

# Developments In Business Simulation & Experiential Exercises, Volume 22, 1995

## AN ANALYTICAL ADVERTISING MODEL APPROACH TO THE DETERMINATION OF MARKET DEMAND

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### ABSTRACT

The dynamic nature of decision-making in business enterprise simulations depends on the computation of aggregate market demand. The aggregate demand models in simulations are essentially based on the economic model of an oligopoly industry. Despite the mathematical rigor in which the models of market demand are incorporated in business simulations, these models in many aspects are gross over simplifications of the real world. The major weakness of the aggregate market demand model in business enterprise simulations is the simplistic treatment of the advertising decision. This paper presents a proposed demand model, which places primary importance on marketing concepts.

### INTRODUCTION

Advertising in microeconomic models is treated as a parameter that causes a shift in the demand curve. Consequently, this same limited viewpoint generally prevails in business enterprise simulations. The inadequate modeling of the advertising variable diminishes the perception of simulation realism. This lack of a realistic advertising model in simulations has been noted several times in simulation literature. In a paper in which he argued for noncompensatory demand functions Lambert (1979) stated:

While the lack of a comprehensive theory of the behavior of sales in response to marketing tactics is a handicap, still every effort must be made in designing these simulations to insure that sales behavior at least appears plausible.

More recently, Carvalho (1993) pointed out the inadequate treatment of advertising in simulations:

Market demand functions do not model individuals' purchase decision processes; they model a condition or state of affairs in the market. A market demand function indicates the quantity that will be purchased at each price by all people in the market. The process by which an individual buyer arrives at the decision to buy or not buy a particular product is not modeled by the market demand function.

Advertising is a far more complex variable than treated in

most business enterprise simulations. Cannon (1984) contended that the teaching of advertising should be based on more theory:

Nevertheless, with the maturation of advertising as a discipline, many of us have begun to search for a less descriptive, more theory-oriented approach. We would like our courses to teach students how to make the decision that older texts simply describe-- how to formulate advertising strategy, how to make media selection, how to set advertising budgets, and so forth.

The implication of Cannon's comments regarding simulations is somewhat obvious. Advertising in business simulations should be based on current marketing theory rather than the early economic models of demand

### NEED FOR AN IMPROVED ADVERTISING MODEL

The need for an improved model of advertising as one determinant of market demand is evident when it is realized that current simulations still adhere to the simplistic economic treatment of advertising.

The aim of advertising is both to shift to the right the demand curve faced by the individual seller and to make it less elastic . . . The purpose of advertising is not simply to attract a greater buying public for a product, but to attract consumers away from the competition. (Albrecht, Jr., 1974)

The economic view that advertising is no more than an assigned value to a single parameter in a demand equation undermines the real importance and complexity of advertising in the decision-making process.

Examples of the standard treatment of advertising in aggregate demand models can be found in two articles by Gold and Pray (1982, 1984). They defined aggregate demand as:

$$Q = g_1 P^{-(g_2+g_3)} M^{+(g_4-g_5)} R^{+(g_6-g_7)}$$
 In this equation, advertising or M (marketing expenditures) is simply a parameter in the total equation. The model requires no more than finding the sum of the advertising budgets of the different firms in the industry. Important advertising variables and parameters are

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excluded from this aggregate demand model. Furthermore, another basic problem with the aggregate demand model, as traditionally used in business simulations, is that when advertising is increased it is not clear whether the increase in market demand is the result of more potential customers in the market or because a higher percentage of the same potential customers have purchased. In the first instance, more salesmen to make calls would be required; and in the second instance, an increase in the sales-calls ratio is implied. Also, it is not clear whether all customers in the market are buying, and if so, whether some customers are purchasing more units than others. The concept of buyers and nonbuyers in the market is not recognized in aggregate demand models currently being used.

The assumptions underlying the advertising decision in the aggregate demand model do not allow the simulation designer to provide any meaningful information that can be used by the decision maker to make a thoughtful and analytical advertising decision. For example, in most simulations no definition of the potential market size is given. Consequently, the decision for budgeted advertising is at best a guess. In order to simulate reality, the decision-maker should be given some market demographics that makes possible meaningful analysis.

