New Product Advertising in Dynamic Oligopolies

E. J. Dockner and S. Jørgensen

Abstract: The success of the introduction of a new product in a market is very sensitive to the marketing decision variables adopted by the firm. In the present paper we are concerned with the question of new product advertising in a heterogeneous oligopoly market consisting of N firms. A dynamic game is formulated to model strategic as well as sales interactions in such a market. Optimal advertising strategies are identified as open-loop Nash solutions.

Key words: new product advertising, differential games, diffusion models, open-loop Nash equilibrium.

1 Introduction

In dealing with policy questions in marketing, attention has to be paid to two major characteristics of real world markets: dynamics and competition. Although static theory has a long tradition in applied economics and marketing, a deeper understanding of markets and market behavior requires a dynamic modelling. Ultimately, this has to result in the use of dynamic optimization techniques rather than one-shot considerations. Indeed, in the last 15 years there has been a growing interest in applying control theory to marketing problems, cast in the framework of sales response models or diffusion models of new product innovation. In the area of advertising this has led to a considerable number of articles and models (see the survey papers by Sethi (1977) and Little (1979); for the application of diffusion models of new product innovation see the recent book by Mahajan and Wind (1986)). The use of dynamic models permits a study of the influence of current advertising on future demand and the resulting

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intertemporal trade-offs. Most of the literature, however, deals with single firm
models and hence does not incorporate competition. As pointed out, competition
is an important feature of markets and should explicitly be taken into
account. Competition is here supposed to mean strategic interdependencies and
interactions between a smaller number of firms acting in the market.

Differential games theory is an appropriate technique to study competitive
encounters among firms in a dynamic environment (market). In this paper we
are primarily interested in optimal advertising policies for firms acting in new
product markets and do not study price competition. Such an analysis is done
in Dockner and Jørgensen (1988b). We use the theory of diffusion models to
formulate general demand equations. It is assumed that firms are controlling
their advertising expenditures in order to maximize the discounted stream of
profits and we assume that unit production costs are declining with cumulative
production volume, i.e., we incorporate the cost learning curve phenomenon.
Firms are planning for a fixed and finite time period and optimal advertising
policies are open-loop Nash equilibrium strategies.

Teng and Thompson (1983) (see also Thompson and Teng (1984)) were among
the first to study competitive advertising diffusion models. They extended the
Bass model (Bass (1969)) by incorporating advertising into the innovation and
imitation coefficients, respectively. Thus, their approach reflects the one used by
Horsky and Simon (1983) for the monopoly case. Horsky and Simon, however,
only considered advertising dependent innovation coefficients. A major diffi-
culty with the approach of Teng and Thompson is, that, due to the complexity
of their model, they had to use numerical techniques to find the optimal advertis-
ing policies. Although they developed an efficient algorithm for solving the
game, their results are obviously only valid for particular parameter situations;
general conclusions cannot be drawn. In this paper we use an analytical ap-
proach to study competitive advertising diffusion models in a general setting as
is mathematically tractable. This will yield policy conclusions for broad classes
of demand and cost functions. As can be imagined, additional assumptions have
to be made for our approach to carry through. Nevertheless, a certain degree of
generality can be maintained. The study of flexible advertising diffusion models
for the monopoly case is done in Dockner and Jørgensen (1988a). In the present
paper we approach oligopolistic competition.

The paper is organized as follows: In Section 2 we present the basic model and
motivate each of its elements. Section 3 contains the main results. In this section,
some subclasses of the general model are also discussed: (i) the static demand
case, i.e., competition with advertising effects only; (ii) competition with advertis-
ing and firm specific adoption effects and (iii) an extension of the Horsky and
Simon (1983) model to incorporate competitive encounters. Section 4 concludes
the paper.