing mix decisions simultaneously. The channel members would prefer to decide of their marketing efforts and prices in separate periods only if prices are decided after ME (N3).

Fig. 13 shows the optimal sequence of move for each channel member and for the entire channel. As we can see, N3 is preferred by both the manufacturer and the retailer in most of the feasible

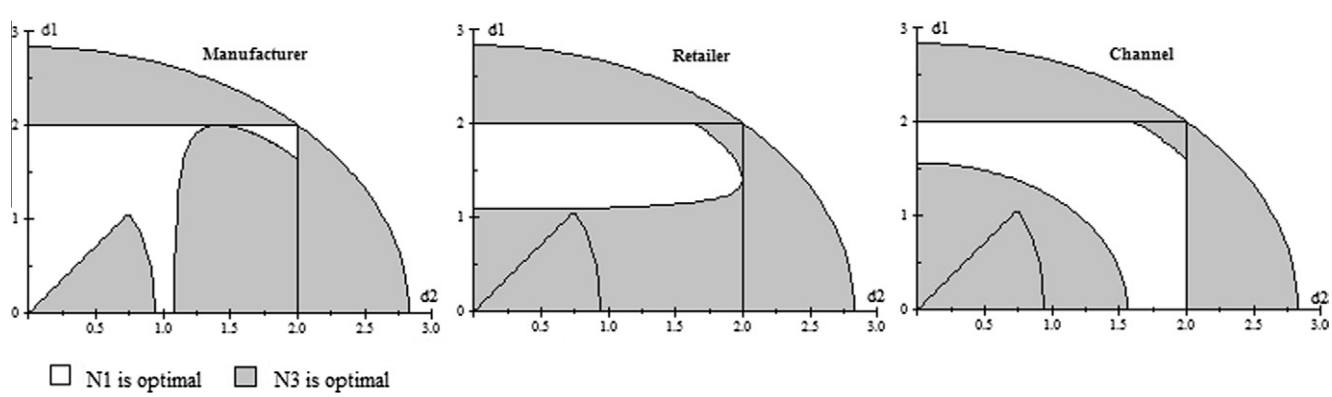

Fig. 13. Optimal sequence of move for Ni.

domain. Further, the simultaneous sequence of move of both pricing and ME (herein N1), which has been commonly used in the literature, is optimal for channel members and for the entire channel in restricted regions of the parameters domain. Comparison of domain regions where N1 is preferred by both channel members (Fig. 13) shows that conflicted choices of optimal sequences of move can arise for certain levels of d_1 and d_2. For example, in case of low levels of d_1, the manufacturer might prefer to decide of all of its marketing mix elements (prices and ME) simultaneously with the retailer, while the retailer would rather decide of ME and prices at different periods. Conflicted choices of N1 and N3 are also noticed for high levels of both d_1 and d_2.

Looking at the optimal sequence of move for the total channel, this conflict can be alleviated if channel members agree on adopting the sequence of move that yields maximum profits for the entire channel. As we can see in Fig. 13, conflict can be solved if the manufacturer switches to the retailer's preferred sequence of move (e.g., for low levels of d_1 or high levels of both d_1 and d_2). Interestingly, in certain regions of the domain (low d_2 and medium d_1), both channel members can individually prefer the same sequence of move (N1). However, a different sequence of move (N3) would yield the maximum channel profits.

6. Summary and conclusions

This paper investigates the implications of different periodicity (sequence of move) for pricing and marketing efforts decision-making in a bilateral distribution channel. Results from our game-theoretic model show that which sequence of move for price and ME is optimal would depend on the ME effectiveness levels of the manufacturer and the retailer and on channel leadership.

When the manufacturer or the retailer lead the channel, our findings suggest that while the choice of the optimal sequence of move for specific ME effectiveness levels depends on which firm is the leader, the results from both leadership scenarios are qualitatively similar.

Regardless of which is the channel leader, we find that the sequence in which prices and ME are chosen significantly impacts the equilibrium strategies and profits. In fact, sequential decision-making of pricing and ME allows channel members to implement optimal strategies and obtain maximum profits for high levels of ME effects. In particular, for the highest levels of the retailer's ME effects, the only feasible sequence of move for channel members is to decide on ME before prices. However, games characterized by the highest levels of the manufacturer's ME effects are only feasible if prices preceded the ME decisions. When channel members can choose between different sequences of play of ME and prices, we find that the channel leader should decide of prices first in situations characterized by highly effective retailer's marketing efforts.

Further, the channel leader would prefer to decide simultaneously of pricing and ME only in a small region of the parameters domain especially for high enough levels of the manufacturer's ME effects. This highlights the importance of relaxing the simultaneous play assumption of pricing and ME which has been widely used in the coop advertising literature. In particular, the leader can choose a more profitable sequence of move when the retailer's ME are more effective than manufacturer's, and lead the channel considering less restrictive assumptions on the ME effectiveness levels. In fact, for very highly effective marketing efforts, sequential play of pricing and ME allows channel members to implement equilibrium strategies and therefore achieve maximum profits that would not be achieved with simultaneous decision-making.