The primary objective here is to develop a model that provides the firm (student decision-maker) with a rational basis for determining how much to advertise. Specifically, the objective is to answer the questions: (1) what are the elements and variables that must be considered in determining the size of the advertising budget, and (2) what is the nature of a model that incorporates these variables?

### **THE NATURE OF ADVERTISING**

Advertising is recognized to be a strategic management decision involving different levels of complexity. Consequently, the model being presented does not pretend to encompass all aspects of advertising. The total advertising decision involves other factors such as the advertising message, the selection of media, timing of advertising, and methods of evaluating results. This paper is not concerned with these elements and is limited to the development of a model that realistically deals with the advertising budget decision. An excellent definition of advertising that provides the basis for an improved theory has been provided by Cotler (1967):

The purpose of advertising is to make potential buyers respond favorably to the firm's offering. It seeks to do this by providing information to customers, by trying to modify their desires, and by supplying reasons to prefer the particular company's products.

The definition provides several important clues about how to develop a more analytical and realistic model of advertising. The definition makes clear that advertising informs customers. Without advertising customers are uninformed and, therefore, are unable to purchase. Consequently, two important concepts are implied: informed customers and uninformed customers. Uninformed customers, of course, are nonbuying customers. Also, from real world experience we know that even some informed customers do not always purchase. Consequently, two other useful concepts emerge from the definition of the purpose of advertising: buying customers and nonbuying customers.

The decision-maker in making the advertising budget decision at a minimum would probably ask the following questions:

How many potential customers are in the market?

What dollar amount of advertising is required to reach one potential customer?

What effect does repetition of the same message have on response to the advertising?

What will be the response of customers to the amount budgeted advertising?

The analytical advertising model being presented does directly address these questions.

### **BASIC THEORY OF AN ANALYTICAL ADVERTISING DEMAND MODEL**

From experience we know that some customers may be more informed than others. A customer who has seen an ad several times may be more informed than one who has seen an ad only once. Repeated exposure increases the desire to buy. Therefore, the need to measure the degree of being informed results from the concept of an advertising exposure index.

When the concepts of informed customers and uninformed customers and buying customers and nonbuying customers are recognized, a functional relationship may be established between the exposure index and the candidates for a sale percentages. This relationship may be called the

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proportion of response function. This functional relationship then provides a foundation for a more realistic and analytical model to the determination of market demand. This function is illustrated in Figure 2.

When it is recognized that the market consists of buying and nonbuying customers, it is then axiomatic that the percentage of customers purchasing in a given period will be less than 100%. The percentage of the potential market that respond to advertising may be called candidates for a sale.

Based upon the above analysis, the development of an analytical advertising model at a minimum would include the following concepts:

1. Potential customers (maximum market size)
  - Informed customers
  - Uninformed customers
  - Buying customers
  - Nonbuying customers
2. Advertising cost per customer
3. Exposure index
4. Proportion of response function
5. Industry candidates for a sales
6. Proportion of purchase function
7. Firm candidates for a sale

The analytical advertising demand model being proposed is summarized as in Figure 1.

### Potential Customers

The market for a product consists of an identifiable segment or class of individuals who can benefit from the use of the product. These individuals may be labeled potential customers. Some potential customers readily perceive a benefit and require very little advertising. Others potential customers have no or very little knowledge of the product but are capable of benefiting or being influenced by advertising.

Some potential customers will never purchase the product regardless of the amount of advertising. Consequently, the response to advertising will always be less than 100%. Separately identifying or isolating these different types of potential customers is difficult if not impossible. Therefore, the all customers of the market must be the target of advertising.

A potential customer can be a candidate for a sale of more than one firm in the industry. A potential customer who is a

candidate for sale of more than one firm will eventually select only one industry firm from which to purchase in a given period. The selection of the specific firm is affected by both the number of ad exposures and the advertised price. The number of customers that actually purchase can also be a factor of the number of salesmen, credit terms, and quality of products.

