European Journal of Operational Research 237 (2014) 1–14

Contents lists available at ScienceDirect

European Journal of Operational Research

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

Invited Review

A survey of game-theoretic models of cooperative advertising ☆

Steffen Jørgensen [a], Georges Zaccour [b,*]

[a] Department of Business and Economics, University of Southern Denmark, Odense, Denmark
[b] Chair in Game Theory and Management, GERAD, HEC, Montréal, Québec, Canada

ARTICLE INFO

Article history:
Received 19 April 2013
Accepted 10 December 2013
Available online 31 December 2013

Keywords:
Co-op advertising programs
Marketing channels
Supply chains
Game theory
Nash and Stackelberg Equilibria
Vertical integration

ABSTRACT

The paper surveys the literature on cooperative advertising in marketing channels (supply chains) using game theoretic methods. During the last decade, in particular, this literature has expanded considerably and has studied static as well as dynamic settings. The survey is divided into two main parts. The first one deals with simple marketing channels having one supplier and one reseller only. The second one covers marketing channels of a more complex structure, having more than one supplier and/or reseller.

In the first part we find that a number of results carry over from static to dynamic environments. We also find that the work on static models is quite homogeneous, in the sense that most papers employ the same basic consumer demand specification and address the same situations of vertical integration and noncooperative games with simultaneous or sequential actions. The work on dynamic problems of cooperative advertising also shows some similarities.

The second part shows that models incorporating horizontal interaction on either or both layers of the supply chain are much less numerous than those supposing its absence. Participation rates in co-op advertising programs depend on inter- and intra-brand competition, and participation may not always be in the best interest of the firms in the marketing channel.

1. Introduction

Cooperative advertising is an arrangement between a supplier and a reseller where the reseller's expenditures on local promotional activities are partly paid by the supplier. For example, a retailer may receive one-half of the cost of advertising the supplier's product or service, most probably subject to some upper limit (e.g., 10% of purchases in a given period). Another arrangement is one where the supplier pays an advertising allowance as fixed amount per unit sold of the supplier's product. Lump sum payments have also been seen. Cooperative advertising is often used in consumer goods industries and monetary support from manufacturers is a major part of a retailer's budget for local advertising.

For a supplier, cooperative advertising is an instrument to increase immediate sales at the retail level. When engaging in co-op advertising, a supplier can take advantage of the lower local advertising rates (for newspaper space or television time) that apply to retailers. Moreover, the retailer usually has better information on local market conditions than the supplier. Such information is useful when designing a plan for local promotional activities.

To understand the problems of cooperative advertising it is useful to keep in mind that members of a marketing channel (supply chain) in the vast majority of cases are independent business firms. This means that each firm is free to make decisions that are in its own best interest and need not be concerned with the interests of other channel members. It is well known in marketing channel and supply chain literature that such "uncoordinated" decision making most likely will damage the financial performance of the channel as a whole. The coordination problem asks the question if incentives or contracts can be designed such that, when implemented, they will induce channel members to make those decisions that are in the best interest of the channel.[1] Many mechanisms have been suggested in the literature. In deterministic demand settings we see, for example, quantity discounts, profit or revenue sharing, advertising allowances (lump sum or a fixed amount per unit sold), local advertising cost-sharing, and two-part tariffs. If consumer demand is treated as random, mechanisms are available with the typical purpose of reducing the risk taken by resellers (by being under- or overstocked).

The literature on co-op advertising has used two main approaches. The *first approach* is where (independent) firms in a

☆ We wish to thank three anonymous reviewers and Editor Robert Dyson for very helpful comments. Any remaining errors are the responsibility of the authors. The second author's research was supported by NSERC, Canada.

* Corresponding author. Tel.: +1 514 3406430.
E-mail address: georges.zaccour@gerad.ca (G. Zaccour).

[1] Typically this is taken to mean that channel members' decisions maximize the overall channel profit.

0377-2217/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.ejor.2013.12.017

channel, for any reason, do not wish to cooperate and implement a channel-optimal solution. Nevertheless, the supplier wishes to support retailers' local advertising. Such problems are formulated as games, played by non-cooperating players. If no player knows the decision of her opponents when making her own decision, the game is one of simultaneous moves and the standard "solution concept" is the *Nash* equilibrium. However, it may happen that one player (the "leader") has a first-mover advantage and can decide and announce her strategy before the other players ("the followers") decide. In such games the standard solution concept is the Stackelberg equilibrium. The *second approach* is to assume a situation in which all channel members decide to collaborate and implement strategies prescribed by (typically) the joint profit-maximizing solution. Mathematically, this is a one-person optimization problem.