Our findings also indicate that the channel leader can often benefit from implementing a sequence of move that would not maximize its profits but could extract additional channel profits instead. This not only allows conflict resolution with the following channel member, when the latter prefers a different sequence of move, but could also benefit the leader after redistribution of additional channel profits. However, in some instances channel conflict would persist, in which case the follower will assume the opportunity cost of not choosing its favorite sequence of move.

For the case of power symmetry in the channel, we find that channel members could prefer to decide of their marketing mix strategies at the same period, as conventionally assumed in the existing literature. However, such preference applies mainly for high levels of the manufacturer's ME effects. In other cases; e.g., when both channel members use highly effective marketing efforts or when the retailer's ME are more effective than the manufacturer's ME, channel members are better off implementing a sequential decision-making approach for marketing efforts and prices where prices are decided in a later period than ME. In contrast to the situations where the manufacturer or the retailer are channel leaders, when channel members choose each element of their marketing mix simultaneously, it is not optimal, in any case to decide of prices prior to ME.

These results have many useful implications for managers in the distribution channel field. They highlight the importance of accounting for the periodicity of marketing mix decisions in the channel and its implications for strategic decisions and profits. In particular, our findings indicate that the periodicity of these decisions should be determined, and sometimes negotiated, by channel members in order to achieve maximum profits. Further, these marketing mix decisions should be renegotiated for varying levels of marketing efforts effectiveness and vertical interaction scenarios in the channel.

This paper offers also a theoretic contribution to the cooperative advertising literature. Since firms are considered rational players, the simultaneous decision-making assumption does not always represent the channel members' optimal choice. The results show that allowing for alternative sequences of move for pricing and ME decisions can lead to alternative equilibrium levels at equilibrium, which can influence cooperative advertising programs agreements and negotiations in the channel.

Future research can extend our results by replicating our analysis; e.g., by considering a different model specification (e.g., a multiplicative demand function as in Xie and Neyret, 2009) or by allowing for a portfolio of ME activities by the manufacturer and the retailer. Further, the results in this paper can help the leader whether to decide on price and marketing efforts at separate periods or to lead in all of these decisions at once. We choose the sequences of move in the paper in order to focus on the impact of different periodicity of marketing efforts and pricing decisions as opposed to the commonly assumed simultaneous decision-making approach. It is important to reiterate that the vertical interaction scenarios considered in the paper were chosen because of their common use in the marketing and OR literature. It is not the paper's purpose to investigate the problem of which channel leadership is appropriate in which situation. For example, in considering the case in which the retailer acts as a Stackelberg leader in both the pricing and the marketing effort games, the paper conforms to the existing literature by considering as exogenous the reasons that enable a retailer to precommit to a certain retail price and marketing efforts. An extension of the paper can endogenize the channel leadership position and study which channel member should be the leader, and for which element of the marketing mix. For example, while we considered the case of full leadership in the channel (the leader moves first for both prices and marketing efforts), future research could explore mixed leadership scenarios where each firm could lead the channel in one decision only (Stern and El-Ansary, 1992). The channel members could also make certain pricing and marketing effort decisions (e.g., retail price and feature promotion) at the same time and make other decisions in other periods. In this case, exploring the situation where there is no clear separation in the timing of price and marketing effort decisions could also be of interest for future researchers.

Finally, empirical research is needed to identify how firms in different industries determine their pricing and marketing efforts and which factors influence the periodicity of such decisions.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ejor.2013.02.012.

References

Agrawal, D., 1996. Effect of brand loyalty on advertising and trade promotions: a game theoretic analysis with empirical evidence. Marketing Science 15 (1), 86–108.

Ahmadi-Javid, A., Hoseinpour, P., 2011. On a cooperative advertising model for a supply chain with one manufacturer and one retailer. European Journal of Operational Research 219 (2), 458–466.

Banerjee, B., Bandyopadhyay, S., 2003. Advertising competition under consumer inertia. Marketing Science 22 (1), 131–144.

Bergen, M., John, G., 1997. Understanding cooperative advertising participation rates in conventional channels. Journal of Marketing Research 34 (3), 357–369.

Berger, P., 1972. Vertical cooperative advertising ventures. Journal of Marketing Research 9 (3), 309–312.

Choi, S., 1991. Price competition in a channel structure with a common retailer. Marketing Science 10 (4), 271–296.

Cotterill, R.W., Putsis, W.P., 2001. Do models of vertical strategic interaction for national and store brands meet the market test? Journal of Retailing 77 (1), 83–109.

Desai, P.S., 2000. Multiple messages to retain retailers: signalling new product demand. Marketing Science 19 (4), 381–389.

Draganska, M., Mazzeo, M., Seim, K., 2009. Beyond plain vanilla: modeling joint product assortment and pricing decisions. Quantitative Marketing & Economics 7 (2), 105–146.

Geylani, T., Dukes, A.J., Srinivasan, K., 2007. Strategic manufacturer response to a dominant retailer. Marketing Science 26 (2), 164–178.

