LEONARD S. SIMON

MARSHALL FREIMER

Analytical Marketing

THE HARBRACE SERIES
IN BUSINESS AND ECONOMICS

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Foreword

Management science is rapidly taking its place as an important underlying discipline of marketing. Mathematical models are being used more and more as aids in problem solving, and the advice of model builders is being sought in an ever wider range of situations. The growing importance of this field is confirmed by the number of "quantitative marketing" books and articles now being published.

The turning point in the application of quantitative methods to marketing came when management scientists were able to demonstrate practical uses for formal models and their machinery, such as probability theory, statistical inference, and mathematical programming. Conceptual models and general theories are useful, especially in an elementary exposition of the subject, but they do not nearly exhaust the power of formal methods. The hallmark of the successful book on applied management science is the degree to which it deals with models that are directly relevant to decision making. Thus, a book on quantitative marketing must stress models and model building.

This approach depends as much on the marketing insights of the authors as on their mathematical abilities. Taken together, the authors of *Analytical Marketing* represent a rare combination of training and experience in marketing management and quantitative skills. They have developed sophisticated models and applied powerful techniques, while keeping marketing relevance paramount.

Analytical Marketing is not intended to be merely a survey of management science applications in marketing, although, in fact, a great many applications are covered. Rather, it is designed for the student who wishes

to investigate the structure of representative marketing models, to determine the critical factors in their design and application, and to assess their adequacy. In other words, this book is for the serious student of marketing models—the person who may one day participate in their creation. It is a book on harmony and composition, rather than on music appreciation.

The authors have expended considerable effort to provide a broad coverage of the basics of marketing management as well as the applications of models. This is important because management concepts and modeling considerations are closely intertwined in practice. Students who have already studied marketing management will have a context in which to test the applicability of the models. Students of quantitative methods will be able to learn about marketing management as they go along. Thus, *Analytical Marketing* should be relevant to both the marketing student with a quantitative interest and the student of management science who wishes to apply his skills in this exciting and rapidly growing field.

William F. Massy

Preface

This book stems from a latent need we perceived in our joint research work. During our construction of analytical models for various decision problems in marketing, the question arose as to whether the type of output we were producing would be taught to students specializing in marketing. A search of available materials revealed that there was no marketing text of a level adequate to enable students to evaluate and criticize quantitative research work in marketing. We were not under the illusion that many students would want to develop sufficient skills to be researchers. Rather, it was our belief that the coming generation of marketing managers would wish to have a sufficiently good command of analytical models and their uses that they could provide appropriate and comprehensible guidance to those persons immediately responsible for conducting marketing research efforts. At the same time, the reasonably well trained manager could maintain a critical faculty for evaluating the output of these researchers. Thus, we found the necessary stimulation to write this book from the joining of our belief about the future character of marketing management with the existing lack of appropriate text materials.

Analytical Marketing can be used in any of several ways. Probably, it is most generally suitable for an advanced marketing management course in which the instructor wishes to emphasize the analytical tools available for attacking decision problems in the principal policy areas in marketing. However, it could also be used in conjunction with a more traditional, descriptive, and less quantitative text in an introductory marketing management course or, possibly, with several other texts, each representing a principal policy area such as advertising or sales force management.

The student must bring to this text more than a cursory knowledge of mathematics if the proper benefit is to be derived from the analytical materials. Both elementary probability theory (as contained, say, in a first course in statistics emphasizing theoretical underpinnings) and mathematics covering the basic concepts of the calculus and linear algebra are requisites for the materials discussed. On the other hand, we have attempted to provide each model described with the following framework: (1) a delineation of the assumptions on which the model rests; (2) suggestions as to how else the problem might have been attacked; and (3) discussion of the applicability of the results, particularly emphasizing whether the models are primarily useful for the insights they yield or because they produce valid solutions to real world problems. We may have not succeeded in accomplishing all of this in every case, but at least it should be clear to the student that we are not merely running through a series of mathematical exercises.

Chapters 2, 3, and 4 review some of the mathematical training we feel is desirable and also introduce certain other material generally applicable to managerial decision making in marketing. These introductory chapters are also referenced at many points in succeeding chapters when it might be advisable for the student to refresh himself regarding the mathematics in a particular analysis. Chapters 5 through 9 discuss each of the basic policy areas in marketing. Chapter 10 focuses on mathematical approaches to the analysis of consumer behavior, which—although not a policy area—is of pivotal importance to decisions in the policy areas and frequently the vehicle by means of which the effects of such decisions are assessed. Chapter 11 is a brief introduction to the concept of management information systems applied to marketing. This area, an entirely separate subject in itself, is introduced here primarily to alert the student to the magnitude of the problem of structuring an adequate data base in order to utilize the models discussed in earlier chapters.