Some potential customers in a market require more than one unit of advertising to be a candidate for a sale. Consequently, the repeat exposure of the same advertising will prove beneficial. The repeat exposure of an ad is a determinant of market demand. Potential customers are more likely to purchase as the exposure to advertising increases.

An essential element of the analytical model of demand is a functional relationship between the exposure index and the percentage of potential customers responding to advertising.

### Advertising Cost per Customer

Advertising can be treated as if it consists of discreet units. For example, one flyer or one brochure is a discreet unit. Even TV and radio advertising can be considered to consist of discreet units. If 5,000 out of 50,000 potential customers are viewers of TV at a specific time slot, then a one-time ad may be considered as consisting of 5,000 units of advertising. A discreet unit of advertising can be assigned a specific cost per unit.

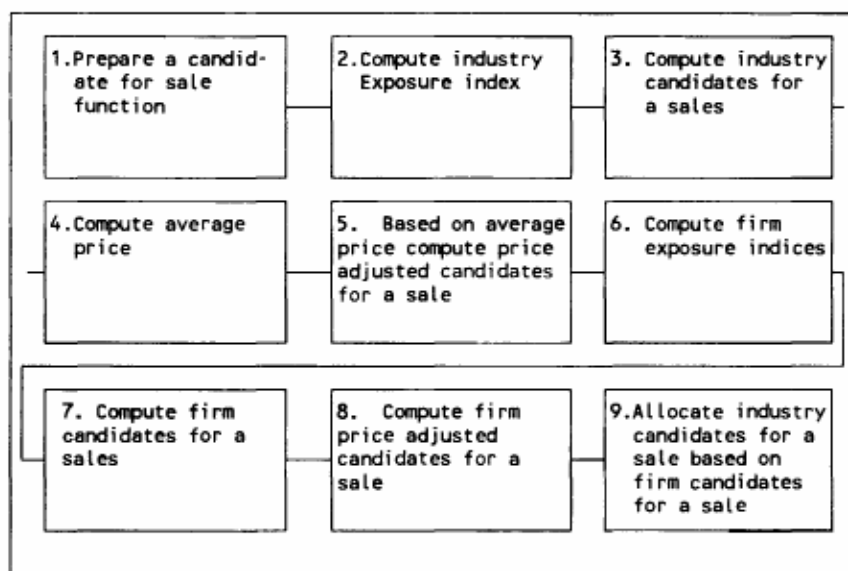
Given the number of potential customers, the advertising cost per unit, and the desired exposure rate, the preparation of the advertising budget becomes a relatively easy task. If the advertising cost per potential customer is known, then the total advertising required to inform all potential customers would be:

$$TRAC = ACPC \times TPC. \quad (1)$$

*TRAC* - Total required advertising cost  
*ACPC* - Advertising cost per customer  
*TPC* - Total potential customers

The amount of advertising required to expose the total potential market to an ad can be easily calculated. However, the unknown factor is the number of exposures necessary to cause a desired percentage of the market to respond. Therefore, the number of times to repeat an ad becomes an important decision.

**Figure 1 Diagram of Analytical Demand Advertising Model**



This industry exposure index may be computed:

$$EI = \frac{\sum ADV_i}{(ACPU \times TPC)} \quad (2)$$

$ADV_i$  - Budgeted advertising of individual firms

$EI$  - Exposure index

$ACPU$  - Advertising cost per unit

$TPC$  - Total potential customer or market base

An index of 3, for example, would indicate that potential customers on the average were the recipient of 3 units of advertising.

## Importance of the Industry Demand Curve

In the model being proposed, the industry demand curve applies only to informed customers who have made a conscious decision to seriously consider purchasing in the current period. Since the number of informed customers can vary significantly with the amount of advertising, the demand curve must be presented on a relative (percentage) basis. Rather than showing units at each price, the demand curve must be restructured to show the percentage of the informed customers that will purchase at a given price. The relationship of price to the percentage purchasing may be called a proportion of purchase distribution function.