Kadiyali, V., Chintagunta, P., Vilcassim, N., 2000. Manufacturer–retailer channel interactions and implications for channel power: an empirical investigation of pricing in a local market. Marketing Science 19 (2), 127–148.

He, X., Prasad, A., Sethi, S., 2009. Cooperative advertising and pricing in a dynamic stochastic supply chain: feedback Stackelberg strategies. Production and Operations Management 18 (1), 78–94.

Huang, Z., Li, S., 2001. Co-op advertising models in manufacturer–retailer supply chains: a game theory approach. European Journal of Operational Research 135 (3), 527–544.

Huang, Z., Li, S., Mahajan, V., 2002. An analysis of manufacturer–retailer supply chain coordination in cooperative advertising. Decision Sciences 33 (3), 469–494.

Jørgensen, S., Sigue, S., Zaccour, G., 2001. Stackelberg leadership in a marketing channel. International Game Theory Review 3 (1), 13–26.

Jørgensen, S., Sigue, S., Zaccour, G., 2000. Dynamic cooperative advertising in a channel. Journal of Retailing 76 (1), 71–92.

Kadiyali, V., Sudhir, K., Rao, V.R., 2001. Structural analysis of competitive behavior: new empirical industrial organization methods in marketing. International Journal of Research in Marketing 18, 161–186.

Karray, S., Zaccour, G., 2006. Could co-op advertising be a manufacturer's counterstrategy to store brands? Journal of Business Research 59 (9), 1008–1015.

Karray, S., Zaccour, G., 2007. Effectiveness of coop advertising programs in competitive distribution channels. International Game Theory Review 9 (2), 151.

Karray, S., Martin-Herran, M., 2008. Investigating the relationship between advertising and pricing in a channel with private label offering: a theoretic model. Review of Marketing Science 6 (1).

Kim, S.Y., Staelin, R., 1999. Manufacturer allowances and retailer pass-through rates in a competitive environment. Marketing Science 18 (1), 59–76.

Kopalle, P.K., Rao, A.G., Assunção, L., 1996. Asymmetric reference price effects and dynamic pricing policies. Marketing Science 15 (1), 60–85.

Kunter, M., 2012. Coordination via cost and revenue sharing in manufacturer–retailer channels. European Journal of Operational Research 216 (2), 257–508.

Lee, E., Staelin, R., 1997. Vertical strategic interaction: implications for channel pricing strategy. Marketing Science 16 (3), 185–207.

Li, S., Huang, Z., Zhu, J., Chau, P., 2002. Cooperative advertising, game theory and manufacturer–retailer supply chains. Omega 30 (5), 347–357.

McGuire, T., Staelin, R., 1983. An industry equilibrium analysis of downstream vertical integration. Marketing Science 2 (2), 161–191.

Nagler, M., 2006. An exploratory analysis of the determinants of cooperative advertising participation rates. Marketing Letters 17 (2), 91–102.

National Register Publishing (NRP) for coop advertising programs source book sample. <http://www.co-opsourcebook.com/coop_sample.htm> (retrieved on 28.09.12).

Parker, P.M., Soberman, D.A., 2006. The economics of quality-equivalent store brands. International Journal of Research in Marketing 23, 125–139.

Raju, J.S., Srinivasan, V., Rajiv, L., 1990. The effects of brand loyalty on competitive price promotions. Management Science 36 (3), 276–304.

Rao, V.R., 2009. Handbook of Pricing Research in Marketing. Edward Elgar Publishing, ISBN 1847202403.

SeyedEsfahani, M.M., Biazaran, M., Gharakhani, M., 2011. A game theoretic approach to coordinate pricing and vertical co-op advertising in manufacturer–retailer supply chains. European Journal of Operational Research 211, 263–273.

Stern, L.W., El-Ansary, A.L., 1992. Marketing Channels. Prentice Hall, New Jersey.

Szmerekovsky, J., Zhang, J., 2009. Pricing and two-tier advertising with one manufacturer and one retailer. European Journal of Operational Research 192 (3), 904–917.

Weitz, B.A., Wensley, R., 2002. Handbook of Marketing. SAGE Publications.

Xie, J., Ai, S., 2006. A note on cooperative advertising, game theory and manufacturer–retailer supply chains. Omega 34 (5), 501–504.

Xie, J., Neyret, A., 2009. Co-op advertising and pricing models in manufacturer–retailer supply chains. Computers & Industrial Engineering 56 (4), 1375–1385.

Xie, J., Wei, J., 2009. Coordinating advertising and pricing in a manufacturer–retailer channel. European Journal of Operational Research 197 (2), 785–791.

Yan, R., 2009. Cooperative advertising, pricing strategy and firm performance in the e-marketing age. Journal of the Academy of Marketing Science 38, 510–519.

Yue, J., Austin, J., Wang, M., Huang, Z., 2006. Coordination of cooperative advertising in a two-level supply chain when manufacturer offers discount. European Journal of Operational Research 168 (1), 65–85.