The book concludes with a series of five case studies, each derived from a real situation. These cases are of a sufficiently broad nature that materials from many different sections of the text may be applied in developing solutions. However, it is our hope that students will not confine themselves solely to the application of models from the text but will employ the more basic methodologies or tools to structure new, possibly unique, approaches to the managerial problems presented. The cases are offered primarily for their illustrative value and are not intended to represent either good or bad managerial practices.

Any book is the product of the ideas of many people. We are particularly indebted to the vast number of researchers whose earlier work produced the models and analytical techniques discussed here. Numerous colleagues have offered criticism and advice that have strengthened the book; in particular we would like to thank Marcus Alexis, William Gavett, George Haines, and P. S. R. S. Rao. Lawrence Bumpus, Douglas Dobson, Walter

Foertsch, Robert Gagan, and Linda Reinschmidt are a few of our students who deserve special note for their help in the preparation of the cases. We also owe a major debt to the many executives who gave so freely of their time in helping us develop the case materials. William Massy contributed far more than could reasonably have been expected of an advisory editor. For the necessary financial support, we are indebted to the Ford Foundation, Community Savings Bank, and Dean William Meckling of the College of Business Administration of The University of Rochester. Finally, a special note of thanks is due to Elizabeth Eggleton, Janet Evangelista, Rochelle Plascoe, and Martha Riley, who struggled through typing, editing, and proofing the numerous versions of this manuscript. We confess complete responsibility for the final product, although the temptation is great to make all jointly liable.

Leonard S. Simon
Marshall Freimer

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MODELS AND DECISION MAKING IN MARKETING

CHAPTER ONE

Our purpose in this chapter is to provide some of the history and rationale for mathematical analysis of marketing problems. In addition, we suggest how such work may be applied in the construction of a total marketing strategy for the firm, and we end by reviewing the factors that will most strongly influence future developments.

Mathematical models in marketing

The use of mathematical techniques in marketing is by no means new. Even the early marketing researchers performed fundamental, classical statistical analyses on the information they had collected. But the mathematical techniques employed and the attitudes of the people developing and utilizing them have become more sophisticated. Where the marketing researcher may once have been satisfied with a nose count and a few logical inferences from the data, he now concerns himself with building models of real-world processes from which he can draw inferences regarding the marketing environment. Similarly, where an executive may once have been satisfied merely to accept results and interpretations from researchers, he may now demand an explanation of the underlying structure of their work and evaluate for himself the credibility of their assumptions. This change in philosophy and operations has made it necessary for marketing managers to be conversant with mathematics as it may be applied to marketing decision making. One objective of this book is to encourage the development and use of the necessary skills. A second objective is to provide those who prefer the analytical work of constructing models and analyzing data with a

taste of the probable future character of analytical marketing. If we do our job well, we should help managers and staff analysts to improve their communication with each other and to become more cognizant of the particular contributions each can make in building models of marketing processes.

Since the early 1950s, the scope of the mathematical techniques employed in marketing has expanded so far beyond the classical statistics that there probably no longer exists any class of marketing problems that has not been attacked with a mathematical model. The principal reason for this change is the development of operations research techniques, beginning with their application to military problems in World War II and followed by their rapid absorption into industrial environments after the war. Marketing has probably been the slowest of the functional areas in industry to adopt the tools of operations research. This is not because the problems are not amenable to such tools, but rather because it is so much more difficult to identify cause and effect in marketing than in, say, production or finance. For instance, the production planner knows that if a certain process is carried out, the product is altered in a particular way. Unfortunately, the interrelationships are not that clear-cut in marketing; for example, no one has yet been able to describe precisely how advertising affects sales volume. The problem is additionally complicated by the fact that it is not always clear what variables are relevant to a particular marketing problem. To illustrate, if we were exploring the question of the rate at which a new product would be adopted by the consuming public, could we unequivocally identify the total set of appropriate variables on which to take measurements?

The second enormous difficulty in marketing involves the question of measurement. What is an appropriate measurement of a specific consumer attitude that affects the decision to purchase a product? If we could decide what to measure, how would we scale it? Moreover, the definition, measurement, and scaling problems in marketing are particularly complicated by the question of allocation. In a production process, we may clearly demonstrate that a given machine has been responsible for producing certain defects. But in marketing, if we examine a given sales territory, we cannot necessarily attribute all the sales in that territory to the salesman's effort; advertising and technical service, for example, may have played a major role in helping that salesman achieve a particular level of success, but their contribution is not readily determinable.

Our principal concern in this book, however, is not with the philosophy of measurement. Our goal is to give the reader a feeling for the principal decision areas in marketing and how their problems can be attacked with mathematical techniques. We do not wish to embroil ourselves with the questions of scaling, measurement, accuracy and validity of data, and so on, in each model we present. On occasion, we have made comments on such questions, but appropriate treatment of them in every case would be impractical. Rather, we hope that, once he has been seduced into modeling market-