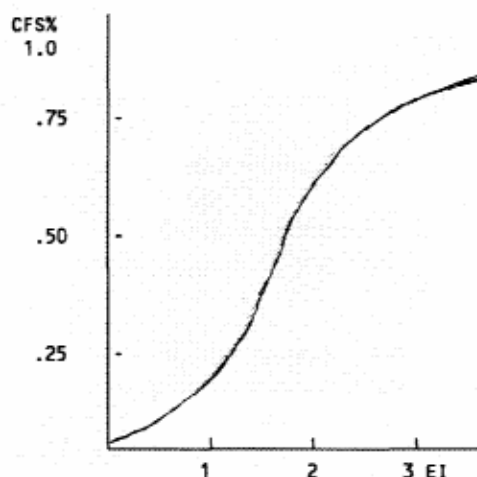
In Figure 3, a traditional demand curve converted to a proportion of purchase distribution is illustrated. The details and mechanics of constructing this distribution is explained in a later section.

There is no need in the proposed model for both an industry demand curve and an individual firm demand curves as required in the traditional aggregate demand models. What is being allocated is not units sold but rather informed customers willing to buy (candidates for a sale ) from a specific firm. Allocation is accomplished by using firm candidates for a sale rather than units of product. This model requires calculation of candidates for a sale from both the firm and industry viewpoints.

## Computing Industry and Firm Exposures Indices

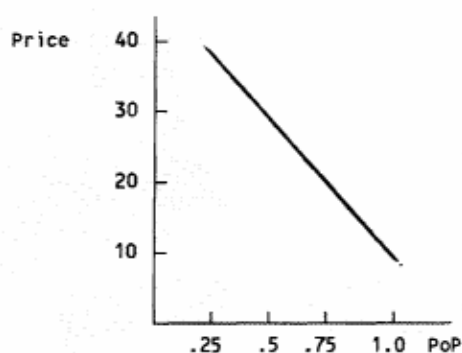
Because the proposed advertising demand model depends on the extent to which customers have been informed, the calculation of both firm and industry exposure indices are required. The calculated exposure index identifies the appropriate firm and industry candidates for sale percentages.

**Figure 2. Proportion of Response Function**



**Figure 3. Proportion of Purchase Function**

Price	Quantity	Proportion of Purchase
40	10	.25
30	20	.50
20	30	.75
10	40	1.00



The industry exposure index is the average number of times that individuals in the market have been the recipient of ads from all firms. The total includes all repeat exposures of the same ad.

## Proportion of Response Function

As previously mentioned, a functional relationship exists between the industry EI and the percentage of potential customers who become candidates for a sale. The percentage of the candidates for a sale in response to advertising is a type of effectiveness index. This relationship is illustrated in Figure 2. The functional relationship between the exposure index and the percentage of customers responding can be easily programmed by using Goosen's and Kusel's (1993)-interpolation method.

## Industry Candidates for a Sale

A customer who has been informed by one or more units of advertising and who has been favorably impressed may be defined as a candidate for a sale in the current period. The total number of industry candidates for a sale in a given time period is a direct function of the total firm advertising and advertised price.

The exposure index, as explained above, can be used to identify the candidate for a sale percentage. This percentage

then can be used to compute the total number of industry candidates for a sale:

## Proportion of Purchase Function

The industry TCFS (equation 3) has been computed without regard to price. Unless all firms have set the lowest possible price, not all candidates will purchase. Therefore, the TCFS must be adjusted for the industry price. The industry price which is an average of firm prices may be calculated:

$$TCFS' = CFSP \times TPC \quad (3)$$

*CFSP* - Candidate for sale percentage

*TCFS'* - Total industry candidates for a sale

*TPC* - Total potential customers

Given the IP, then the appropriate proportion of purchase percentage can be determined and used to compute the industry price adjusted candidates for a sale.