The study of cooperative advertising in a marketing channel, using an optimization approach, probably originated with the paper by Berger (1972) although cooperative advertising had received the attention of researchers much earlier; see, e.g., Lyon (1932), Hutchins (1953), and Lockley (1957). Lyon's paper on advertising allowances, although it did not contain a mathematical model, may be the first analysis of the problems of cooperative advertising. In practice there has been an increasing use of cooperative advertising. Nagler (2006) estimate the total expenditure in 1970 in the US on cooperative advertising to be $0.9 billion. By 2000 that amount had grown to $15 billion and estimates for 2007 report an amount of $25 billion (Chutani & Sethi, 2012b). Cooperative advertising support definitely is important for retailers: Dant and Berger (1996) report that 25–40% of retailers' local promotion expenditures (including advertising) are funded by manufacturers.

To present the literature we make use of the notation stated in Table 1. Notation (mainly Greek letters) not appearing in the table are nonnegative constants. We shall label a retailer by $r \in \{1,2,\ldots,\mathcal{R}\}$ and a manufacturer (or his brand) by $m \in \{1,2,\ldots,\mathcal{M}\}$. With a few exceptions, which are easy to see from the context, we use capital letters for variables and parameters pertaining to manufacturers and small letters for retailers. When time is involved, we denote it by t and time-dependent variables have t as an argument.[2]

The survey is organized as follows. Section 2 presents literature dealing with the simple marketing channel having one manufacturer and one retailer. This section is divided into two parts where the first one surveys static models. The second part concerns dynamic models, written in continuous time as differential games or optimal control problems. Each part makes a distinction between models with advertising only and models with advertising and other decision variables. Section 3 has the same structure as Section 2 and deals with more complicated models of marketing channels with multiple manufacturers and retailers. Section 4 concludes.

Surveys that complement the present one are Sethi (1977) and Feichtinger, Hartl, and Sethi (1994) dealing with optimal control models in advertising, Erickson (1991), Jørgensen and Zaccour (2004) and Huang, Leng, and Liang (2012) are concerned with for differential games in advertising. Finally, He, Prasad, Gutierrez, and Sethi (2007) and Ingene, Taboubi, and Zaccour (2012) survey game-theoretic models in supply chains and marketing channels.

2. One-manufacturer, one-retailer marketing channel

This section deals with the simplest possible marketing channel where a supplier sells a particular product or service through a single reseller. In the literature it is customary to refer to the two channel members as the manufacturer and the retailer. Henceforth the manufacturer is a "he" and the retailer is a "she". To motivate the assumption of a single retailer one may think of a situation in which the retailer is the manufacturer's exclusive dealer in a certain market area. The two-firm marketing channel clearly is an extreme case as it disregards competition among manufacturers and among retailers. Also competition between channels is disregarded. More complex channels like these will be considered later on in the survey.

Table 1
Main notation used in the survey.

D_r^m	Consumer demand at retailer's outlet r for brand m
a_r^m	Local advertising effort/expenditure of retailer r for brand m
A_m	National advertising effort/expenditure of manufacturer m
c_r	Unit processing cost of r
C_m	Unit production cost of m
S_r^m	Advertising support rate offered by m to r
p_r	Selling price of r
W_r^m	Wholesale price of m charged to r
π_r	Profit margin of r
Π_m	Profit margin of m
J_r	Profit function of r
J_m	Profit function of m
$G_m(t)$	Goodwill stock (brand image) for brand m
$R_m(t)$	Reference price of brand m
$Y_m(t)$	Fraction of market aware of brand m

We present the literature by making a categorization according to the time horizon of the cooperative advertising model. Section 2.1 is devoted to static models while Section 2.2 deals with dynamic models cast in continuous time.

2.1. Static models

A static game model assumes that players (firms) decide for one period only. The environment – as reflected in consumer demand functions, profit functions, and the roles players have in the game – is fixed. The implications of current decisions on the players' future situation and opportunities are left out of consideration. Despite its strong assumptions, a static model may be a reasonable modeling choice in circumstances where the decision environment is fairly stable and today's decisions do not have significant consequences beyond the current period. Indeed, in game theory, economics, and operations research, valuable insights have been gained from the study of static models. Results coming from static models should, however, be put to the test in a dynamic setup where the environment no longer is stable, players can (if they wish) learn from the game history, stocks can be accounted for, and so forth.

This section presents papers that consider advertising only and others that look at advertising and additional decision variables, typically pricing. We shall observe a considerable similarity among the papers, in terms of modeling, analysis, and results. To avoid unnecessary repetition we have chosen to report for each paper the principal model components (consumer demand function and profit functions of channel members), which decision problems are studied, and what are the novelties of a paper. For the benefit of the reader we have – at the end of Section 2.1 – consolidated the lessons that might be learned from the literature surveyed.

2.1.1. Models with advertising only

A seminal paper in this area is Berger (1972) who considered a situation in which the manufacturer offers an advertising allowance to the retailer. The manufacturer produces at unit cost C and charges wholesale price W per unit sold to the retailer. The latter has a unit margin (before paying the wholesale price and before receiving the advertising allowance) of π. The manufacturer pays

[2] When the supply chain involves a single manufacturer and a single retailer there is no need for indices and superscripts.