$$IP = \frac{\sum P_i}{N} \quad (4)$$

*IP* - Industry price

*N* - Number of firms in industry

The appropriate proportion of purchase percentage is found by reference to a proportion of purchase function such as the one illustrated in Figure 3. For example, at a price of \$30, the proportion of purchase percentage would be 50%. The PACFS will be allocated to each firm according to each firm's share of the total of all price adjusted candidates for a sale.

$$PACFS = TCFS_i \times PPP \quad (5)$$

*PACFS* - price adjusted candidates for a sale

*TPC* - total potential customers

*PPP* - proportion of purchase percentage

## Computation of Firm Candidates for a Sale

Computations of the candidates for a sale of each firm involves:

1. Computing the Exposure Index (EI) of each firm
2. Computing the total candidates for a sale before price)

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3. Computing the price adjusted candidates for a sale
4. Allocating the industry price adjusted candidates for a sale according to the ratios of the firms' price adjusted candidates for a sale.

The firms' EI's may be defined as:

$$EI_i = \frac{ADV_i}{(ACPU \times TPC)} \quad (6)$$

**$ADV_i$**  - advertising budget of a specific firm  
 **$ACPU$**  - cost per unit of advertising

Given the EI of each firm, the candidates for a sale percentage can be determined by reference to the same functional relationship used in computing the industry TCFS (See Figure 2).

Since it has been assumed that the response to advertising and the willingness to purchase is affected by advertised price, the candidates for a sale of each firm require adjustment for a price weight. The lower the price, the higher the weight.

$$CFS_i = CFSP_i \times TPC \quad (7)$$

**$CFS_i$**  - Total candidates for sale of a specific firm  
 **$CFSP_i$**  - Candidates for a sale percentage of each firm  
 **$TPC_i$**  - Total potential customers

The allocation percentage of each firm then may be computed as:

$$CFSAP_i = \frac{(CFS_i \times PW_i)}{\sum (CFS_i \times PW_i)} \quad (8)$$

**$CFSAP_i$**  - Total candidates for a sale allocation percentages  
 **$PW_i$**  - Price weight (proportion of purchase percentages)

Given the set of allocation percentages, each firm's share of the industry candidates for a sale can be allocated as follows:

$$ACFS_i = CFSAP_i \times PACFS \quad (9)$$

Now that each firm has been assigned its share of the total industry candidates for a sale, other factors, if desired, such as credit and number of salesmen can be brought into play to determine the actual units of product sold by the firm.

### Explanation of Price Weights

To understand the purpose of weights based on price, it is necessary to consider certain attributes of a demand curve. At each price, a specific number of units may be sold. Assuming that each customer purchases only 1 unit, the number of units at each price also represent the percentage of the total market (potential customers) that is purchasing. Consequently, the industry demand curve can be stated as a proportion of purchase distribution independent of quantity.

Assume the following:

Price	Quantity	Proportion of Purchase
\$40	10	25%
\$30	20	50%
\$20	30	75%
\$10	40	100%

Assuming price will never be lower than \$10, the maximum sales (customers) will be 40. At each price the corresponding units can be stated as a percentage of maximum aggregate demand. At a price of \$30 only 50% of the potential market will purchase. At a price of \$30, the proportion of purchase percentage was computed by dividing quantity at the price of \$30 by the quantity at a price of \$10. The quantity at the price of \$40 represents the maximum market demand.

At each price of a given demand curve, the related units can be stated as a percentage of the total market demand. The advantage of using percentages rather than quantity in the demand curve is that a limit to the number of units that may be purchased can be easily specified. Also a shift in demand can be accomplished by simply changing the value of maximum market demand which also happens to be the quantity value at the lowest allowed price.

The proportion of purchase distribution derived from the demand curve permits the elimination of those informed potential customers who are not willing to pay the advertised price. The remaining customers are willing to pay the price. However, because these remaining potential candidates for a sale of firm A may also be willing to buy from Firm B, then an allocation of the industry candidates for a sale must be made according to the price adjusted candidates for a sales percentages of the individual firms.

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### Illustration of Analytical Advertising Model

The proposed model can be easily illustrated. Assume the following data:

TPC = 10,000

ACPU = 2.00

Based on the above assumed data and decisions, the following computations may be made.

#### Candidates for a Sale Function

El	Percentage
.5	.40
1.0	.50
2.0	.75
4.0	.90

#### Industry Demand Schedule

Price	Quantity	Proportion of Purchase
40	10	.25
30	20	.50
20	30	.75
10	40	1.00

#### Price and Advertising Decisions of each Firm

Firm	Advertising:	Price
Fa	15,000	40
Fb	15,000	30
Fc	15000	20
Fd	15,000	10

At an exposure index of 3, the candidate for sales percentage is 82.5%. Given a total market potential of 10,000, the industry candidates before price adjustment for sale would be 8,250. The proportion of purchase percentage at an average price of \$25 is

#### Industry Level:

*Total budgeted advertising* = \$60,000

*Total required advertising* = \$2 x 10000 = \$20,000

*Exposure index (EI)* = (\$60,000 / \$20000) = 3

*Candidates for sale percentage (CFS%)* = 82.5

*Total Industry candidates for sale* = (10,000 x 82.5) = 8,250

*Industry price (IP)* = \$25

*Price adjusted industry candidates for a sale*

*PACFS') = (.825 x 8,250) = 5,156*

62.5%. Therefore, the industry price adjusted candidates for sale would be 5,156. The allocation of the industry PACFS is illustrated in figure 4.

### CONCLUSIONS AND SUMMARY

The advantage of the proposed analytical advertising model is that it explicitly recognizes several important advertising variables. Price has little or no relevance unless a customer knows of the product and knows of the existence of a specific firm. An informed customer is a necessary prerequisite for a sale.

The analytical advertising model approach:

- (1) emphasizes the number of potential customers in a market.
- (2) emphasizes the number of individuals responding to an ad.
- (3) emphasizes the effectiveness of advertising in generating a response.
- (4) emphasizes the competition of firms for the same pool of candidates for a sale.
- (5) allows for each firm to manage other factors in converting candidates for a sale into customers that actually purchase.

Potential customers who have received one or more exposures of an ad become a candidate for a sale if they react favorably to the ad's message. As the exposure index increases, the number of candidates for a sale increases. A potential customers may become a candidate for a sale of one than one firm

Candidates for a sale of each firm then evaluate the firm based on advertised price. Some customers will cease to become a candidate for a sale at this point because the advertised price is too high. However, not all customers reject a firm because it has a higher price. The percentage of customers that continue to be a candidate for a sale after evaluation of price is determined by the appropriate proportion of purchase percentage.

The distribution of potential informed customers that make up each firm's candidates for sale is the same as the distribution of customers as determined by the industry demand curve. Consequently, only a market demand curve presented as a proportion of purchase distribution is required.

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**Figure 4 Allocation of Industry Candidates for a Sale to Individual Firms**

PACFF = 5,156

Firm	EI	CFS%	CFS	PoP (PW)	Price Adj. CFS	CFS%	PACFS
A	.75	.45	4500	.25	1125	.10	516
B	.75	.45	4500	.50	2250	.20	1,032
C	.75	.45	4500	.75	3375	.30	1,548
D	.75	.45	4500	1.00	4500	.40	2,064
18,000				11,250		5,156	

The traditional model allocates aggregate demand in terms of units of product. The proposed advertising model allocates industry candidates for a sale based on the firm's individual candidates for a sale. Total demand in units then is simply each firm's total candidates for a sale multiplied by the average number of units that each customer is assumed to purchase.

The analytical advertising model for determining aggregate demand has now been presented. A comparison of elements and factors with the traditional aggregate demand is helpful in visualizing differences and similarities:

Factors	Traditional Demand Model	Analytical Advertising Model
Industry demand curve	x	
Firm demand curve	x	
Proportion of purchase distr.		x
Proportion of response distr.		x
Average price	x	x
Informed and uninformed customer		x
Exposure index		x
Explicit market potential		x
Allocation weights based on firm demand(units)	x	
Allocation weights based on candidates for a sale		x
Candidates for a sale		x
Percentage of market responding		x

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